AMERICAN SOCIETY OF HEATING, REFRIGERATING

AND AIR-CONDITIONING ENGINEERS, INC.

1791 Tullie Circle, N.E.
Atlanta, GA 30329
404-636-8400

TC MINUTES COVER SHEET

TC/TG/TRG NO TC 5.2 DATE Later

TC/TG/TRG TITLE Duct Design

DATE OF MEETING January 21, 2014 LOCATION New York, NY

MEMBERS PRESENT	TERM TO	MEMBERS ABSENT	YEAR APPTD	EX-OFFICIO MEMBERS AND ADDITIONAL ATTENDANCE
Larry Smith	6/30/15			Johnny Andersson CM
Herman Behls	6/30/17			Cindy Bittel CM **(YEA Member)**
Wesley Davis	6/30/16			Pat Brooks CM
Kevin Gebke	6/30/17			Tim Eorgan CM
Steve Idem	6/30/16			Luis R. Escobar CM **(YEA Member)**
Ralph Koerber	6/30/16			John Hamilton CM
Gary Miller	6/30/16			Robert Hassler CM
Vikram Murthy	*			Ed Koop CM
Robert Reid	6/30/14			Bruce Meyer CM
Mark Smith	6/30/15			Mark Modera CM
Bill Stout	6/30/17			Mike Resetar CM
Craig Wray	6/30/17			Bill Smith CM
				Kent Anderson G
				Roy Cox G
				Scott Hobbs G
				V. Krishnan G
				Zacc Poots G **(YEA Member)**
				Luis Vargas G
				Mike Wolf G
				Mike Vaughn MORTS
				Ken Peet TAC Section Head

*Member Non-Quorum

- DISTRIBUTION

All Members of TC plus the following:	
TAC Section Head	Ken Peet
TAC Chair	Walter Grondzik
2017 Handbook Liaison (Fundamentals)	Larry Akers
2016 Handbook Liaison (Systems & Equipment)	Annette Dwyer
RAC Liaison	Piotr Domanski
Standards Liaison	Rick Larson
ALI/PDC	Hugh McMillan
Chapter Tech Transfer	James Arnold
Manager of Research & Technical Services	Mike Vaughn

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONIONG ENGINEERS

1791 Tullie Circle, N.E.
Atlanta, GA 30329

ASHRAE Winter Conference, New York, NY
TC 5.2 Duct Design

Tuesday, January 21, 2014
Time: 3:30-6:00 PM
Location: Clinton (Hilton 2nd floor)

1) **Call to Order:** Chairman Larry Smith called the meeting to order at 3:30 PM

2) **Special Announcements and Handouts**
   i. Agenda (refer to Exhibit 1).
   ii. Mini-seminar on air terminal leakage will be in this room at 5:00 PM (refer to Exhibit 2). Today's mini-seminar courtesy of Gus Faris (TC 5.3) and Gaylon Richardson (TC 7.7) is our first TC 5.2 educational opportunity.
   iii. TC 5.2 Vision Statement (refer to Exhibit 3).
   iv. Membership sub-committee chair will be Cindy Bittel (also a YEA member).
   v. Chair will approach Tom Werkema (ASHRAE Vice President and Chair, Technology Council) for assistance in improving relations with SMACNA.
   vi. Young Engineers in ASHRAE (YEA) Challenge
      a. Six words were requested from members to describe what TC 5.2 does.
      b. 18 TC members responded with suggestions (see Exhibit 4).
      c. Awarded to Gary Miller for "**HVAC Duct System Design and Performance**".
      d. $25 gift certificate courtesy of Lindab.
      e. Award to be posted on the TC 5.2 website and submitted to YEA for their use.
   vii. Proposed Standard (SPC 215P -- Method of Test to Determine Leakage Airflows and Fractional Leakage of Operating Air Handling Systems (Handout provide -- A copy of the proposed title, purpose, and scope for SPC 215P is available upon request from the TC Chair (tc0502@ashrae.net).
   viii. ASHRAE Code of Ethics (see Exhibit 5). The pre-amble states "…we pledge to act with honesty, fairness, courtesy, competence, integrity and respect for others in our conduct."
   ix. Next meeting is June 2014 in Seattle

3) **Introductions and Attendance**
   i. Attendee's introduce themselves
   ii. Voting Members Present -- 12
   iii. Voting Members Not Present -- 0
   iv. Chair announced that there is a quorum for the meeting
   v. Corresponding Members present (refer to cover sheet for attendees) -- 12
   vi. Provisional Corresponding Members present -- 0

vii. YEA members present -- 3 (Cindy Bittel, Luis Escobar, Zacc Poots)
viii. Guests present (refer to cover sheet for attendee's) -- 7

4) **Denver (June 25, 2013) Meeting Minutes**
- Motion to approve Denver meeting minutes by Craig Wray; 2nd by Mark Smith. Motion approved unanimously.

