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 August 30, 2015

TC/TG/TRG TITLE Duct Design

DATE OF MEETING June 30, 2015 LOCATION Atlanta, Ga.

MEMBERS PRESENT	Term To	Members Absent	Year Appointed	EX-OFFICIO MEMBERS AND ADDITIONAL ATTENDANCE
Larry Smith	6/30/15	J. Andersson*	NA	Cindy Bittel, CM
Tim Eorgan	6/30/18	Scott Hobbs	6/30/18	Patrick Brooks, CM
Herman Behls	6/30/17	Bill Stout	6/30/17	David Diaz (CM)
Wesley Davis	6/30/16			John Hamilton, CM
Kevin Gebke	6/30/17			Bruce Meyer, CM
Steve Idem	6/30/16			Bob Reid, CM
Ralph Koerber	6/30/16			Alex Kouvolo, PCM
Gary Miller	6/30/16			Joe Brooks, G
Vikram Murthy*	NA			John Constantinide, G
Mark Smith	6/30/15			Gus Farris, G
Craig Wray	6/30/17			Robert Hassler, G
				David Krufde, G
				Ron Mitchel, G
				Shawn O Hara, G
				Tim Orris, G
				Ken Peet, G
				Julian Rochester, G
				Kezhen Shen, G
				Steven Watson, G
				Lauren Zelinski, G

*** Member Non-Quorum**
CM = Corresponding Member
PCM = Provisional Corresponding Member
G = Guest

Distribution: All Members of TC plus the following:	
TAC Section Head	Ken Peet
TAC Chair	Eric Adams
2017 Handbook Liaison (Fundamentals)	Larry Akers
2016 Handbook Liaison (Systems & Equipment)	Annette Dwyer
RAC Liaison	David John
Standards Liaison	Rick Larson
ALI/PDC	Darin Nutter
Chapter Tech Transfer	James Arnold
Manager of Research & Technical Services	Mike Vaughn

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1791 Tullie Circle, N.E.
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ASHRAE Summer Conference, Atlanta, Ga.

TC 5.2 Duct Design

Tuesday, June 30, 2015
Time: 3:30-6:00 PM

Location: Atlanta Hilton – RM 304

1. **Call to order:** Chairman Larry Smith called the meeting to order at 3:30 PM.
2. **Introductions and Attendance**
   i. Introduction of people present
   ii. Quorum established (10 voting members and 1 non-quorum member present)
   iii. There were no corrections/additions to the approved agenda
3. **Chicago (January 2015) Meeting Minutes**.
   - Minutes from the Chicago meeting were approved by electronic ballot April 22, 2015 7/0/0 CV.
4. **Special Announcements**
   i. ASHRAE Code of Ethics – "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."
   ii. ASHRAE Vision - ASHRAE will be the global leader, the foremost source of technical and educational information, and the primary provider of opportunity for professional growth in the arts and sciences of heating, ventilating, air-conditioning and refrigerating.
   iii. Chair Larry Smith recognized the following members for their accomplishments and contributions.
      a. Chair welcomed Cindy Bittel, Membership Subcommittee Chair, from maternity leave. Congratulations Cindy,
      b. Representing the Sheet Metal Air Rail & Transit (SMART) Union thru Local 104. David Diaz for his contribution on the Codes & Standards Interaction Subcommittee.
      c. Presentations. Dr. Ahmad Sleiti, Neal Walsh and Craig Wray for their presentation at the TC Duct Design Guide Subcommittee meeting.
5. **Subcommittee Reports**
   i. Section Head (Chair Larry Smith for Ken Peet, TAC Liaison)
      a. Please update your on-line ASHRAE bio if needed.
   ii. Honors and Awards (Steve Idem). Steve had nothing to report
   iii. Handbook (Kevin Gebke)
      a. 2016 Systems & Equipment Handbook, Duct Construction chapter
         - The chapter is undergoing some last minute revision based on the Codes and Standards Interaction Subcommittee report submitted by Chair Ralph Koerber at this meeting. Chapter will be sent for electronic ballot by October 30.
      b. 2017 Fundamentals Handbook, Duct Design chapter
         - Reviewers and revisers needed. Herman Behls and Ralph Koerber volunteered.
   iv. Membership (Cindy Bittel)
      a. Need more mentors for the mentorship program. We have one mentor in the

program: Larry Smith. E-mail Cindy if interested.

