

System Commissioning and IAQ

Theodore Cohen, P.E.

INTRODUCTION

I welcome this opportunity to speak with you on a small portion of the commissioning process. Before we get into the details of this discussion, I would like to review the commissioning process as it is developing at this time — from the standpoint of one TAB engineer.

Commissioning is a comprehensive procedure to ensure that HVAC systems are constructed and tested to perform as the design intended. The procedure, in essence, involves close cooperation among the design professionals, installing contractors, and testing agencies to ensure that all components are selected, installed, and verified to ensure optimal performance of the overall HVAC system.

The potential benefits of this procedure are obvious. By ensuring that systems are built and brought into operation properly, building owners can avoid the high cost of modifying HVAC systems after installation.

As an original member of the ASHRAE Guideline committee for commissioning HVAC systems, I have tracked industry's acceptance of commissioning. Already I have noticed that design consultants and a few large construction management firms are adapting portions of the ASHRAE guideline for the commissioning of an HVAC system. They are not waiting for the full-blown program to be completed.

It may be that commissioning will come into use in our industry in this incremental way. Regardless, the point is that acceptance of commissioning is growing.

COMMISSIONING AND IAQ

Recognizing both that commissioning is taking hold and that IAQ is largely dependent on HVAC system operation, it stands to reason that commissioning should be expanded to include IAQ procedures. This addition should not represent any major change in the format of the ASHRAE Commissioning Guideline. IAQ requirements will just be added to the scope of work in building and commissioning HVAC systems.

Let me outline briefly the development of IAQ procedures as I see them and how they fit into the commissioning process. This outline applies primarily to the construction of a new facility. Improving the air quality

in an existing building will be similar, but probably more complicated than for new facilities.

This is how I expect the process to work: the design engineer will incorporate the code requirements and ventilation standards into the design documents. This will include the fresh air ventilation rates and the automatic controls that will maintain the minimum fresh air ventilation rate, regardless of the variations in the total air flow rate, as the load on the system changes. In addition, the air distribution system must be designed so that at minimum air flow to any individual space, the required ventilation rate will be maintained.

These few statements on "fresh air ventilation rates" and "ventilation efficiency" represent new requirements that we do not see in the standard variable volume systems. Let's examine them.

For example, the design documents call for an HVAC system to have the following capabilities:

- a) Maximum supply air flow 20,000 CFM
- b) Minimum fresh air intake 2,500 CFM

This quantity (2,500 CFM) will provide fresh-air ventilation of 20 CFM/person balance the fixed constant exhaust from the building and provide for a slight positive pressure within the building.

All of the requirements for the fresh-air intake — ventilation, balancing the exhaust, and pressurizing the building — are constant operating conditions. They must remain at the same levels regardless of the total air flow rates in the HVAC system.

Let's look at the relationship of constant ventilation air to a total air flow that varies:

Total Air Flow	F.A.I. Vent.	%F.A.I. of Total
20,000	2,500	12.5%
19,000	2,500	13.2%
18,000	2,500	13.9%
15,000	2,500	16.7%

The total air flow rate varies with the thermal load on the building. The ventilation requirement remains constant. We do not see new control systems being applied to provide for these conditions.

In a similar manner, the HVAC supply to an individual office may be required to provide 20 CFM of

fresh air to the occupant. This would make it necessary for the minimum air flow rate to the office to be high enough to include 20 CFM of fresh air.

Automatic controls systems, air flow rates, and TAB procedures will have to change to meet these new requirements.

As part of the construction process the temperature control contractor will set up and calibrate the controls for these functions. The TAB contractor will test and adjust the ventilation rates and the air distribution to meet the IAQ standards and the specification requirements.

At the completion of the construction process, the design engineer or his representative will verify in the field that the submitted documentation for: test and balance, the automatic controls, and the IAQ procedures are indeed "as built" records of the air quality.

The concept of field testing of the installed capacity of the major heat-exchange components and verifying the TAB report and the performance of the automatic temperature control systems is part of the ASHRAE guideline for commissioning an HVAC system. These tests can provide an invaluable source of information to the building owner and the design consultant throughout the life of the facility. Let's look at some of the advantages that these tests could provide:

1) These test reports will pinpoint any deficiencies in the performance of the HVAC system as compared to the design requirements and the occupancy requirements which may have changed since the design documents were prepared. The design consultant can prepare the documents for any modifications and they can be implemented before the occupancy is advanced too far.

2) The as-built records of equipment performance, air and water flow distribution, and the performance of the automatic control systems will be of utmost performance in evaluating future occupancy changes.

