

AABC Commissioning Group

AIA Provider Number 50111116

Leakage Testing of HVAC Systems

Course Number: CXENERGY1930

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American Testing Inc.

April 16, 2019



Test & Balance Seminar for CxAs, Engineers, & TAB Professionals

Tuesday, April 16, 2019

8:30 a.m. – 4:30 p.m.

CX
ENERGY
2019
CONFERENCE & EXPO
APRIL 15 - 18 | ORLANDO, FL



“Leakage Testing”

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American Testing, Inc.

Leakage testing is a key component of HVAC Systems. Review the energy losses and cost savings relative to sealing and leakage testing, evaluate the dominant methodologies and industry standards including discussion of procedures and coordination.

Topics will include:

- Case study for comparison in-house vs in-field testing
- Guidance for engineers and commissioning providers to gain knowledge of leakage testing requirements.



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Course Description

This presentation will review the AABC National Standards –
Chapter 5 – “LEAKAGE TESTING”

A presentation to review AABC Certified Total System Balance (TSB) “LEAKAGE TESTING” as related to the Commissioning Process – Engineering Practices – Owner acceptance.

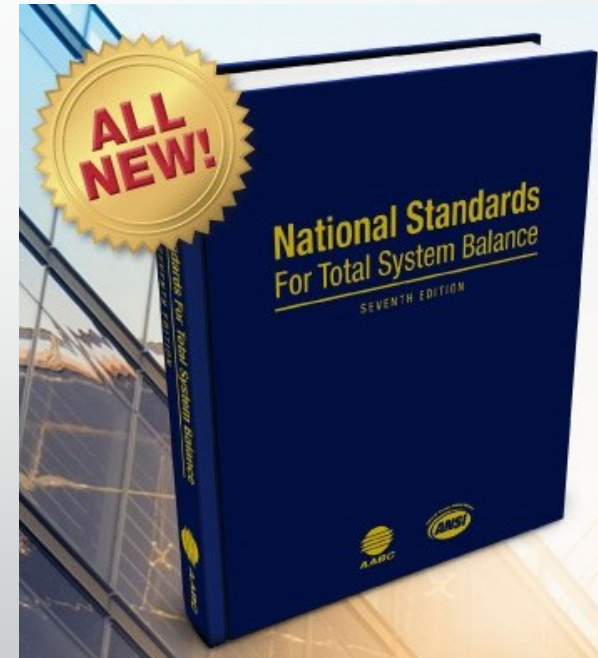
Using industry specified methods with a practical and objective approach to the Leakage Testing processes and documentation of the AABC TSB standard, will produce more efficiently operating HVAC systems.

Seminar Learning Objectives

AABC - Total System Balance:

Chapter 5 - "LEAKAGE TESTING"

- Specification? – Specified in both TAB and Duct Construction spec sections.
- Testing Methods? - In-Field vs In-House/Lab processes and environmental impacts.
- Documentation & Witnessing? - Whom will document and witness the Leakage testing – The installer?
- Energy Savings? – The costs of proper install and sealing vs life long leakage expense.



Standards & Methodologies

- AHRI & SMACNA Standards and methods relate to leakage classification. The leakage class is based on pressure and surface area.
- AABC Standards & Methods are relative to percentage of air quantity.

AIR-CONDITIONING HEATING & REFRIGERATION INSTITUTE (AHRI) STANDARD

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**ANSI/AHRI STANDARD 1351 (SI)-2014 WITH
ADDENDUM 1
Mechanical Performance Rating of Central Station
Air-handling Unit Casings
September 2015**

- **STANDARDS FOR AHU CONSTRUCTION**



SMACNA MANUAL

HVAC AIR DUCT LEAKAGE TEST MANUAL

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by

**SHEET METAL AND AIR CONDITIONING CONTRACTORS'
NATIONAL ASSOCIATION, INC.**

4201 Lafayette Center Drive
Chantilly, VA 20151-1219

Printed in the U.S.A.