5) **Agenda**
i. No additions/deletions made.
ii. There were no requests by attendee's to speak regarding the proposed standard SPC 215P.

6) **Subcommittee Reports**
i. Section Head Highlights
   a. Section 5 has been requested to sponsor a track. TC 5.2 suggested the ASHRAE Duct Design Guide for Chicago 2015.
   b. TC is requested to emphasize the ASHRAE Code of Ethics.
   c. New MTG Formed: MTG.HCDG (Hot Climate Design Guide)
ii. TC 5.2 Vision Statement (Larry Smith)
iii. Honors and Awards (Idem)
   a. Research award to Herman Behls January 2013 (Dallas).
   b. 2013-2014 Hightower Award Recipient: G.D. Mathur (TC 5.7 – Evaporative Cooling)
   c. Herman Behls volunteered to put forth the paperwork to recommend Steve Idem as an ASHRAE fellowship.
iv. Handbook (Gebke)
   a. 2016 Handbook, Duct Construction chapter. First draft is due to the Handbook editor May 2015. We now have the option to update the chapter continuous on the website Handbook. For each change we need a vote recorded in the meeting minutes.
   b. 2017 Handbook, Duct Design chapter. First draft is due May 2016.
v. Membership (Larry Smith)
   a. New Membership Chair – Cindy Bittel.
   b. The 2014/2015 roster changes as a minimum will be as follows: Johnny Andersson as a non-quorum voting member; Scott Hobbs and Tim Eorgan as voting members.
vi. Programs (Idem)
   a. TC submitted a seminar pertaining to Air Dispersion Systems for this meeting. It was rejected. We will resubmit for Seattle (due February 13).
   b. We also submitted for New York a seminar related to fan performance and duct effects. The seminar was to be cosponsored with TC 5.1 (Fans), but it was rejected. We will contact TC 5.1 to see if they are interested in cosponsoring that seminar for Seattle.
   c. TC is planning for Chicago 2015 a series of seminars (track) related to the Duct Design Guide.

vii. Duct Design Guide (Pat Brooks)
   a. First draft of all chapters (see list below) is on the website. If you wish to review any chapter click on link http://files.unitedmcgill.com/6d48ff3195. The file share location is protected, so you will need the user name "ASHRAE" and password

"MEMBERS" (without the quotes) to access it.

b. Approval by TC 5.2 to release document to ASHRAE editor is scheduled for August 2014.

File	Chapter Title	Date Uploaded
TOC, Rev 26.doc	Table of Contents	15Jan2014
Chapter 1, Rev 1.doc	Introduction	9Jun2013
Chapter 2, Rev 11.doc	Sectioning a Duct Section for Design and Duct Design Considerations	20May2013
Chapter 3, Rev 9.doc	Equipment Room Locations and Fan Room/Duct Layout	16May2013
Chapter 4	Sectioning a Duct System for Design (Moved to Chapter 2)	Removed 1Feb2012
Chapter 5 Rev 4.doc	Duct Design Methods	16May2013
Chapter 6, Rev 1.doc	Duct Design -- Equal Friction	2Jul2012
Chapter 7, Rev 1.doc	Duct Design -- Static Regain	2Jul2012
Chapter 8, Rev2.doc	Duct Design – Local Exhaust Systems (Constant Velocity(	2Jul2012
Chapter 9, Rev 14.doc	Air Dispersion System Design	24Nov2013
Chapter 9 -- CD.xls	Chapter 9 – Example Designs	24Nov2013
Chapter 10, Rev 1.doc	Chapter 10 – Fan Selection	2Jul2012
Chapter 11, Rev 2.doc	Duct System Acoustics	12Nov2012
Chapter 11.Example Problems 11-6 & 11-7.xls	Chapter 11 Example Problems	2Jul2012
Chapter 12 Rev 6.doc	HVAC System Air Leakage	2Jun2013
Chapter 12 Leakage Class Calculator, Rev 2.xls	Leakage Class Calculator	2Jun2013
Chapter 13, Rev 4.doc	HVAC System Commissioning	23Apr2013
Chapter 13, Room Sound Power Calc.xls	Room Sound Power Calculator	23Apr2013
Chapter 14, Master Specifications for HVAC Duct Systems.docx	Specifying Ductwork	20Jan2014
Chapter 15, Rev 17.doc	Duct System Materials	15Jan2014
Appendix A, Rev 2.doc	Fundamentals	2Jul2012
Appendix B Rev 6.doc	Design Tools	2Feb2014
Appendix B, Table B-4 (I-P).xls	Equivalent Flat Oval Duct Dimensions (I-P)	2Feb2014
Appendix B, Table B-4 (SI).xls	Equivalent Flat Oval Duct Dimensions (I-P)	2Feb2014
Appendix C, Rev0.doc	Supplement To Chapter 8, Duct Design – Local Exhaust Systems	2Jul2012
Appendix D, Rev 2.doc	Supplement To Chapter 11, Fundamentals Of Acoustics	12Nov2012

