

Testing Smoke Control Systems

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- AABC National Standards for Total System Balance, Seventh Edition
- 2012 Edition of the International Building Code (IBC) Chapter 9 entitled "Fire Protection Systems"



Learning Objectives

- Identify the type of smoke control system
- Determine testing requirements
- Develop a test plan
- Evaluate the test data and determine whether systems achieve the design intent



What is smoke control system?

Smoke control systems are mechanical systems that provide a tenable environment for the evacuation or relocation of occupants.

Smoke control systems typically utilize two methods:

- Pressurization Method: Pressurization systems utilize pressure difference across smoke barriers. Common examples of these systems are elevator hoistway and stairwell pressurization systems.
- Exhaust Method: The exhaust method of smoke control is used for large enclosed volumes. A common example is an atrium smoke control system.



The requirements of the systems and testing are determined by local jurisdictions. In my experience the requirements are typically those indicated in the IBC. For this presentation, we will reference the 2012 edition of the IBC Chapter 9 entitled "Fire Protection Systems".

Chapter 9 – Section 909 indicates the following:

Ducts shall be constructed and supported in accordance with the International Mechanical Code. Ducts shall be leak tested to 1.5 times the maximum design pressure in accordance with nationally accepted practices. Measured leakage shall not exceed 5 percent of design flow. Results of such testing shall be a part of the documentation procedure.



- Belt-driven fans shall have 1.5 times the number of belts required for the design duty, with the minimum number of belts being two.
- The smoke control system shall be supplied with two sources of power. Primary power shall be from the normal building power systems. Secondary power shall be from an approved standby source.
- Control systems for mechanical smoke control systems shall include provisions for verification. Verification shall include positive confirmation of actuation, testing, manual override, the presence of power downstream of all disconnects and, through a preprogrammed weekly test sequence, report abnormal conditions audibly, visually and by printed report.
- All wiring, regardless of voltage, shall be fully enclosed within continuous raceways.



- A fire-fighter's smoke control panel for fire department emergency response purposes only shall be provided and shall include manual control or override of automatic control for mechanical smoke control systems. The panel shall be in a fire command center.
- The fire-fighter's control panel shall provide control capability over the complete smoke-control system equipment.



- The fire-fighter's control panel actions shall have the highest priority of any control point within the building. Once issued from the fire-fighter's control panel, no automatic or manual control from any other control point within the building shall contradict the control action. Where automatic means are provided to interrupt normal, nonemergency equipment operation or produce a specific result to safeguard the building or equipment (i.e., duct freezestats, duct smoke detectors, high-temperature cutouts, temperature-actuated linkage and similar devices), such means shall be capable of being overridden by the fire-fighter's control panel.
- Stairways are pressurized to a minimum of 0.10" WC and a maximum of 0.35" WC.
- Shaft pressure shall be measured relative to building with all stairway doors closed.



- Door-opening force shall not exceed 30 lbs.
- Elevator hoistway shall be pressurized to a minimum of 0.10" WC with a maximum of 0.25" WC.
- Pressure shall be measured at midpoint of each hoistway door, with all elevator cars at the floor of recall and all hoistway doors on the floor of recall open and all other hoistway doors closed.
- The opening and closing of each hoistway door or stairway door must be demonstrated.
- The supply air intake shall be from an outside, uncontaminated source located a minimum of 20 feet away from any exhaust system or outlet.



- The fan system shall be equipped with a smoke detector that will automatically shut down the fan system when smoke is detected.
- A separate fan system shall be provided for each hoistway.
- The pressurization system shall be provided with standby power.
- The system shall be activated upon activation of the building fire alarm system or activation of the elevator lobby smoke detectors.
- In no case shall airflow toward the fire exceed 200 FPM.



To what length should a smoke control system be tested by the test and balance agency? Design air volume is indicated on the plan drawings for systems and equipment, seems simple enough.

The seventh edition of the AABC National Standards defines Total System Balance as "the process of testing and balancing the heating, ventilating and air-conditioning (HVAC system) and related control systems to perform at the **design intent** and operate at an optimum level". So, what is the intent of these systems and what is the optimum level?



With the design intent outlined above it is now apparent various aspects of the system will be tested and inspected throughout the phases of construction. For pressurization systems the design air volume is a starting point based on the generally accepted principles of engineering. However, during testing, close coordination with the design engineer of record may be required to set the system to the final operating conditions. The following outlines the inspection and test procedures for the test and balance agency:

During the design phase, the test and balance agency will review the documents for balanceability with the following in mind:

• Are separate fan systems provided for each hoistway or stairway?



- Are supply air intakes located minimum 20 feet away from any exhaust system or outlet?
- Are the systems provided with two sources of power, primary and standby?
- Are positive means of confirmation for actuation, testing, manual override, presence of power downstream of all disconnects and weekly test sequence provided through the control systems for verification?
- Is a fire-fighter's control panel provided for fire department emergency response purposes?



During the construction phase the test and balance agency will make field observations and review submittals the following in mind:

- Are supply air intakes located minimum 20 feet away from any exhaust system or outlet?
- Have the ducts been leak tested to 1.5 times the maximum design pressure in accordance with nationally accepted practices?
- If belt-driven, do the fans have 1.5 times the number of belts required for the design duty, with the minimum number of belts being two?
- Is all wiring, regardless of voltage, fully enclosed within continuous raceways?
- Are smoke barriers sealed with no obvious penetrations that would affect the ability of the shaft to achieve pressure?



During the test and balance phase, the testing of all equipment, systems and subsystems are completed. The smoke control systems will be tested as follows:

- While simulating an alarm condition:
 - Test and balance the systems in accordance with AABC National Standards to the design air volume indicated on the documents within the limitations of the equipment installed.
 - Measure pressure differences across smoke barriers, each stair vestibule to corridor, each stair vestibule to stairway and each stairway to corridor.



- Measure and record door opening forces and verify doors latch at each stair vestibule to corridor, each stair vestibule to stairway and each stairway to corridor.
- □ Measure and record makeup air velocities into the Atrium.
- Perform control sequence verification to verify:
 - When smoke is detected within the system by the equipped smoke detector the system is automatically shut down.
 - When the building fire alarm system or the elevator lobby smoke detectors are activated, verify the systems are activated.
 - □ The fire-fighter's control panel shall provide control capability over the complete smoke-control system equipment.



- The fire-fighter's control panel actions shall have the highest priority of any control point within the building. Once issued from the fire-fighter's control panel, no automatic or manual control from any other control point within the building shall contradict the control action. Where automatic means are provided to interrupt normal, nonemergency equipment operation or produce a specific result to safeguard the building or equipment (i.e., duct freezestats, duct smoke detectors, high-temperature cutouts, temperature-actuated linkage and similar devices), such means shall be capable of being overridden by the fire-fighter's control panel.
- If acceptable performance cannot be achieved because of any system or construction deficiency, the test data will be documented and submitted in writing to the appropriate parties.



 If acceptable performance was achieved at a revised air volume through coordination with the engineer, the final operating conditions and explanation of testing will be documented within the summary of the final report.



Conclusion

To verify smoke control systems perform to the design intent, the test and balance agency must perform a design review for balanceability, site observations, submittal review and closely coordinate testing activities with the construction team and engineer through various stages of construction. Smoke control systems are life safety systems and are integral to the safe egress of building occupants in the event of a fire. It is imperative that these systems perform when the need arises.





Thank you for your time!