At the start of this presentation, I said that implementing these IAQ procedures applies to both new facilities and to existing ones. There is one significant qualification that cannot be ignored. In the process of designing for improved air quality in an existing facility, the design consultant must have a complete current survey of the operation of the HVAC system. It is essential to work from the original design documents, as proposed modifications in unverified documents may not provide the required performance. The survey should be made by a qualified TAB agency, an automatic control expert, and an industrial hygienist.

It is quite possible that the increasing demand for improved air quality in the workplace will drive this facet of the commissioning process into use and perhaps the entire commissioning process into a greater degree of acceptance.

The commissioning process has included these procedures from the start, and I believe that the requirement for IAQ documentation and certification will fit into the process very nicely.

Verification and functional performance testing is, to my mind, the most important contribution that the commissioning process brings to the construction of an HVAC system.

AABC IN COMMISSIONING FOR IAQ

Agencies of the Associated Air Balance Council are prepared to certify their work in these IAQ commissioning procedures. As a result, AABC has been asked to prepare a specification on commissioning. Several engineers stopped at our Anaheim booth at the ASHRAE show with that request. When a consulting engineer asked one of our agencies for an expanded TAB specification to include commissioning, I prepared one. It is being edited now and will shortly be circulated.

This specification states up front: the intent of this specification is to prepare a comprehensive program for a TAB agency to complete a portion of the process of commissioning an HVAC system. The TAB agency will work with the design consultant throughout the project, from the design phase to the final acceptance of the HVAC system.

This is a good deal less than the entire scope of a comprehensive commissioning process, but it is a step in the right direction and we should welcome it.

In the past year, I have been in touch with one owner and one large construction management firm that intends to follow this approach on their projects.

If you are questioning why this approach to commissioning should be made a part of the TAB specification there are several reasons:

1) The TAB agency's work is completely dedicated to the performance of the HVAC system.

2) The verification tests and functional performance tests fall within the capability of many TAB agencies to perform. I expect TAB agencies to be quoting on these services.

THE NEED FOR A MULTI-DISCIPLINARY APPROACH

The important point in any discussion of the various disciplines that may be involved in an IAQ investigation is that there must be a multi-disciplinary approach to the problem.

TAB engineers are not industrial hygienists and do not intend to get into the testing for contaminants that may exist within or outside a facility. Likewise, hygienists, are not experts or knowledgeable in the measurement of ventilation rates, air distribution, ventilation effectiveness, or temperature control.

The important consideration is that several disciplines are required to resolve IAQ problems. A TAB agency, an automatic controls expert, and an industrial hygienist should be involved. All of us in the industry

must accept this multi-disciplinary approach to the development of improved air quality in the workplace.

In my own experience the best results occurred when my TAB agency and an industrial hygienist completed the investigations and reported to a design consultant who prepared the design documents for the required modifications.

Theodore Cohen, P.E., is president of Air Conditioning Test & Balance Co., Inc., a test and balance firm in Great Neck, New York. Mr. Cohen also is president of the Associated Air Balance Council.

Commissioning Specification

(516) 487-6724

THEODORE COHEN, P.E.

AIR CONDITIONING TEST & BALANCE CO., INC.

55 RUXTON ROAD, P. O. BOX 4073, GREAT NECK, N.Y. 11023

MEMBER AABC

TRUBLE SHOOTING AND SURVEYING
AIR & WATER FLOW BALANCING

AIR CONDITIONING SYSTEMS
CONSERVATION OF ENERGY



Associated Air Balance Council

Purpose:

The intent of this specification is to prepare a comprehensive program for a TAB agency to complete a portion of the process to commission an HVAC system. The TAB agency will work with the design consultant throughout the prospect from the design phase to the final acceptance of the HVAC system.

The objective of this program is to bring the HVAC system into operation and performance in accordance with the design intent. In addition, the final documentation will be an "as built" record of the system's performance that will serve as a reliable record for future modifications of the occupancy.

This specification is based on the premise that the TAB agency will have a separate contract for his services. The TAB agency will be under the supervision of the construction management group, the design consultant, or the owner, as the owner will direct. In any case, the TAB agency will work closely with the design consultant to complete this program it would be necessary to retain the TAB agency early in the development of the design documents.

Scope of the Program:

Following is tabulation of the scope of work that could be included in the commissioning process. The program for each project would depend on the type and complexity of the HVAC system, and the extent of the construction budget.

I. Design

- A) Review of the design documents from the standpoint of the commissioning process.
- B) Assist the consultant in the preparation of a detailed specification for the project. This would include:
 - 1) TAB procedures
 - 2) Verification procedures
 - 3) Functional performance tests
 - 4) Documentation requirements

II. Construction phase

- A) Review submittals for equipment and shop drawings for distribution systems from the standpoint of the commissioning process.
- B) Field inspection during construction of HVAC system.
- C) Complete TAB of system and submit final report

III. Functional performance and Verification Tests

- A) TAB report
- B) Temperature control systems

- C) Functional performance tests of major heat-exchange equipment.
- IV. Submittal of Documentation for Review by Design Consultant
- V. Preparation of design documentation for modifications of HVAC system to achieve performance in accordance with original design intent or the occupancy requirements at the time of completion of the project.
- VI. Recommissioning of HVAC system after modifications are completed.
- VII. Preparation of final documentation as "as built" records.