viii. ALI (Brooks)

- Pat Brooks to submit a proposal to the ASHRAE Learning Institute (ALI) for development of a short course based on the ASHRAE Duct Design Guide. A

short course is a 3 hour instructor-led educational session.
- Contact is Karen Murray.

ix. TC Website (Mark Smith)
- Chair reports that TC 5.2 website is up to date.
- Kenneth Peet, TAC Section Head, reviewed our website and reported via a 1/21/14 e-mail to Larry Smith that TC 5.2 website is complete and up to date.

x. Liaisons (Larry Smith)
- Chair proposed Craig Wray and Scott Hobbs to be official TC 5.2 liaisons to SSPC 90.1 and SSPC 189.1 respectively. Motion to approve named liaisons was by Craig Wray, seconded by Bob Reid. Vote was unanimous (Craig Wray abstained for his nomination).

xi. Research (Behls)

a. RP 1606 – Lab Testing of Flat Oval Transitions (University of Illinois) – Final report with comments has been sent to Steve Ford. A meeting to discuss comments has been scheduled for February 6, 2014.

b. RP 1682-Study to Identify CFD Models to Determine HVAC Duct Fitting Loss Coefficients. PMS (Herman Behls, Kevin Gebke, Larry Smith, Craig Wray) met Monday January 20, 2014 with Piotr Domanski (RAC Liaison) to rank and vote on a recommended bidder. The PMS vote was 4-0-0 0 to recommend the bidder with the lowest bid price and highest average point total... Our RAC Liaison concurred.

   At this meeting the TC went into executive session. Everyone except voting members vacated the meeting room including voting member Steve Idem because he was a bidder. After discussion the TC voted 10-0-0-1 (Chair NV) to award the project to the bidder with the lowest bid price and highest average points total.

c. Future Work Statements. Report was given by Craig Wray for Herman Behls. There are a total of 38 different MTG.EAS ideas that have been generated (current list available from Herman Behls, tc0502.res@ashrae.net). TC 5.2 will take an active role for the six listed below. Larry Smith, as TC 5.2's Voting Member on MTG.EAS, is the TC's conduit for engaging with these potential projects. Parties interested in working to generate a work statement should contact Larry Smith and Herman Behls, who can then notify the contact person listed parenthetically in each case.

   1) MTG.EAS-026-10 Energy Impacts from Air Handler Casing Leakage (Julie Ferguson)
   2) MTG.EAS-027-10 Determine Air Leakage of Duct Transverse Joints and Associated Energy Costs (Bob Reid)
   3) MTG.EAS-028-10 Cost Effectiveness of HVAC System Air Leakage Tests During Operation (Jeff Boldt)
   4) MTG.EAS-029-10 Air Leakage of Duct-Mounted Equipment (Herman Behls)
   5) MTG.EAS-037-00 Cost Effectiveness of HVAC System Air Leakage Tests During Construction (Jeff Boldt)
   6) MTG.EAS-038-10 Economics of Airtight Non-Fan-Powered Single-Duct Terminal Units (Jeff Boldt)

xii. Standards

a. SMACNA/ASHRAE co-sponsored Standard BSR-SMACNA 021 – HVAC Total System Air Leakage Manual (Modera/Boldt). Dr. Modera and Jeff Boldt, ASHRAE voting and non-voting members respectively of BSR-SMACNA 021, report that there has been no contact since their original kickoff meeting at SMACNA February 2012 (2 years). They report that the status of the cosponsored standard is not known.