v. Programs (Steve Idem)
   a. We had three presentations during the Duct Design Guide Subcommittee meeting.
      i. "Estimating Leakage in Duct Systems: Internal Aerosol Sealing" by Neil Walsh
      ii. "Fan Power in Non-Residential Building Air-Handling Systems: A Part-Load Operation Perspective" by Craig Wray
      iii. "Introduction to Computational Fluid Dynamics (CFD)" by Dr. Ahmad Sleiti

vi. Duct Design Guide (Pat Brooks)
   a. There's a new website to download and review the Duct Design Guide: https://files.ashrae.org/ftp/login/?next=/ftp/private/browse/#path=/&limit=25&sort=name (Username**; tc5.2ddg;** Password**: DDG@dmin1**)

vii. Duct Fitting Database (DFDB) -- (Herman Behls)
   a. The current version of the DFDB is 06.00.04.
   b. A 7 May 2015 DFDB inquiry by Cheryl Nuttall questioned why for the exact same fitting the total pressure loss coefficients from SMACNA's HVAC Systems Duct Design manual (1977) are different than ASHRAE's iPhone DFDB (2011). See Exhibit 1 for a detailed explanation. A short explanation is that the 1977 SMACNA manual and the ASHRAE 2011 "App" are referenced to different cross sections (velocity pressures), thus there are different loss coefficients. Either way the total pressure losses are the same.
   c. The 1977 SMACNA manual and the loss coefficient in the 1977 ASHRAE Handbook were exactly the same then because the loss coefficients were referenced to the velocity pressure at the common section of junctions,

viii. Code Interaction (Ralph Koerber)
   - Subcommittee report attached (Exhibit 2).
   - Material to be included into the ASHRAE Handbooks (Duct Construction and Duct Design chapters) and Duct Design Guide, as appropriate.

ix. Awards (Steve Idem) -- Nothing to report.

x. ASHRAE Learning Institute (ALI) (Pat Brooks).
   - Short course for the ASHRAE Duct Design Guide is ON HOLD.

xi. Webmaster (Mark Smith)
   a. The website is up to date.
   b. Will update 2015/2016 roster when published by ASHRAE.

xii. Special Publication – ADI**/**ASHRAE Flex Duct Size Calculator (Herman Behls & Steve Idem).
   a. Received draft calculator from ADI (Chris Rite).
   b. Comments returned to Chris 22 June 2015.
   c. When changes (essentially editorial) are satisfactory, Steve Idem will email ballot to TC 5.2 with a motion that recommends that ASHRAE (Steve Comstock) allow ADI to publish the calculator with ASHRAE logo.

xiii. Liaison Reports
   a. Standard 90.1 (Craig Wray)
      - Addendum o regarding updates to duct sealing requirements completed public review in Oct 2014, only one comment (supportive) was received, the Mechanical Subcommittee recently addressed errata for IP units, and 90.1 is now contemplating next steps.
      - 90.1 is working to address past comments received on this issue and may have an updated proposal to discuss at the 90.1 Oct 2015 interim meeting.
      - Mark Smith will transition into being the TC 5.2 liaison.

xiv. Research (Herman Behls)
   a. RTAR-1764, Determine the Absolute Roughness for Phenolic Duct Board and Loss Coefficient for a Rectangular Radius Elbow

- Approved at Atlanta meeting by RAC with comments.
- Work with Research Liaison to address RAC comments on RTAR before proceeding with the development of the project's work statement.

b. WS-1758, CFD Modeling and Laboratory Testing of Flat Oval Diverging Flow Tees to Determine Loss Coefficients.

- Rejected by RAC.
- By rejecting this topic, RAC is strongly suggesting to the TC that this particular topic be dropped from the TC research plan based on the information provided.

c. RP-1682, Study to Identify CFD Models for Use in Determining HVAC Duct Fitting Loss Coefficients (Dr. Ahmad Sleiti)

- 85% completed on 8-inch elbows, 65% complete on 12 –inch elbows.
- Trends are consistent to aid in data development of other elbow sizes.
- Project completion expected 30 November 2015

xv. Standards

a. SMACNA/ASHRAE Co-sponsored Standard BSR**/**SMACNA 021 – HVAC Total System Air Leakage Standard (Mark Modera/Jeff Boldt).