Following is a more detailed description of each part of this specification. The final section of this document is an index that provides examples for the following:

- 1) TAB specification
- 2) TAB report format
- 3) Details of verification procedures
- 4) Details of functional performance tests

I. Design phase

- A.) Review of design documents. Verify that all of the control devices that have been specified for control of air and water flow distribution systems are shown on the mechanical plans and in locations that will allow them to function effectively.

This includes the following devices and systems:

- 1) Volume dampers
 - 2) Balancing valves
 - 3) Metering devices for all systems
 - 4) Controls that will assure that the fresh-air ventilation will meet the air quality standards that are required for the occupancy of the facility.
 - 5) Review the design of the automatic temperature control systems and the compatibility of the control systems with the commissioning process.
- B) Assist the design consultant in the preparation of detailed specifications for the commissioning of the HVAC system. This could include the following:
 - 1) Test and balance procedure for the project
 - 2) Verification procedures:
 - a) Final TAB report
 - b) Performance of the automatic temperature control systems

- 3) Functional performance tests
 - a) Chillers, refrigeration equipment
 - b) Cooling towers
 - c) Boilers

II. Construction phase

- A) Review of submitted data for equipment and shop drawings for the distribution systems.

The TAB agency shall be responsible to assure the design consultant that the various flow control and metering devices are being provided and will be installed in the locations where they will perform effectively.

The TAB agency will determine that the flow control devices, i.e. dampers, balancing valves, metering devices are size properly to be able to control the projected flow rates.

- B) Field inspections. The TAB agency will provide for field inspections during construction of the project to assure the design consultant that the control devices and all systems are being installed to allow the commissioning process to proceed smoothly.

- C) Start up of systems

The TAB agency will witness the start up of all equipment and systems to determine that they are operating in accordance with the design intent.

The TAB agency will determine that the HVAC system is operating in its normal modes so that the TAB procedures can be started.

- D) Complete the TAB of all systems in accordance with the approved TAB procedures and submit the final TAB report.

With the submittal of the TAB report, the construction phase is completed and the verification and functional performance tests can start.

III. Verification tests

- A. TAB report

The TAB agency will provide technicians and instrumentation as detailed in the specifications to accompany the owner, the design consultant, or their representative in the field to verify that the data included in the TAB report is accurate.

The systems or portions of systems to be verified will be selected by the authorized representative verifying the TAB report. The measurements will be made by the TAB agency.

If there are discrepancies between the TAB report and the verification tests, the TAB agency will be directed to rebalance portions of the HVAC system or complete systems in accordance with the TAB specifications. An allowance for the time required to complete these tests will be included in the TAB contract.

B) Temperature Control Systems

The TAB agency will verify the performance of the automatic temperature control system in accordance with the specified procedures for this work. This could include the verification of all readouts such as air flow rates, water flow rates, temperature, humidity, pressure, etc. It could also include functional performance tests as specified.

IV. Functional performance tests of the major heat exchange equipment. The intent of these tests is to provide a record of the "as built" capacity of the equipment. These tests will be conducted by the TAB agency in accordance with the approved procedures. The TAB agency will provide the necessary instruments and record all data for review.

It shall be the responsibility of the equipment manufacturer to provide part load data so that their equipment can be tested at less than full load conditions. This applies to all heat exchange equipment in the HVAC system. This data has been prepared by the manufacturers of cooling towers for many years. TAB agencies have been using this data to field test cooling towers as part of our services. The same type of data will have to be prepared by the manufacturers of refrigeration equipment, heat transfer coils, and boilers.

V. Review of the verification and functional performance tests by the design consultant.

The design consultant will review the results of these tests and determine if the HVAC system can be recommended for acceptance or if modifications are required. The modifications may be required and bring the HVAC system up to the performance in accordance with the design intent, or to meet the owners revised occupancy that has changed since the design was completed.

The design consultant will prepare the documentation for the modification, and when the work is completed, the TAB agency will recommission the systems as required. Systems will be rebalanced and retested as the new revised design documents will specify.

VII. Final documentation.

The TAB agency will prepare the final documentation for submittal as an "as built" record of the system's performance. This documentation will include the final TAB report and the record of all verification tests and functional performance tests.

This documentation will form the basis for future modifications of the HVAC system to suit changes in occupancy.

The HVAC system will be recommissioned after all modifications and the "as built" documentation brought up to date.