

THE LONG ISLAND SOUNDER

January 2010



ASHRAE Long Island Chapter, Region 1...Founded in 1957

www.ashraeli.org

American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.

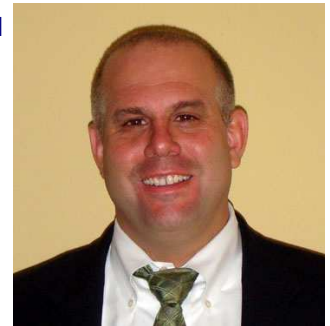
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President's Message

Happy new year! Last month's holiday party, which doubled as "Member Appreciation Night," is a testament to the dedicated group of professionals who make up our chapter. We ended 2009 on a high note and look forward to projecting that momentum forward as we enter a new decade.

We have an exciting lineup planned for this year. The featured speaker at our January 12 meeting will be John Mazza, P.E., from Hauppauge-based Airpath Engineering, PC. John will enlighten us on how to interpret HVAC systems test/balancing procedures and reported data. The ASHRAE definition of HVAC system Testing, Adjusting, Balancing (TAB) is applied by various agencies, including the National Environmental Balancing Bureau; Sheet Metal Contractors Testing, Adjusting, Balancing Bureau; and the Associated Air Balance Council. All organizations provide procedural standards for the balancing activities and each has similar procedures, but they differ in the technical requirements, certification process of technicians and certified professionals, report forms, report language, and quality control/compliance.



Engineers who specify a TAB firm or agency assume the responsibility of selecting an independent firm and approving a certified or noncertified report for the client. John will walk us through a quality TAB report for air and water systems, and describe the implied warranties by certified balancing firms.

Later this month, ASHRAE Society will host its 2010 Winter Conference. Staying focused on "sustainability" from last year's Winter Conference in Chicago titled "Sustainable Urban Design," ASHRAE blows out of the Windy City into Orlando, Florida, January 23-27. ASHRAE will tackle a common complaint often heard in tropical climates such as Florida, "It's not the heat, it's the humidity," with this year's Conference theme: "Building Sustainability from the Inside Out."

Advance registration is now closed, but registration will open at the Rosen Shingle Creek Hotel, Orlando, on Friday, January 22. Registration fees are as follows: ASHRAE members, \$660; nonmembers, \$830.

In addition, the long awaited Standard 189.1 will be released early this year, and ASHRAE needs your help to spread the word to your colleagues. ASHRAE's goal is to have ANSI/ASHRAE/ USGBC/

CHAPTER MONTHLY MEETING

DATE:	Tuesday, January 12, 2010
TIME:	6:00 PM - Cocktails/Dinner 7:00 PM - Dinner Presentation 8:45 PM - Conclusion
LOCATION:	Westbury Manor South Side of Jericho Tpke. 25 Westbury, NY 11590
FEES:	
Members -	\$35.00
Guest -	\$40.00
Student -	\$15.00

Reservations requested, but not required.

Call (516) 333-7117

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Long Island Chapter Officers & Committees

ASHRAE 2009/2010 OFFICERS

POSITION	NAME	PHONE	FAX	EMAIL
President	Steven Giammona, P.E., LEED AP	516.827.4900	516.827.4920	srg@cameronengineering.com
President-Elect	Nancy Román	516.568.6509	516.568.6586	nroman@adehvac.com
Vice President	Carolyn Arote	516.568.6550	516.568.6575	carote@adehvac.com
Financial Secretary	Brian Simkins, LEED AP	203.261.8100	203.261.1981	bsimkins@accuspecinc.com
Treasurer	Andrew Manos, LEED AP	631.981.3990	631.981.3971	amanos@emtec-engineers.com
Secretary	Janeth Costa	631.242.8787	631.242.7084	jcosta@apollohvac.com
Board of Governors	Richard Rosner, P.E.	631.574.4870	631.574.4871	rrosner@nassausuffolkea.com
Board of Governors	Thomas Fields, P.E., LEED AP	212.695.1000	212.695.1299	tfields@lilker.com
Board of Governors	Steven Friedman, P.E., HFDP, LEED AP	212.695.1000	212.695.1299	sfriedman@lilker.com

ASHRAE 2009/2010 COMMITTEES

COMMITTEE	NAME	PHONE	FAX	EMAIL
Programs & Special Events	Nancy Román	516.568.6509	516.568.6586	nroman@adehvac.com
Membership	Richard Rosner, P.E.	631.574.4870	631.574.4871	rrosner@nassausuffolkea.com
Chapter Technology Transfer (CTTC)	Brian Simkins, LEED AP	203.261.8100	203.261.1981	bsimkins@accuspecinc.com
Newsletter Editor	Liset Cordero	212.643.9055	212.643.0503	liset.cordero@mgepc.net
Resource Promotion	Andrew Manos, LEED AP	631.981.3990	631.981.3971	amanos@emtec-engineers.com
Historian	Carolyn Arote	516.568.6550	516.568.6575	carote@adehvac.com
Student Activities	Thomas Fields, P.E., LEED AP	212.695.1000	212.695.1299	tfields@lilker.com
Webmaster	Janeth Costa	631.242.8787	631.242.7084	jcosta@apollohvac.com
Nominating	Michael Gerazounis, P.E., LEED AP	212.643.9055	212.643.0503	michael.gerazounis@mgepc.net
Reception & Attendance	Anita Singh, LEED AP	516.827.4900	516.827.4920	abs@cameronengineering.com
PR & Engineering Joint Council of LI	Peter Gerazounis, P.E. LEED AP	212.643.9055	212.643.0503	peter.gerazounis@mgepc.net
Golf Outing	Peter Gerazounis, P.E., LEED AP Steven Friedman, P.E., HFDP, LEED AP	212.643.9055 212.695.1000	212.643.0503 212.695.1299	peter.gerazounis@mgepc.net sfriedman@lilker.com

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President Message (Cont'd.)