- ASHRAE's Board of Directors approved ASHRAE participation in the subject standard 11 February 2011.
- No action to date (4 ½ years).

b. SPC 120-2008R (Kevin Gebke).

- Work plan and units plan (SI only) approved by SPLS and Standards Committee at Atlanta meeting
- SPC voting members approved subject standard for its third public review.

c. SPC 126-2008R (Kevin Gebke).

- Work plan and units plan (SI only) approved by SPLS and Standards Committee at Atlanta meeting
- SPC voting members approved subject standard for its second public review.

d. SPC 215P MOT to Determine Leakage Airflows and Fractional Leakage of Operating Air Handling Systems (Craig Wray).

- Subject standard is progressing on schedule and might be out for public review late this year.

6. Old Business

i. The TC title and scope changes (Exhibit 3) were discussed with Ken Peet (TAC Liaison) and other TC representatives in attendance.

ii. Ken Peet (TAC Liaison) recommended TC 5.2 withdraw their request for a TC title and scope change. This would allow further discussion with other TCs.

iii. TC 5.2 voted unanimously on the change in title**/**scope and advised Mr. Peet to proceed to TAC for a vote.

iv. TAC voted in executive session to deny the proposed TC 5.2 title/scope change, See Exhibit 4 for discussion by attendees at the TAC meeting.

v. Additional discussion with TAC will take place with Larry Smith in the lead.

7. New Business

- No new business

8. Action Items

TC 5.2 (Duct Design) Action Items			
No.	Description	**Assigned to**	Status

1	Comparison of DFDB fittings vs. plasma machine libraries or current manufacture's catalog	Larry Smith Herman Behls	Active
2	Submit proposal to ALI for Duct Design Guide	Pat Brooks	Active
3	Submit to Standards Committee Scott Hobbs as TC 5.2's liaison to SSPC 189.1	Larry Smith	Active
5	Submit TC 5.2 scope change to TAC	Larry Smith	Active

9. Adjournment (5:00 PM)

Exhibit 1
Cheryl Nuttall DFDB Inquiry
7 May 2015

I am noticing that there is a huge difference between SMACNA and ASHRAE fitting loss coefficient. Do you know (Eli Howard, Peyton Collie) who to talk to at ASHRAE, or maybe you have studied this?

I am noticing that SMACNA is higher for elbows but ASHRAE is much, much greater for T's especially the 90 degree tap-off for the branch losses. This is especially true in the latest program where most air going straight thru. There is a chance that the first or second tap is a higher pressure drop than a long run with many taps (I have a system with 31 taps).

Herman Behls Response:
The 1972 ASHRAE Handbook and earlier editions had the fitting data in terms (1) additional length, (2) zero length (local) pressure loss coefficients as a function of velocity, (3) static pressure regain, (4) static pressure loss for junctions as a function of velocity, (5) total pressure loss as a function of velocity pressure difference (area change), and (6) total pressure loss coefficients.

For the 1977 Handbook the data was converted to total pressure local loss coefficients. At this time the number of fittings was 68. Over the next three Handbooks (1977, 1985 & 1989) the number of fittings was increase to 103. Today the number of fittings exceeds 200, Loss coefficients were obtained by an international search of published literature and ASHRAE research.

In 1977 SMACNA published the same tables as ASHRAE in their "HVAC Systems Duct Design" manual. David Bevirt of SMACNA was a member ASHRAE's Technical Committee (TC) 5.2 (Duct Design) subcommittee responsible for the database. The only difference was SMACNA's fitting drawings were three dimensional and ASHRAE's two dimensional. Note that the junction main and branch loss coefficients are referenced to the common section, $C_{c,s}$ and $C_{c.b}$ respectively.

For the 1993 and older Handbooks the junction (tees, wyes) loss coefficient are referenced to the main (C_s) and branch (C_b) cross section areas. To convert the loss coefficients from the "common" section to the "branch" or "main" section refer to the 2013 Handbook of Fundamentals, Chapter 21, page 21.9 (Local Loss Coefficients section).

In 1993 ASRAE published a DOS=based Duct Fitting Database (DFDB), In 2008 ASHRAE published a Windows=based DFDB program. ASHRAE discontinued publishing the loss coefficient in the database because the DFDB programs will do the table interpolation and in recent years the local loss coefficients are expressed as equations. In addition to loss coefficient table

interpolation the DFDB calculates velocity, velocity pressure and fitting pressure drop for any air density (project elevation).