b. SPC 120-2008R (Gebke). Public review period has closed. No comments were received. As a result of RP-1606, there are three additional substantial changes that will require an ISC (Independent Substantive Change) public review specifically for those changes.

c. SPC 126-2008R (Gebke) – TPS change was approved by ASHRAE and SMACNA's BOD. SPC 126 has approved its release for public review.

d. SSPC 90.1 -- Energy Standard for Buildings Except Low-Rise Residential Buildings (Smith, 90.1 Liaison)

- No action with respect to the content of 90.1 covered by the scope of TC 5.2 (i.e., 6.4.4.2 Ductwork and Plenum Leakage).
- Craig Wray reported the following to SSPC 90.1 members (Larry Smith, the TC 5.2 Liaison, was not present):

d1. TC 5.2 continues to work on finalizing the ASHRAE Duct Design Guide that was started several years ago with RP-1180. The guide is expected to be completed later this year.

d2. TC 5.2 added HVAC system leakage to the Duct Construction and Duct Design chapters in the 2012 and 2013 Handbooks. SSPC 90.1 members should review the new material, and recognize that the scope has expanded from discussing only duct leakage area to considering leakage flows from the entire system during operation.

d3. TC 5.2 will be discussing the proposed title, purpose and scope of SPC 215P (Method of Test to Determine Leakage Airflows and Fractional Leakage of Operating Air-Handling Systems} under New Business." A TC 5.2 motion to support the proposal will be also be considered then. The proposal has already been approved by the Standards Committee, and the ASHRAE Board of Directors will consider approving the proposed TPS for SPC 215P on January 22, 2014.

d4. TC 5.2 will be hosting a technical seminar about VAV box leakage at its meeting on Tuesday, January 21 from 5:00 to 6:00p. Presenters will be Gaylon Richardson from Engineered Air Balance and Gus Faris from Nailor Industries. All are welcomed to attend.

e. SSPC 189.1 -- Standard for the Design of High Performance Green Buildings, except Low Rise Residential Buildings

- No report.

7) <u>Deadlines</u>

- Air Dispersion Systems seminar paperwork for Seattle (due 13 February).

8) <u>Old Business</u>

- ASHRAE/ADI Flex Duct Calculator (Chris VanRite not present; Present at Sunday's Subcommittee meeting)

a. Herman Behls provided comments (Exhibit 6) to Chris VanRite (ADI).

9) **New Business**

i. Proposed Standard SPC 215P – Method of Test to Determine Leakage Airflows and Fractional Leakage of Operating Air Handling Systems (Larry Smith)

- Bob Reid made a motion and it was seconded by Herman Behls for TC 5.2 to support the development of this proposed MOT standard to determine leakage airflows and fractional leakage of operating air-handling systems. The vote was 10-0-1-1 (Chair NV). Craig Wray abstained because he is the author of the proposed TPS for SPC 215P

ii. ASHRAE Publication Policy (Miller).

- Larry Smith reported that Steve Comstock (Director of Publications) and Ken Fulk (Chair, Fiscal Planning Subcommittee of Publishing Council) attended the subcommittee meeting and reported that for financial reasons not every publication will be free, but they will make publications available free of charge by having the TC chair submit requests to Mr. Comstock with justification.

10) Action Items

TC 5.2 Action Items			
Number	**Description**	**Assigned to**	**Status**
1	Investigate DFDB App – • Staff Contact: Steve Comstock • Developed by Carmel Software • App not maintained by ASHRAE • TC 5.2 not consulted	Kevin Gebke	Completed
2	Prepare & Distribute Vision Statement • Attached (Exhibit 3)	Larry Smith	Completed
3	Comparison of DFDB library and plaza machine libraries	Larry Smith Mark Terzigni Herman Behls	Active (Initiated June 2013)
4	Ad-hoc committee initiated for advocacy objectives for air distribution systems in existing and new buildings	John Hamilton Erik Emblem	Active (Initiated Jan 2014)
5	Submit proposal to ALI for Duct Design Guide course	Pat Brooks	Active (Initiated Jan 2014)
6	Submit to Standards Committee Scott Hobbs as TC 5.2's Liaison to SSPC 189.1	Larry Smith	Active (Initiated Jan 2014)
7	Change 90.1 Liaison from Larry Smith to Craig Wray Note: To change contact 90.1 chair, Drake Erbe (drakeerbe@airxchange.com) directly,	Larry Smith	Active (Initiated Jan 2014)

11) Adjournment at 5:00 PM

- Motion by Craig Wray second by Wes Davis. Motioned passed unanimously.