IES Standard 189.1, Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings, utilized as widely as possible to have a positive impact on the industry. More information on the standard can be found at this link: www.ashrae.org/greenstandard.

Please keep in mind that our February 9 meeting will be Student Activities Night and our March 9 meeting will be Resource Promotion Night, both of which were very successful in the fall. Let's continue to move our chapter forward!

Again, a happy and healthy new year to you and your family.

Steven Giammona, P.E., LEED AP
President - Long Island Chapter

Chapter Monthly Meeting - Program for 2009/2010

September 15, 2009 * At Westbury Manor - 1 PDH  Dinner Presentation - Chilled Beam Systems MEMBERSHIP PROMOTION NIGHT	February 2010 NATIONAL ENGINEERS WEEK DINNER
October 20, 2009 * At Westbury Manor - 1 PDH  Dinner Presentation - Going Green-Reducing Emissions and Improving Fuel Efficiency in Commercial and Industrial Boiler Applications STUDENT ACTIVITIES NIGHT	March 9, 2010 * At Westbury Manor Dinner Presentation - Stack Effect RESOURCE PROMOTION NIGHT
November 10, 2009 * At Westbury Manor - 1.5 PDH  Dinner Presentation - Introduction to LEED NC Building Commissioning JOINT MEETING WITH USBGC RESOURCE PROMOTION MEMBERSHIP PROMOTION NIGHT	April 13, 2010 FIELD TRIP - Allegria Hotel Facility
December 8, 2009  Holiday Party - Westbury Manor	May 3, 2010 * Cherry Valley Club, Garden City, NY ANNUAL GOLF OUTING
January 12, 2010 * At Westbury Manor Dinner Presentation - Interpretation of HVAC Systems Test/Balancing Procedures and Reported Data	May 11, 2010 * At Westbury Manor Dinner Presentation - Refrigeration REFRIGERATION NIGHT ASHRAE DISTINGUISHED LECTURER
February 9, 2010 * At Westbury Manor Dinner Presentation - Energy Audits & New ASHRAE Standards STUDENT ACTIVITIES NIGHT ASHRAE DISTINGUISHED LECTURER	June 8, 2010 * At Westbury Manor PAST PRESIDENTS & OFFICER INSTALLATION
February 2010 ASHRAE Winter Meeting	June 8, 2009 ASHRAE Annual Meeting PAS PRESIDNETS NIGHT

August 2009 - Chapter Regional Conference Region I

PAOE POINTS FOR 2009/2010

Chapter Members	Membership Promotion	Student Activities	Research Promotion	History	Chapter Operations	CTTC	Chapter PAOE Totals
301	310	295	425	50	100	150	1,330

January Program

You are cordially invited to our January 2010 Meeting...



Dinner Presentation

“Understanding the HVAC Systems Balancing Process & Interpreting the Certified Testing/ Adjusting/Balancing Report”

Presented by

John Mazza, P.E.

**President of Airpath Engineering, PC,
and Airpath Testing Services**

DATE:	TUESDAY, JANUARY 12, 2010		
Time:	6:00 PM – Cocktails and Hors D'oeuvres 7:00 PM – Dinner Presentation 8:45 PM – Conclusion	Fee:	\$ 35.00 Member \$ 40.00 Guest \$ 15.00 Student
Location:	WESTBURY MANOR (516) 333-7117 Jericho Tpke (South Side), 3/10 of mile east from Glen Cove Rd., Nassau County, NY. Directions are posted at @ www.ashraeli.org.		
Presentation:	The ASHRAE definition of HVAC system Testing, Adjusting, Balancing is applied by various agencies, including the National Environmental Balancing Bureau (NEBB), Sheet Metal Contractors Testing, Adjusting, Balancing Bureau (TABB), and the Associated Air Balance Council (AABC). All organizations provide a procedural standards for the balancing activities. Each have similar procedures, but differ in the technical requirements, certification process of technicians and certified professional (supervisors), report forms, report language, and quality control / compliance. Engineers who specify a TAB firm or agency assume responsibilities in selecting an independent firm, accepting (approving) a certified or non certified report for the client. The presentation will illustrate many of the features of a quality TAB report for air and water systems, explain the information provided in the report, and describe the implied warranties by certified balancing firms.		
About our Speakers:	John Mazza, P.E. has been practicing in the HVAC Industry for over 30 years. He graduated SUNY Stony Brook in 1978, received his MS degree in Engineering Advanced Energy Technologies. From 1978 to 1991, John was Associate Professor at SUNY Farmingdale, teaching in the Department of Air Conditioning Engineering Technologies. In 1991, John opened his own engineering firm, and became a NEBB firm certified to perform TAB, and certified Building Systems Commissioning.		

CHAPTER MAY NOT ACT FOR SOCIETY

An International Organization

Research Promotion

Last months meeting was Resource Promotion Night where we recognized last year's donors. I would like to say thank you again to all that have contributed.