FIRST EDITION – 1985
SECOND EDITION – 2012

SMACNA – LEAKAGE CLASSES

Duct Class	½ in., 1 in., 2 in. wg	3 in. wg	4 in., 6 in., 10 in. wg
Seal Class	C	B	A
Sealing Applicable	Transverse Joints Only	Transverse Joints and Seams	Joints, Seams and all Applicable Wall Penetrations
Leakage Class			
Rectangular Metal	16	8	4
Round Metal	8	4	2

Table 5–1 Recommended Leakage Classes

SMACNA – APPENDIX A

APPENDIX A

Leakage Class (CL)	Fan cfm Prorated* per ft ²	Static Pressure (in. wg)						
		½	1	2	3	4	6	10
48	2	15	24	38	Rates in this area do not apply to HVAC duct constructed to SMACNA standards			
	2.5	12	19	30				
	3	10	16	25				
	4	7.6	12	19				
	5	6.1	9.6	15				
16	2	5.1	8.0	13	16			
	2.5	4.1	6.4	10	13			
	3	3.4	5.3	8.4	11			
	4	2.5	4.0	6.3	8.2			
	5	2.0	3.2	5.0	6.5			
8	2	2.5	4.0	6.3	8.2	9.8		
	2.5	2.0	3.2	5.0	6.5	7.9		
	3	1.7	2.7	4.2	5.4	6.6		
	4	1.3	2.0	3.1	4.1	4.9		
	5	1.0	1.6	2.5	3.3	3.9		
4	2	1.3	2.0	3.1	4.1	4.9	6.4	8.9
	2.5	1.0	1.6	2.5	3.3	3.9	5.1	7.1
	3	0.8	1.3	2.1	2.7	3.3	4.3	6.0
	4	0.6	1.0	1.6	2.0	2.5	3.2	4.5
	5	0.5	0.8	1.3	1.6	2.0	2.6	3.6
2	2	0.6	1.0	1.6	2.0	2.5	3.2	4.5
	2.5	0.5	0.8	1.3	1.6	2.0	2.6	3.6
	3	0.4	0.7	1.0	1.4	1.6	2.1	3.0
	4	0.3	0.5	0.8	1.0	1.2	1.6	2.2
	5	0.3	0.4	0.6	0.8	1.0	1.3	1.8

Table A-1 Leakage as Percent of Flow in System

*Typically $\frac{FAN_CFM}{DUCT_SURFACE_AREA}$ will be 2 to 5 cfm/square ft of duct surface.

Class 48 is average unsealed rectangular duct. Class 16 and lower are anticipated results for sealed ducts.

AABC – CHAPTER 5 - OVERVIEW

- Duct leakage testing is an additional test, not considered part of AABC ***Total System Balancing*** unless specifically specified.
- The AABC recommends that the leakage testing be specified in both the testing and balancing section, as well as the duct construction section of the specifications.
- Since contractors are responsible for the construction and sealing of the duct, it is their responsibility to prepare the system for testing, and provide initial testing to assure a successful outcome at the final witnessed test.
- The TAB agency shall provide the calibrated instrumentation and be an independent witness to the testing.

AABC – CHAPTER 5 – OVERVIEW (cont)

- Duct leakage reduces the air quantity at the system terminals and should be minimized. Excessive leakage will lead to increased fan speeds to compensate for the reduced terminal airflow, and, therefore, increase energy use to overcome the leakage.
- Excessive leakage can make balancing the terminal distribution SYSTEM to the design criteria OFTEN impossible.
- Duct leakage occurs at openings in the duct (through joints, seams, access doors, rod penetrations, etc.) as a result of reduced quality workmanship.
- The leakage rate is a function of the openings in the duct and the static pressure in the duct.
- Building codes generally require that ducts be sufficiently airtight to ensure energy conservation and control of the air movement, humidity, and temperature in the space.
- Selecting a duct construction static pressure class suitable to the operation of the system, and specifying the proper sealing of the ductwork can accomplish this.
- The AABC recommends that all duct systems, including low-pressure systems, be sealed and tested in accordance with this chapter as a minimum threshold of duct construction performance.

CONSTRUCTION & APPLICATION

"Accuracy, Repeatability and Integrity"



- ❖ **Construction methods per industry/manufacture recommendations**
- ❖ **Application of mastics and tapes applied per spec and or manufacturer recommendations**
- ❖ **Temperate environment to not compromise sealants or construction.**

AABC – ALLOWABLE LEAKAGE

- LISTED AS FOLLOWS:
- **Type of System - Minimum Test Pressure - Maximum Allowable Leakage**
- 1. Fractional horsepower fan system; fan coils, small exhaust/supply fans, and residential systems 0.50" WC (125 Pa) 2%
- 2. Small systems; split DX systems — usually systems under 2000 CFM (940 l/s), and residential systems 1.00" WC (250 Pa) 2%
- 3. VAV and CAV terminal boxes and associated downstream ductwork 1.00" WC (250 Pa) 2%
- 4. Single zone, multi-zone, return ducts, and exhaust duct systems 2.00" WC (500 Pa) 2%