12) <u>VAV Box Leakage Mini Seminar (4:00 – 6:00 PM)</u>

- Presentations by Gaylon Richardson and Gus Faris followed by Q/A and open discussion.

Exhibit 1
Agenda

1. Call to Order
2. Special Announcements and Handouts
3. Introductions and Attendance
4. Denver Meeting Minutes
5. Agenda
6. Subcommittee Reports
   I. Section Head Highlights
   II. TC 5.2 Vision
   III. Honors and Awards
   IV. Handbook
   V. Membership
   VI. Programs
   VII. Duct Design Guide
   VIII. ALI (ASHRAE Learning Institute)
   IX. TC Website
   X. Liaisons
   XI. Research
   XII. Standards
7. Deadlines
8. Old Business
9. New Business
10. Action Items
11. Adjournment

Exhibit 2
Seminar – Terminal Unit Leakage
By Gus Faris & Gaylon Richardson

The purpose of this mini-seminar is to provide a better appreciation of terminal unit leakage and its impact on the HVAC industry

A PowerPoint presentation will be made regarding air leakage of VAV terminal unit control dampers and casing for various configurations (single duct, dual duct, series flow fan-powered, and parallel flow fan-powered) and appurtenances (access doors, hot water coils and electric coils).

Also included in the mini-seminar will be a 12 minute video showing how damper and casing leakage tests are performed for a single duct box, a dual duct box and a series flow fan-powered box. The video shows the inlets, the fan in the fan-powered box, and other inspection points on the boxes. We will show how air leakage is established for each box.

Open discussion and Q/A to follow.

Gus Faris has over 35 years experience in the air conditioning and air distribution business. Gus is the Vice-President of Engineering for Nailor Industries, Inc. with direct responsibility for product design and development, quality assurance, field services, and IT. Mr. Faris is a member of the AHRI Board of Directors, a member of the AHRI Systems Working Group, chair of AHRI Air Control and Distribution Devices section, chair of AHRI Heat Transfer Products section, active in AHRI Standard 880 and Standard 885 committees, past chair of ASHRAE TC 5.3 (Room Air Distribution), chair of ASHRAE RP-1292 [Development of Models for Series and Parallel Fan Variable Air Volume Terminal Units [Final Report: January 2007)], and a voting member of TC 7.7 (Testing & Balancing).

Gaylon Richardson is the president of Engineered Air Balance Co. and has chaired ASHRAE TC 7.7 (Testing & Balancing) and is currently the chair of ASHRAE Standard 111 (Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems). Gaylon has over 40 years experience in testing and balancing of HVAC air and hydronic systems and the commissioning of HVAC systems.

Exhibit 3

TC 5.2 Scope

TC 5.2 is concerned with the design, characteristics and construction of all types of ductwork for the handling of air and other gases, but does not include chimneys.

2014 Vision Statement

1. ASHRAE Duct Design Guide
   - Complete the initial version prior to the Chicago meeting (January 2015).
   - Present a track program with other TCs at the Chicago Winter Conference (January 2015).
   - Conduct 3-hour instructor-led ALI sessions at ASHRAE Winter/Annual Conference and ASHRAE Chapter meetings.
   - Provide complementary copies of the ASHRAE Duct Design Guide to architectural/mechanical engineering schools for the purpose of teaching duct design fundamentals and design.
2. Historian – Digitize and catalog all historical records from various members.
3. Membership chairperson
   - Planned roadmap for voting members and leadership positions.
   - Mentoring new members with respect to TC 5.2's activities and ASHRAE procedures.
4. Get contractors involved (maybe through TC 7.2 – HVAC&R Construction & Design Build Technologies.
5. Conduct educational programs at the TC's winter and annual meetings (Example: Item 12 above).
6. Improve the SMACNA/TC 5.2 working relationship.