This year's overall resource promotion goal is \$2,001,900 with over 75 research projects on board. Our chapter is expected to raise approximately \$12,881 towards the overall goal of which we have already raised \$9,155. I am hoping I can count on the continued support of all of our past contributors who have generously supported us over the years.

I also look forward to gaining the support of new contributors this coming year. Please help support ASHRAE in any way you can.

I would like say 'thank you' to all the contributors listed below whom have already donated to ASHRAE this year:

Mr Andrew E Manos	Mr Michael O'Rourke
Mr Andrew J Garda	Ms Nancy Roman
Mr Arthur A Huebner	Mr Patrick J Lama
Mr Brian C Simkins	Mr Raymond G Schmitt
Ms Carolyn Arote	Mr Richard L Rosner, PE
Mr Christopher M Schwarz	Mr Ronald J Kilcarr, PE
Mr Fred H Weber	Mr Steven R Giammona, PE
Ms Janeth Costa	Mr William L Mahon
Mr Jerome T Norris	A O Smith Water Heaters
Mr Jerome A Silecchia	Taco Inc
Mr John D Nally	Viessmann
Mr Michael Gerazounis, PE	

CONTRIBUTIONS CAN BE MADE IN THE FOLLOWING WAYS:

1) You can mail your checks, made out to ASHRAE Resource Promotion, to:

Andrew Manos
ASHRAE Research Promotion Chair
c/o Emtec Consulting Engineers
3555 Veterans Memorial Highway
Ronkonkoma, NY 11779

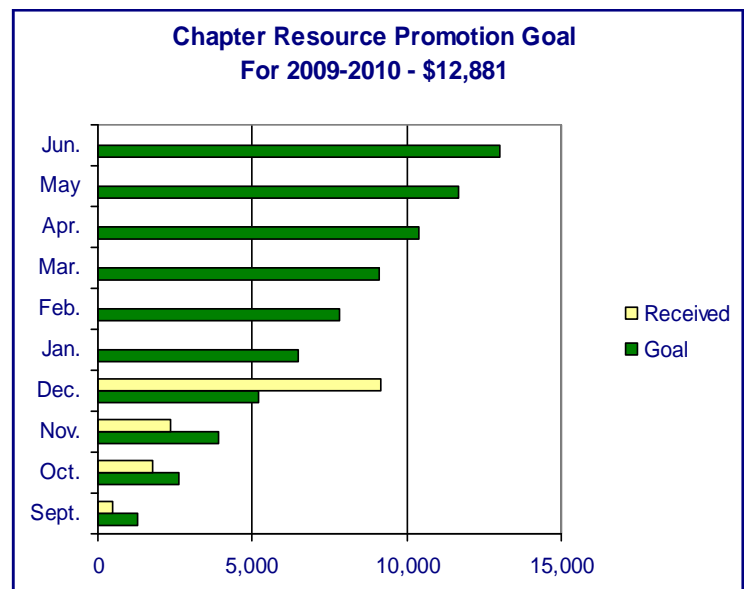
2) You can bring your check to any of the meetings and give it to me. I will mail it into headquarters.

3) You can contribute via paypal [from](#) the ASHRAE LONG ISLAND web site just click on the donate button.

4) You can contribute directly on-line. www.ashrae.org
*** Please make sure your accredit your contribution to the LONG ISLAND CHAPTER 006 ***

Thank you again for all your support!

Andrew Manos, LEED AP
Resource Promotion Chair



CTTC

Problems Related to Air Handler Leakage

Air leakage of air-handling units (AHUs) is a subset of a much larger duct leakage problem that exists in homes. There are large energy and demand impacts associated with duct leakage. This article considers energy impacts of AHU leakage, but focuses primarily on IAQ problems and health risks caused by duct leakage, especially as they relate to the location of the AHU.

It is often desirable to locate air handlers and furnaces in unoccupied portions of the house, such as a basement, crawlspace, attic or attached garage. Placing mechanical equipment in those zones avoids use of occupied space and limits noise.

There are a number of disadvantages of locating the air handler or furnace (air handler is intended to include furnaces) in unconditioned space. Restricted access to equipment located in a crawlspace or attic may reduce the frequency and quality of servicing. Added conduction losses from the AHU and adjacent ductwork reduce system efficiency. The most serious disadvantages relate to air leakage—in the air handler cabinet, at connections to the return and supply plenums and in adjacent ductwork located in those spaces. ANSI/ASHRAE Standard 152-2004, *Method of Test for Determining the Design and Seasonal Efficiencies of Residential Thermal Distribution Systems*, provides methods for measuring duct leakage and calculating the impacts of conduction and air leakage losses.