AABC - ALLOWABLE LEAKAGE (cont)

- 5. Chilled-beam primary supply 2.00" WC (500 Pa) 1%
- 6. All ducts in chases and concealed spaces, main return ducts on VAV and CAV systems, main ducts on general exhaust or outside air systems 3.00" WC (745 Pa) 1%
- 7. VAV and CAV terminal boxes tested with upstream ductwork 4.00" WC (995 Pa) 1%
- 8. Supply ducts for VAV and CAV systems 4.00" WC (995 Pa) 1%
- 9. Dual duct systems, both hot duct and cold duct 6.00" WC₄ (1495 Pa) 1%
- 10. High pressure induction system 6.00" WC₄ (1495 Pa) 0.5%

AABC – AHU LEAKAGE TESTING

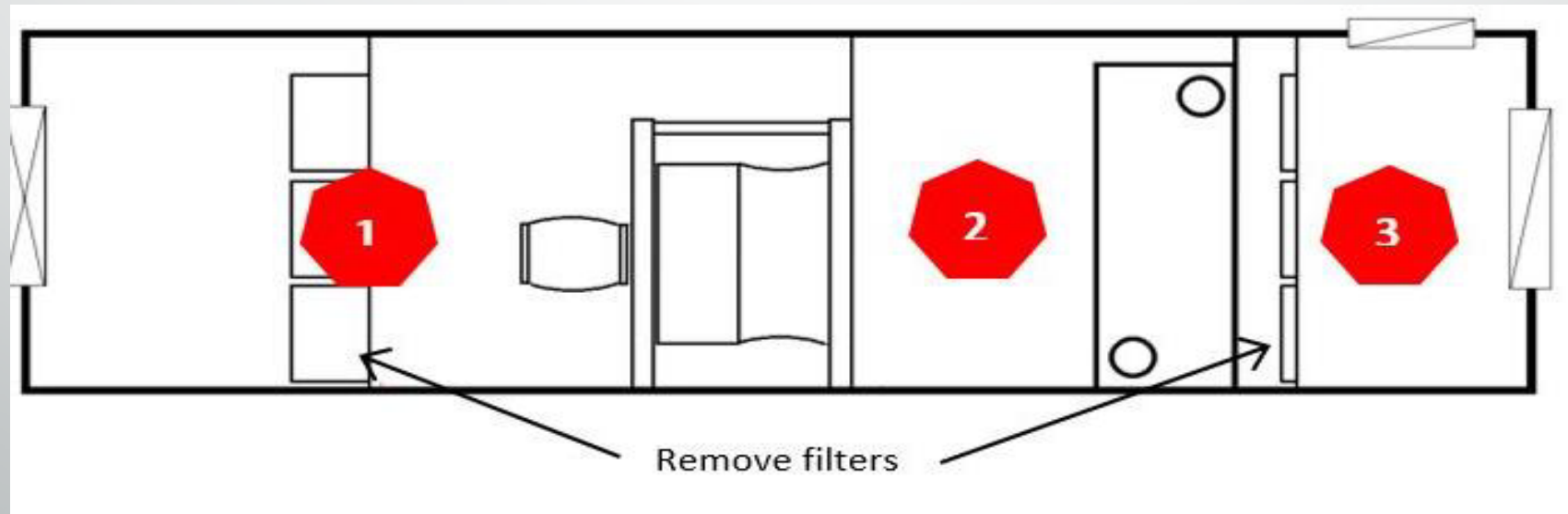
- Unit shall be furnished with proper blank offs to facilitate the pressure testing, and around flanged opening for the test orifice.
- With unit set in place, leveled, and ready to receive duct work connections, unit shall be tested for casing leakage by sealing all openings and pressurizing to 2.5 times rated pressure (defined as total static pressure of unit), or 10" WC, whichever is smaller.
- Maximum allowable leakage rate is 1.5% of rated unit flow.
- Test is to be performed by the manufacturer using orifice tubes for leakage measurement sized for 1.5% of the AHU design airflow and able to provide the pressure defined above.
- The test set-up will be a positive-pressure test for the entire AHU.
- The access doors in the negative section of the AHU can be taped, because the seals are for a negative pressure. A representative of the TAB agency shall witness the final test.