Exhibit 4
YEA Challenge Contest

1. Standardize performance rating HVAC airflow components (Robert Hassler)
2. Optimize ducted air distribution system efficiency (Jeff Boldt)
3. Specifying standards for efficient air transportation (Vikram Murthy)
4. Making guidelines for efficient air transportation (Vikram Murthy)
5. Improve HVAC duct design and installation (Kevin Gebke)
6. Champion improvement of HVAC air distribution (Kevin Gebke)
7. Strive towards improved HVAC duct use (Kevin Gebke)
8. Advance air distribution designs and installations (Kevin Gebke)
9. Create high performance duct design standards (Bill Stout)
10. Develop air distribution design system standards (Wes Davis)
11. The best ways to transport air (Bob Reid)
12. Designing high efficiency air distribution systems (Ralph Koerber)
13. Designing more efficient air distribution systems (Ralph Koerber)
14. Efficiently channel healthy and comfortable air (Dr. Charles Culp)
15. Optimize ducted air distribution system design (Mark Smith)
16. Art of duct design and construction (Larry Smith)
17. Design climate control affecting every person (John Hamilton)
18. **HVAC Duct System Design and Performance (Gary Miller) – Winner of Contest**

Exhibit 5
ASHRAE Code of Ethics

(Approved by ASHRAE Board of Directors January 30, 2013)

As members of ASHRAE or participants in ASHRAE committees, we pledge to act with honesty, fairness, courtesy, competence, integrity and respect for others in our conduct.

A. Efforts of the Society, its members, and its bodies shall be directed at all times to enhancing the public health, safety and welfare.

B. Members and organized bodies of the Society shall be good stewards of the world's resources including energy, natural, human and financial resources.

C. Our products and services shall be offered only in areas where our competence and expertise can satisfy the public need.

D. We shall act with care and competence in all activities, using and developing up-to-date knowledge and skills.

E. We shall avoid real or perceived conflicts of interest whenever possible, and disclose them to affected parties when they do exist.

F. The confidentiality of business affairs, proprietary information, intellectual property, procedures, and restricted Society discussions and materials shall be respected.

G. Each member is expected and encouraged to be committed to the code of ethics of his or her own professional or trade association in their nation and area of work.

H. Activities crossing national and cultural boundaries shall respect the ethical codes of the seat of the principal activity.

Exhibit 6
ADI's Flex Duct Calculator
(Herman Behls' Comments)

TABS correspond to the attached EXCEL tabs. Not Attached

TAB: CFM-FPM Check

(1) I recommended that (1) the "Velocity" scale be limited to 5000 fpm (eliminate greater than 5000 cfm), and (2) the "Air Quantity" scale be extended from 80,000 cfm to 180,000 cfm.
(2) For the 90 in. steel duct diameter the "Air Quantity" scale needs to be lengthened to accommodate the combination "velocity/air quantity scales, but the equivalent rectangular scales are in the way?
(3) I recommend that the equivalent rectangular dimensions be eliminated because this only encourages "sizing" of duct "systems". Our goal as a TC is to encourage the "design" of duct systems.
(4) Accuracy of cfm/fpm scale is within 5.5% (OK).

TAB: CFM-IN. WATER Check

(1) The air quantity scale should be increased from 100,000 cfm to 200,000.
(2) The friction loss accuracy is within 16% (Table 1).
(3) Friction loss accuracy needs improvement.
(4) Friction Loss is for e=0.0003 ft.

Table 1 Friction Loss Accuracy

Diameter (Sheet Metal), in.	CFM	∆p, in. water		% Diff.
		Calculated	Calculator	
10	3000	3.801	4	**5.2**
20	10,000	1.147	1.26	**9.9**
30	20,000	0.563	0.65	**15.5**
40	40,000	0.503	0.58	**15.3**
50	60,000	0.356	0.4	**12.4**
90	100,000	0.05	0.06	**14.0**

TAB: FLEX DUCT DIAMETER Windows

(1) Change 96% Stretched to 4% Compressed
(2) Change 85% Stretched to 15% Compressed
(3) Change 70% Stretched to 30% Compressed
(4) Each Window: Increase flex duct scale from 16 in. to 20 in.
(5) Each Window: Increase low end of scale from 6 in. to 4 in.