Air leakage is likely to increase the space conditioning load. This has impacts on energy waste, peak demand and occupant comfort (if the load exceeds the system's capacity). During cold weather, duct leakage can create a large increase in heating load. The low dew-point air drawn into the house by the duct leakage can produce low indoor RH. During hot and humid weather, duct leakage can create a large increase in cooling load, especially if the air leaking into the system originates from the attic. A return leak of 15% from a hot attic (120°F) (49°C) dry bulb, 80°F (27°C) dew-point temperature) can reduce the effective capacity and efficiency of a cooling system by about 50%.¹ Duct leakage also can increase indoor relative humidity (RH) during hot and humid weather, especially for supply leaks. In the case of dominant supply leaks, the building is depressurized, and this causes humid air to be drawn into the conditioned space (untreated) through various envelope leaks. However, return leaks produce less summer humidity impact than supply leaks because the return leak air (in most cases) runs across the cooling coil, where most of the added moisture is stripped away.²

Return leakage from unconditioned spaces can result in dust accumulation inside the ductwork, on the cooling coil, blower wheel, etc., which can diminish system performance and increase the likelihood of IAQ problems. If the filters are located at the return grill(s), the return ductwork operates under a greater level of depressurization, increasing return leakage airflow and causing much or all of the return leak air to bypass the filter. Both factors increase ductwork and AHU contamination.

Duct leakage may depressurize the zone where combustion appliances are located and cause drafting problems, such as spillage, backdrafting, incomplete combustion and flame roll-out. Therefore, it is important, even when the AHU is located inside the house, that space depressurization be avoided to protect against combustion safety problems.³

Additionally, air-distribution system leakage may transport pollutants from a contaminated zone to occupied space. Attic AHUs can transport water vapor and loose insulation fibers into the house. Crawlspace or basement AHUs can transport musty odors, radon and pesticides into the conditioned space. Garage AHUs can transport carbon monoxide, fuel vapors and other vapors into the house.

Two additional problems of AHU leakage in the garage, attic, or outdoors are related to water vapor condensation. First, in some AHUs the cabinet insulation is lined with foil, in effect placing a vapor barrier on the cold side of the insulation assembly. During hot and humid weather, moist air sucked into the cabinet meets the cold foil surface causing condensation. This results in saturated cabinet insulation that becomes ineffective. Second, return leakage in the AHU cabinet between the coil and the blower can draw hot and humid air into an airstream that is about 55°F (13°C). If the dew-point temperature of the return leak air is 75°F (24°C) (a common summer dew-point temperature in the southeastern U.S.), and if the return leakage is sufficiently large, then condensation will create a "fog" that will wet the surfaces between the

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coil and blower, and the supply ductwork (*Figure 1*).



Figure 1: Condensation on metal electric panel inside air handler. Figure 2: Refrigerant line penetration into air handler without seal.

Air Leakage Characteristics of Air Handlers

In a sample of 69 homes, the leakage characteristics of the air handler or furnace cabinet were measured in newly constructed Florida homes.^{4,5} The homes were constructed between 2001 and 2002, and were less than 12 months old at the time of testing. A calibrated blower was attached to a return grill of the air-distribution system to measure the leakage of the air-distribution system, or a portion of that system. In a majority of the cases, a panel was inserted (and sealed) into the supply plenum to isolate the supply system from the air handler and return. All grills and registers in the tested portion of the system were sealed with masking material. The leakage of the system was measured by depressurizing the system to -25 Pa (-0.10 in. w.c.) with respect to (wrt) its surrounding environment: attic, garage or indoors.

The leakage metric used was $Q_{25, \text{total}}$ ($Q_{0.10, \text{total}}$), or cu-bic feet per minute (cfm) of leakage at 25 Pa (0.10 in. w.c.). Throughout this article, the units for Q_{25} and $Q_{25, \text{total}}$ will be cfm at 25 Pa (0.10 in. w.c.). The test was repeated a second time with all cracks, penetrations and holes in the cabinet sealed (temporarily) by tape and/or putty. The difference in $Q_{25, \text{total}}$ between the two tests then represented the leakage of the air handler cabinet, as installed in the field. Leakage at the connection of the AHU to the supply plenum and to the return plenum was sealed and measured separately using the same subtraction methodology. The measured leakage is called total leakage, rather than leakage to outdoors, meaning that the leakage is to all immediate environments, whether indoors, outdoors or to a buffer zone. In 2007 ASHRAE established a committee, SPC193P, Method of Testing for Determining the Air-Leakage Rate of HVAC Equipment, to develop a test method of AHU cabinet airtightness.

In addition to measuring Q_{25} , normal operating static pressure was measured at two locations in the air handler cabinet and at connections of the cabinet to the two plenums with the AHU blower operating. Given Q_{25} and operational static pressure, actual (as operated) air leakage (Q) could be calculated using the equation $Q = Q_{25} (dP_{\text{actual}}/25)^{0.60}$ (equation derived from Equation C-1 of ANSI/ASHRAE Standard 152-2004, *Method of Test for Determining the Design and Seasonal Efficiencies of Residential Thermal Distribution Systems*) where dP_{actual} is the static pressure (Pa) occurring within the AHU. The results of this field testing are found in *Table 1*.

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The airtightness results from all 69 air handlers are as follows: Q 25 in the air handlers was 20.4, Q 25 at the return connection was 3.9, and Q 25 at the supply connection was 1.6. These measured leakage amounts were as-found, that is, the leakage of the system was measured without making any changes to the system, with one exception. If the filter access door was off or ajar (found in two houses), then it was placed in its proper position. In one case, a missing filter access door represented Q 25 = 189. In the other case, an ajar filter access door represented Q 25 = 37.

Based on the measured operational pressures and the Q 25 for each location, estimated air leakage (Q) has been calculated for the negative pressure and the positive pressure zones of the air handler, plus connections for the 69 systems. The negative pressure zone had an average (as operated) leakage of 58.8 cfm (27.8 L/s), representing 4.9% of the average 1,207 cfm (569.6 L/s) of air handler airflow. The positive pressure zone had an average leakage of 9.3 cfm (4.39 L/s), or 0.8% of air handler flow.