The diverging tee loss coefficients in your example do not match for two reasons: (1) the data sources (references) are different, and (2) the 1977 SMACNA and 2005 Handbook tables and the ASHTAE "App" are referenced to different cross sections as previously noted.

The 1977 SMACNA manual and the 1977 ASHRAE Handbook are based on Idelchik (1986). Fittings SD5-9 and SD4-10 in the 2005 ASHRAE Handbook and the 2005 DFDB are based on research by UMC (1986).

References:

Idelchik, I.E. 1986. Handbook of Hydraulic Resistance. Hemisphere Publishing Company, Washington, New York, London.

UMC. 1986. An experimental evaluation of the performance characteristics of various cybernation fittings. Laboratory Report No. SRF386, United McGill Corp., Westerville, OH.

Exhibit 2
ASHRAE TC5.2
Code Interaction Subcommittee Meeting Minutes
28 June 2015

Subcommittee Members:

Ralph Koerber, Chair
Dave Dias
Kevin Gebke
John Hamilton
Perry Philip
Mark Smith

Agenda:

Finalize recommended wording for Duct Design Guide related to flexible air ducts and air connectors.

Action:

The Code Interaction subcommittee submitted the following draft for inclusion in the Duct Design Guide. **Approved 6-0-0 (6).**

FLEXIBLE DUCTS

Flexible ducts are categorized by their listing as either an *Air Duct* or an *Air Connector* (see definitions). Air ducts and air connectors may be metallic or non-metallic and they shall be listed and labeled as Class 0 or Class 1 to the UL181 Standard for Safety Factory-Made Air Ducts and Air Connectors. These ducts shall be installed per the conditions of their listing and per the manufacturer's installation instructions provided. The maximum allowed temperature inside these ducts is 250°F (121°C) per their listing and NFPA 90A and 90B requirements.

DEFINITIONS

Flexible Air duct - A *flexible air duct* is a flexible duct that must pass all applicable tests in the UL 181 Standard to be listed as an "Air Duct". These tests include surface burning characteristics (ASTM-E84), flame penetration, burning, corrosion, mold growth & humidity, temperature, puncture, static load, impact, erosion, pressure, collapse, tension, torsion, bending, and leakage. Flexible air ducts are identified with a square or rectangular listing mark indicating the product is a Class 0 or Class 1 "Air Duct".

Flexible Air Connector - A *flexible air connector* is tested to only 13 of the 16 applicable tests within the UL181 Standard. Flame penetration, impact, and puncture testing are not required for air connector approval. Flexible air connectors are identified with a round listing mark indicating the product is a Class 0 or Class 1 "Air Connector".

Class 0 - An air duct or air connector having a Flame Spread and Smoke Developed Index of "zero" determined in accordance with ASTM E-84 (UL 723) can be listed as "Class 0".

Class 1 - An air duct or air connector having a Flame Spread Index not over 25 without evidence of continued progressive combustion and a Smoke-Developed Index of not over 50 determined in accordance with ASTM E-84 (UL 723) can be listed as "Class 1".

LIMITATIONS

Flexible air connectors are intended for limited-use within an HVAC system. They are limited by their listing, the IMC & IRC, and NFPA 90A & 90B to maximum 14 feet (4.3 m) installed length and limited by the UMC (2015) to maximum 5 feet (1.5 m) installed length.

Flexible air connectors shall not pass through any wall, partition, or enclosure of a vertical shaft that is required to have a fire resistance rating of 1 hour or more. Air connectors shall not pass through floors or ceilings.

RECOMMENDED INSTALLATION GUIDELINES

1. For nonresidential applications, flexible air ducts and air connectors should be limited to 6 feet installed length unless the duct system has been specifically engineered for use of longer duct lengths. Residential applications should use the minimum length required to make the run and connection.

2. Flexible air ducts and air connectors should be installed fully extended with minimal compression. Excess length is not allowed for possible future relocation of air terminal devices.

3. When installing flexible air ducts and air connectors in inaccessible spaces, attention should be given to the ability to clean the flexible duct following applicable industry practices.

4. When installing flexible air ducts and air connectors in inaccessible spaces, the use of metal worm-gear clamps is recommended. Non-metallic fasteners (plastic straps) are not recommended.