TAB: Colebrook Equation Solution

This tab documents EXCEL programs to calculate (1) the friction factor and (2) duct pressure loss for any density, absolute roughness (e), airflow, diameter, and length. Colebrook equation uses EXCEL's Solver. The EXCEL program to solve for friction factor was not used in this study. Friction factors were calculated by use of the ASHRAE Duct Fitting Database (visual basic program).

TAB: Flex Duct PDCF

This TAB has the **Pressure Drop Correction Factor (PDCF)** for the Abushakra/Culp equation in the 2013 Handbook. The base resistance is for ducts in the medium rough category (e=0.003 ft).

This is important because this complicates the calculation for equivalent diameter flex duct. Equivalent duct is define as the diameter of flex duct (e=0.003 ft) at any compression ratio (K_c) that has the same resistance as a sheet metal duct (e=0.0003 ft) at the same airflow (Q) and length (L).

TAB: Equivalent Flex Duct

I used Equation (1) to calculate the equivalent diameters in Table 2. Equation 2 was calculated using the ASHRAE Duct Fitting Database.

The source for the **Calculator** equivalent diameter calculation is not known. I contacted Dr. Culp and he has not responded. I suspect Equation 1 was used and the solution of Equation 1 was simplified by assuming that the roughness factor for the sheet metal and flex ducts were the same (e=0.0003 ft). Culp has shown that the base roughness factor for flex duct is 0.003 ft.

Sheet Metal Duct Resistance = Flex Duct Resistance

$$\left(\frac{12\,FF_{0.0003}\,L\,\rho}{D_{SM}}\right)\left(\frac{Q*4*144}{\pi\,D_{SM}^2 1097}\right)^2=\left[\frac{12\,FF_{0.003}\,L\,\rho}{D_{FLEX}}\right]\left(\frac{Q*4*144}{\pi\,D_{FLEX}^2\,1097}\right)^2\left(1+0.58*K_c\,e^{[-0.126\,D_{FLEX}]}\right) \quad (1)$$

$$\frac{1}{\sqrt{FF}}=-2*\log\left(\frac{12\,\varepsilon}{3.7\,D}+\frac{2.51}{Re\sqrt{FF}}\right) \quad (2)$$

Where:

L = duct length, ft
D_{SM} = diameter, sheet metal, in.
D_{FLEX} = diameter, flex, in.
Q = airflow rate, cfm
FF = friction factor, ft
K_c = duct compression, %
Re = Reynolds number, dimensionless
e = absolute roughness, ft
ρ = air density, lb/ft^3

Table 2 Equivalent Diameter of Flex Duct								
% Comp.	4 in. Sheet Metal Duct		7 in. Sheet Metal Duct		10 in. Sheet Metal Duct		13 in. Sheet Metal Duct	
0	4.5	--	7.7	--	10.8	--	14.2	--
4	5.1	<6	8.5	7.9	11.6	11.5	15	15.4
15	6.0	6.0	9.7	9.2	13	12.5	16.4	>16
30	6.6	6.7	10.7	10.1	14	14.2	17.2	Out of Range

Recommendations

1. Replace Calculator by a "visual basic' program. The Calculator is "old" technology (monographs) for solving equations.
2. If you elect to retain the DUCT SIZE CALCULATOR the following is recommended.
   a. Change title to FLEX DUCT CALCULATOR

b. Change “steel duct diameter” to “sheet metal duct diameter.”
c. Remove the rectangular duct dimensions. I recommend that the equivalent rectangular dimensions be eliminated because this only encourages "sizing" of duct "systems". Our goal as a TC is to encourage the "design" of duct systems.
d. Change “96% Stretched” to “4% Compressed.”
e. Change “85% Stretched” to “15% Compressed.”
f. Change “70% Stretched” to “30% Compressed.”
g. Change flex duct scales from 6 in. to 16 in. to 4 in, to 20 in.
h. Limit the velocity scale to 5000 fpm.
i. Increase the air quantity scale from 80,000 cfm to 180,000.
j. Increase accuracy of Air Quantity/Friction Loss scales. In many cases the accuracy is greater than 5%.
k. Base the equivalent round flex duct diameters on a visual basic program or complete all sizes by the solution method attached.

3. If you do a Calculator I will complete Item 2k above.
4. If you do a Calculator I will do the SI calculator.