Variations in Pressure Related to AHU Location

From *Table 1*, the reader can observe variations in the pressure differential and airtightness test data from one AHU location to another. The degree of negative pressure in the return plenum for the garage AHUs is greater compared to the indoor location, and differs even more compared to the attic location. Variables such as filter media efficiency, filter loading, filter location, duct sizing, layout and duct leakage affect the return plenum pressure.

Considering that filtration and duct leakage did not consistently account for the greatest differences in plenum pressure, it appears that the lower magnitude of depressurization for the attic AHU systems was related to the layout of the ductwork. In the attic, the AHU typically lies horizontally and the return and supply ducts are more in-line with the AHU without severe changes in direction. AHU installations in the garage and indoors having return ductwork dropped from an above attic space result in a 180 degree turn through a rectangular duct into the upright AHU (without turning vanes). Sixty-five percent of the garage installations, 35% of the indoor installations and 0% of the attic installations had this type of layout.

Table 1 also shows that AHU cabinet and connections leakage varies from one AHU location to another, with the greatest leakage (Q 25) in the garage location. However, when gas furnaces (nine units) are excluded, the leakage in the cabinet is nearly identical for the three AHU locations. The variability of leakage in *Table 1* is affected by representation from six gas furnaces located in the garage with an average cabinet leakage of Q 25 = 39.0. This is about twice the average leakage found in non-gas furnace air-handling units.

While Q 25 in the AHU cabinet is similar for the three AHU locations (excluding furnaces), the calculated operational leakage (Q) is considerably higher in the garage and indoor AHU cabinets compared to those in the attic. This is due to the considerably higher operating pressures at the return connection and in the AHU cabinet for those two locations. Recall that the airflow rate is a function of hole size (Q 25) and pressure differential. For details on how Q is calculated, see Reference 5.

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Sample Size and Location →	Attic (23)	Garage (23)	Indoors (23)	Total (69)
Pressure at Return Connection (Pa)	-68.3	-110.2	-80.7	-86.4
Pressure in AH (-) Region (Pa)	-122.9	-160.2	-154.3	-145.5
Pressure in AH (+) Region (Pa)	98.0	108.8	113.8	107.7
Pressure at Supply Connection (Pa)	53.7	64.1	52.5	56.8
Q_{25} at Return Connection	2.0	5.9	3.8	3.9
Q_{25} in AH (-) Region	17.4	18.3	16.6	17.6
Q_{25} in AH (+) Region	1.4	5.7	1.7	2.8
Q_{25} at Supply Connection	1.7	2.2	1.0	1.6
Q_{25} sum	22.5	32.1	23.1	25.9
Q Return Connection (cfm)	3.7	14.4	7.7	8.2
Q AH (-) Region (cfm)	45.2	55.8	49.5	50.6
Q AH (+) Region (cfm)	3.2	13.8	4.2	6.7
Q Supply Connection (cfm)	2.7	3.9	1.6	2.6
Q AH (+) Connections (cfm)	54.8	87.9	63.0	68.1

Table 1: Average operating pressures (Pa), Q_{25} , and Q (calculated operational leakage) for 69 tested air-handling units. Units for Q_{25} are cfm at 25 Pa.

Impact of Air Handler Location Upon Duct System Q_{25}

Additional duct testing was performed in 20 of the 69 systems. This extended testing included measuring the overall duct system airtightness and is discussed here to show a relationship between air-handler location and duct leakage to out. The duct system airtightness testing followed the duct airtightness test method of Standard 152-2004 obtaining both *total leakage* and *leakage to out* using two calibrated blowers attached to the return and supply sides of the system.

On average, 56% of the leakage of the return ductwork (including air handler) and supply ductwork was to “out” (“out” defined as outside the conditioned space, including unconditioned spaces such as attic or garage). The surprise was that the fraction of the leakage to “out” on the return side varied much more than on the supply side (*Table 2*). For *return ductwork* (including air handler), the proportion of total leakage that is to “out” is 82% for attic AHU location, 68% for garage AHU location and 29% for an indoor AHU location.

This shows that placement of the AHU in an attic space results in a much larger amount of air leakage to an “outdoor” environment that is much more thermally hostile. Placement of the AHU in the attic also requires the return to be placed into the attic, whereas more of the return ductwork for other units was inside the house. Location of the air handler does not change the supply side “leakage to out” proportion much since supply ducts are located in the attic in all of these homes regardless of where the AHU is placed.

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CTTC (Continued from Pg. 9)

AH location	Return			Supply		
	Q_{25}	$Q_{25, total}$	% of Total Leak That Is Outside	Q_{25}	$Q_{25, total}$	% of Total Leak That Is Outside
Attic	32	38	82%	82	109	57%
Garage	43	63	68%	88	171	51%
Indoors	15	51	29%	63	120	53%

Table 2: Average duct system tightness and portion of duct leakage that is to outdoors $[(Q_{25, out}/Q_{25, total}) \times 100]$ in 20 houses.