AHU ENCLOSURE AND CASING

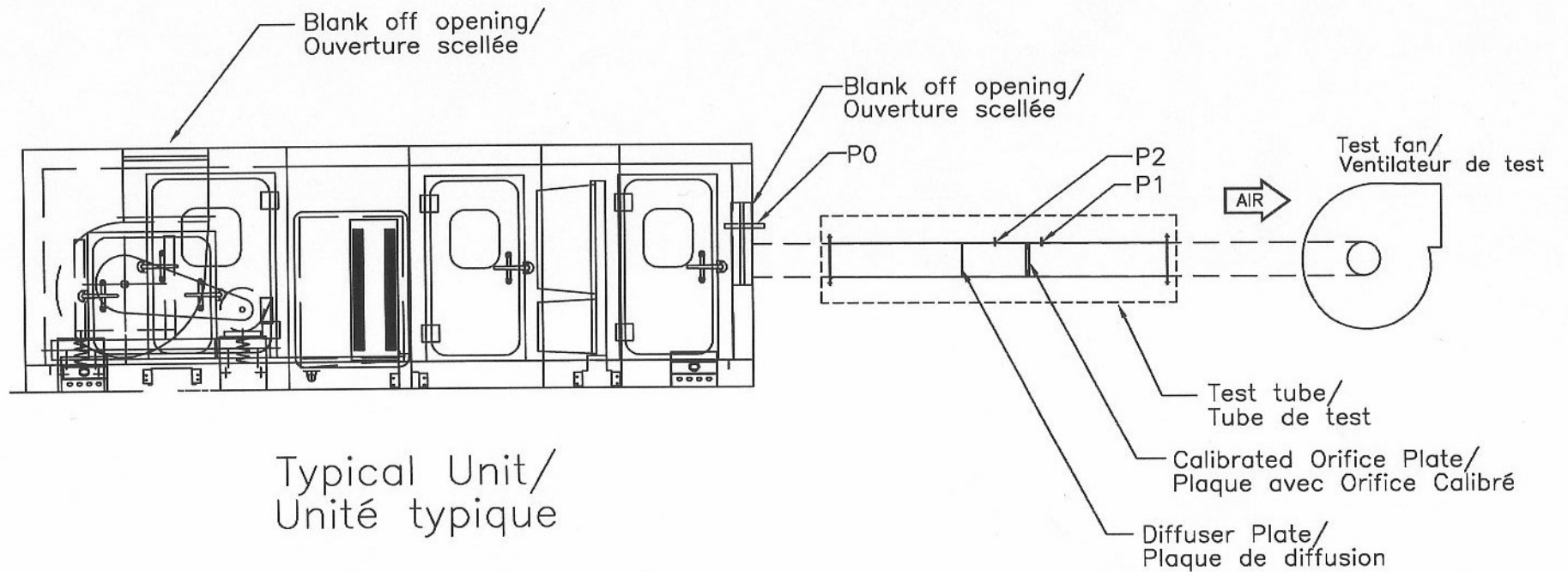
1.= DISCHARGE PLENUM

2.= SUCTION PLENUM

3.= MIXED AIR PLENUM



AHU TEST APPARATUS - SUCTION



AHU LEAKAGE CONDITIONS

Field Conditions vs Laboratory/Manufacturer rating conditions

“Important to understand that there may be differences between In-house and In-field report recorded data and design intent – equipment ratings – conditions??!!!!”



AABC – ROOM/BLDG PRESSURE TESTING

- The measurement will be done by first temporarily sealing the openings of the area being tested
- Then removing air from the area (negative pressure), and then blowing air into the area (pressurization).
- The flow and pressure readings will be converted into an Equivalent Leakage Area (ELA) or the total area of all the cracks, gaps, and holes in the test room.
- The two readings are averaged for an ELA. The leakage area will be calculated by using ***Equation 5.1***:

AABC – ROOM/BLDG EQUATION

- **Equation 5.1 — Equation for Equivalent Leakage Area**
- $ELA = Q / (2610 \times C \times \sqrt{\Delta P})$
- *Where:*
- ELA = the area of room leakage (ft²)
- Q = the measured room offset (CFM)
- ΔP = differential pressure between the room and a referenced adjacent area (inches WC)
- $C = 0.65$ a dimensionless coefficient
- 2610 = Coefficient constant of a square edge orifice

Questions / Conclusion

1. SPECIALIZED TESTS – SEWER..
2. What's the best formula for LEAKAGE TESTING coordination success?
3. What are the recommended standards and methods?
4. How should deviations be handled – how can further testing initiatives be implemented?

“Success is neither magical nor mysterious. Success is the natural consequence of consistently applying basic fundamentals.”

jim rohn