Causes of AHU Leakage

Regardless of manufacturer, the AHU is designed with a metal cabinet requiring refrigerant and electric penetrations, and removable access panels. To integrate the AHU into the entire system, the contractor must make connections and penetrations into the air handler cabinet. In many cases, the manufacturer provides seals supplied that the installer can use to complete the installation. However, the study found that of all the items an installer could have sealed, only an area-weighted 16% were sealed. O-ring style gaskets were rarely installed leaving a gap between the refrigerant line and cabinet (Figure 2).

AHU cabinet leakage is distributed differently between gas and non-gas AHU systems. For gas furnaces, it is estimated (based on visual inspection) that about 80% of AHU leakage (Q_{25}) was due to panel leakage, 15% due to cooling coil box and 5% due to wire penetration. For non-gas AHUs, failure to install O-ring gaskets represented an estimated 50% of cabinet leakage. The other 50% was related to panel leakage, especially at the filter access (Figures 3 and 4).



Figure 3 (Left): Example of panel leakage in electric heat AHU. Figure 4 (Right): Thermostat control wire penetration leak area.

Achieving a tight air handler would be more likely if manufacturers deliver units that are airtight with engineered penetration points that require little effort on the part of the installer to maintain airtightness. Leakage at seams could be eliminated by requiring tighter panel fit tolerances and using thick panel gaskets in access panels. Penetration leakage could be improved by using flexible slip-fit style gaskets built into the cabinet that compress tightly around refrigerant and electrical line penetrations, that would only require the installer to push lines through the gasket. The authors estimate that eliminating leakage at seams and line penetrations could reduce AHU leakage by at least 90%.

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CTTC (Continued from Pg. 10)**Carbon Monoxide Transport From an Attached Garage**

ANSI/ASHRAE Standard 62.2-2007, *Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings*, addresses the problem of air contaminant transport. It addresses two pathways from garage to the occupied space: doorways and the air-distribution system. Section 6.5 states "When an occupiable space adjoins a garage, the design must prevent migration of contaminants to the adjoining occupiable space. Doors between garages and occupiable spaces shall be gasketed or made substantially airtight with weather stripping. HVAC systems that include air handlers or return ducts located in garages shall have total air leakage of no more than 6% of total fan flow when measured at 0.1 in. w.c. (25 Pa), using California Title 24 or equivalent." Of these two pathways, duct leakage would appear to represent a much greater contaminant transport risk.

To examine the level of risk, carbon monoxide (CO) transport experiments were performed in two single-story, concrete masonry unit (CMU), slab-on-grade Florida homes. *Table 3* presents characteristics of the two houses. In House 1, the AHU was located outdoors and no ductwork was located in the garage. The single door from the garage to the den was substantially airtight with gasketing. In House 2, the AHU, all of the return, and a small portion of the supply ductwork was located in the garage. Testing of the air-distribution system in House 2 found that $Q_{25,out}$ was 49 cfm (23 L/s) or 4.9% of the AHU nominal flow rate. Therefore, based on Section 6.5 of Standard 62.2-2007, the AHU qualifies to be located in the garage.

House	Number of Stories	Year Built	ft ²	ACH50	$Q_{25,out}$	House dP	Return Leak cfm
1	1	1985	1750	6.8	151	-0.4	137
2	1	1985	1280	4.0	48.6	+0.9	48

Table 3: Test house characteristics.

Testing at House 1 began by running a 2003 Ford Focus Station Wagon in the closed garage. CO levels in the garage rose within minutes to 18 parts per million (ppm) and remained at that level for a period of 35 minutes, at which time the car was turned off. Clearly this vehicle was not going to produce lethal levels of CO in the garage or the house during this experiment. To produce elevated CO in the garage, a five-year-old four-stroke lawn mower was turned on for a period of 80 minutes. Although operation of a lawnmower in a garage is unlikely, a 1996 NIOSH alert noted frequent accidental CO poisonings from small combustion appliances such as pressure washers, saws and generators in confined spaces.⁷ Indoor CO concentrations never exceeded 24 ppm while CO levels in the garage rose to 2,300 ppm (*Figure 5*).

CO levels in the house are a function of the quantity of CO transported and the house infiltration rate. CO transport is a function of CO concentration at the source, pathways from garage to house, and the driving force. The peak CO concentration of 2,300 ppm in the garage provided the source. Pathways occurred through the wall and doorway between the garage and house, as well as from the garage-to-attic into the house. The driving force (house at -0.4 Pa) was created by continuous operation of a 70 cfm bathroom fan. The interface between the garage and the attic is relatively tight. Nevertheless, attic CO levels rose to as high as 133 ppm. The ratio of indoor CO to garage CO was approximately 1 to 100.

CO levels were sampled at one point inside the wall separating the garage from the den. With the garage CO level at 400 ppm, the concentration in the wall cavity was found to be 303 ppm. Interestingly, when the door between the den and the central hallway was closed, supply air from the continuously running AHU fan created a positive 2.3 Pa pressure in the den wrt the garage and the CO concentration in the wall cavity dropped to 30 ppm within two minutes. This clearly demonstrates that direction of airflow and driving force are critical elements in CO (or any contaminant) transport.

An approximate characterization of the pathway and estimate of CO transport rate can be made. Based on measured house airtightness, a crude assumption that the leakage of the house envelope is uniformly distributed, the house being at -0.4 Pa (-0.0016 in. w.c.) wrt the garage, and the wall common to the house and garage represents 6% of the house surface area, we calculate the infiltration rate from garage to house to be a relatively small 4.3 cfm (2.03 L/s).

Continued on Pg. 12

CTTC (Continued from Pg. 11)

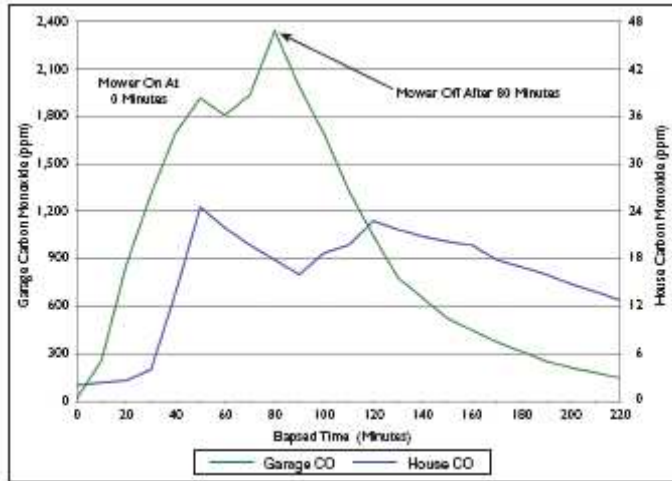


Figure 5: House 1 CO in house and garage shown with house pressure wrt garage.

Testing at House 2 was performed in much the same manner as at House 1. The same lawn mower was operated in the closed garage for a total of 92 minutes. At the end of 25 minutes, the garage CO level had increased to 1,570 ppm, and with the AHU remaining off, indoor CO had risen to only 3 ppm. At 25 minutes, the AHU was turned on and left running continuously for 68 minutes. Indoor CO levels began to increase immediately upon the activation of the AHU, rising to 300 ppm after 23 minutes of AHU operation (*Figure 6*). Garage and indoor CO levels peaked at 3,207 ppm and 600 ppm, respectively. NIOSH has a ceiling rate of 200 ppm that should not be exceeded at any time and has established an 8-hour time weighted average (TWA) "recommended exposure limit" of 35 ppm.⁸ It is of concern that the ratio of indoor CO to garage CO was about 20 times higher in House 2 than in House 1, indicating that AHU leakage and associated duct leakage create serious contaminant transport issues.

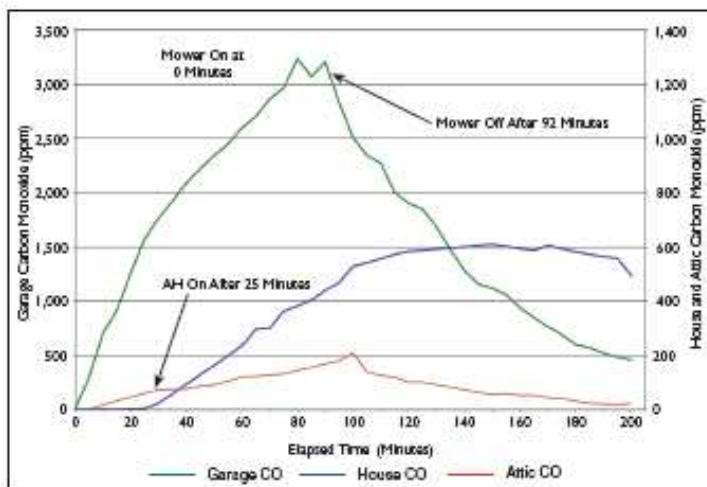


Figure 6: House 2 CO in house, garage and attic.

Testing found that the return leak fraction for the House 2 system was 6.9%, or 48 cfm (22.7 L/s), based on a tracer gas methodology.⁹ So, the question arises; what level of duct system tightness would be necessary to make House 2 safe from CO poisoning risk? If we select 35 ppm as a maximum permissible level, then the leakage that could be permitted would have to be on the order of 20 times less than what currently exists in that house. The return leak fraction, which is currently 6.9%, would need to be reduced to about 0.35%. In practical terms, this is an unachievable level of airtightness. The authors conclude that AHUs should not be located in the garage.

CTTC (Continued from Pg. 12)

Conclusions

AHUs are substantially leaky. On average, the return leak-age in the cabinet alone in 69 homes was found to be 50.6 cfm (23.9 L/s) (actual as-operated leakage), which is 4.2% of the total system measured airflow rate. This level of leakage represents a substantial energy penalty when that air is drawn from an unconditioned space, especially an attic space. A 4.2% return leak from attic air at 120°F (49°C) and 80°F (27°C) dew-point temperature cooled and dehumidified to 75°F (24°C) and 55°F (13°C) dew point temperature causes a 19% increase in energy use. When one considers that locating the AHU in the attic also results in a high proportion of the return leakage from return ducts to also be from the attic, the energy and peak demand implications of the attic location are enormous. The attic is not a good location for AHUs.

Health risks also may result from AHU leakage. As demonstrated by the experiments at House 2, the return leakage occurring in a tighter than average system, and one that meets the 6% total duct leak-age requirement of Standard 62.2-2007, created a transport mechanism that was more than capable of producing dangerous levels of CO in the living space. By contrast, the house without the AHU or ductwork in the garage, demonstrated little potential for CO poisoning risk, even though the house was operating at negative pressure throughout the experiment. The garage also is not a good location for AHUs. The best location for AHUs is inside the house, because leakage of air between the conditioned space and the air-distribution system causes little to no energy or IAQ consequences. However, two important rules should apply for indoor AHU locations. First, avoid use of building cavities as part of the return system, which can lead to high levels of return leakage from the attic, outdoors, basement, etc. Second, avoid zone depressurization that can lead to moisture (water vapor) intrusion or combustion safety problems.

A common argument against locating the AHU in the house is that it uses conditioned space. One effective solution is to place the AHU in the garage but carefully isolate it from the open area of the garage. This can be done by enclosing the AHU in a closet, tightly sealing the walls between the closet and the garage and providing door access to the closet only from indoors or from outdoors. In this design, it is important to allow the closet to be partially vented back to the conditioned space, so that if there is return leakage in the closet, it will draw air primarily from the occupied space.

Brian Simkins
CTTC

Article In: ASHRAE Journal, January 2008. Please see article for all references and credits.
By **James B. Cummings**, Member ASHRAE; and **Charles Withers Jr.**

Membership

I hope you all had a nice holiday and I wish you the best for the New Year.

Delinquent chapter dues are still a problem. I will have a copy of the delinquent list at the meeting and locate it next to the sign in sheet in case you want to check if your name is on the list. Keep in mind there are delays from when the dues are sent in to when they are posted so don't worry if you recently submitted payment.

We hope this will be another banner year for ASHRAE as your efforts to recruit new members and bring out old ones to the meetings is amazing. We are looking to sign up some YEA members, people under 30 years old, which helps us accumulate PAOE points and replenishes and strengthens our society.

See you at the meeting...

Richard Rosner, P.E.
Membership Chairman

Student Activities

I was honored to speak with Professor Kevin Brandt's students at SUNY Maritime last month. His students are studying HVAC Systems and Design. After a brief presentation on the LEED rating system, we discussed their current projects, which are building load calculations. Mr. Brandt's students were curious as to the daily professional life as an engineer, and we discussed their possible career tracks. I recommended that all eligible students consider taking the EIT exam regardless of their future career plans as a part of their professional development. Our chapter's thanks go to Mr. Brandt for the invitation.



The ASHRAE student zone has been updated to include information regarding the National Science, Technology, Engineering, and Mathematics (STEM) Education Coalition. STEM, in which ASHRAE is a member, works aggressively to raise awareness and advocates for the strengthening of STEM-related programs at all levels (K-12 and undergraduate) for educators and students and increased federal investments in STEM education. Please visit www.ashrae.org/students for more information including lesson plans for all age groups.

Our February meeting will be our Student Activities Night. Please consider reaching out to an engineering student you know and inviting them to attend. Additional information regarding the presentation topic will be included in the February newsletter.

Happy New Year to all our members!

Thomas Fields, PE, LEED AP
Student Activities Committee Chair

Charles Lesniak
Vice Chair



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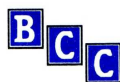


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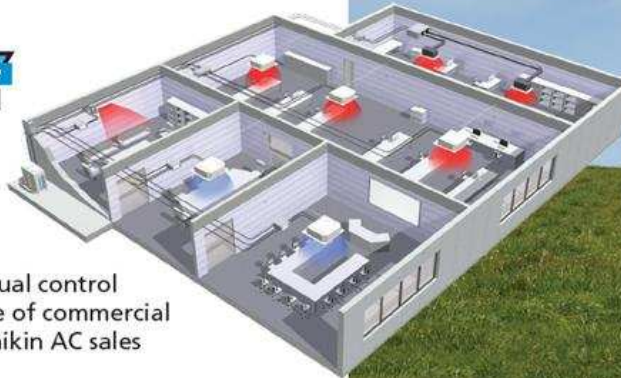
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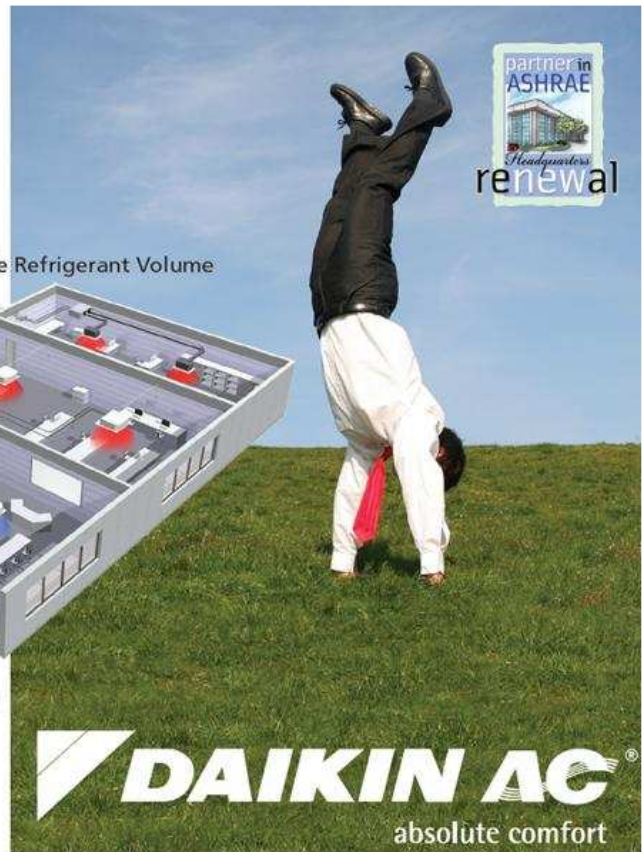
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