5. Install flexible air ducts and air connectors so that bends equal or exceed one duct diameter bend radius (based on the inside duct diameter). Ducts should not be bent across sharp corners such as pipes, wires, joists or trusses.

6. Flexible air ducts and air connectors directly upstream of VAV boxes. It is common to use short pieces of flexible duct for vibration and installation purposes. These lengths should be at least three (3) duct diameters before the VAV inlet.

7. Do not penetrate non-metallic flexible duct inner core with sheet metal screws unless the flexible duct manufacturer's installation instructions specifically allow the use of screws as part of the closure method.

8. Fittings used in combination with flexible air ducts and air connectors should have a 2" (50 mm) minimum rigid attaching collar with a bead. Flexible duct inner cores should be installed at least 1" onto the fitting and past the bead prior to taping and application of the mechanical fastener past the bead. Beaded fittings are not required when metal worm-gear clamps are used.

9. For insulated ducts, the outer vapor barrier should be pulled back over the core and fitting and secured using two (2) wraps of duct tape. A clamp may be used in place of or in combination with the duct tape.

10. Tape and mastic used for sealing flexible duct to metal fittings should be listed and labeled to the UL181B Standard and marked UL181B-FX for tape and UL181B-M for mastic.

11. Non-metallic mechanical fasteners (plastic straps) used with flexible duct should be listed and labeled to the UL181B Standard and marked UL181B-C.

12. Flexible air ducts and air connectors should be supported at intervals not exceeding 4 feet (1219 mm) when installed horizontal and 6 feet (1829 mm) when installed as vertical risers.

13. The maximum sag between horizontal duct supports should be ½" per foot (example: 2" maximum sag for 4 feet support spacing).

14. Flexible air duct and air connector supports should be minimum 1-1/2" (38 mm) wide and of sufficient rigidity to maintain this width (no cloth hangers) to prevent any restriction of the internal duct diameter when the weight of the supported section rests on the hanger.

REFERENCES

ASTM. 2013. Standard E84. Standard Test Method for Surface Burning Characteristics of Building Materials.

IMC. 2015. International Mechanical Code. International Code Council (ICC), Washington, D.C.

NFPA. 2015. NFPA 90A - latest ed. Standard for the Installation of Air-Conditioning and Ventilating Systems. Quincy, MA: National Fire Protection Association.

NFPA. 2015. NFPA 90B - latest ed. Standard for the Installation of Warm Air Heating and Air-Conditioning Systems. Quincy, MA: National Fire Protection Association.

UL. 2013. UL 181 - latest edition, Standard of Safety, Factory-Made Air Ducts and Air Connectors.

UL. 2013. UL 181B - latest edition, Standard of Safety, Closure Systems for Use with Flexible Air Ducts and Air Connectors.

Exhibit 3

Title: Duct ~~Design~~ Systems

Scope: Technical Committee 5.2 is concerned with the design, construction and operating characteristics~~, and construction~~ of ~~ductwork~~ duct systems for ~~the~~ handling air and other gases~~, but does not include chimneys~~. This includes consideration of duct system material and sizes, air velocities, and air leakage, as well as pressure changes and energy use related to ducted flow.

Exhibit 4
TAC Meeting (Atlanta, 1 July 2015)

Attendees:

- TC 5.3: Ken Laudermilk
- TC 5.6: name not known
- TC 6.3: Lauren Zielinski (she is not representing AHRI).
- TC 5.2: Larry Smith, Bob Reid, Steve Idem, Kevin Gebke and Herman Behls.

My impression (Behls) is that TAC will not approve any TC scope change when there is any opposition to a TC scope change. Ken Peet indicated to us that the issue is not closed and that we need to further discuss with each TC.

TC 5.3 (Room Air Distribution)

It appears that TC 5.3's comments are still directed to the earlier scope that was discussed in Chicago. Ken Laudermilk's 5-minute presentation to TAC had "component connections." In discussion with Ken after the TAC meeting it appear we can get agreement with TC 5.3 by direct discussion. My discussion with Ken after the meeting was the following.

(1) TC5.2 needs terminal unit loss coefficients for system analysis and the ASHRAE Duct Fitting Database. We met this goal because ASHRAE Standard 130-2015 has a test to determine terminal unit loss coefficients.

(2) TC 5.2's goal is to test operating HVAC systems and limit the entire system leakage to some maximum that results in significant energy savings. Our need is duct-mounted component leakage data. This goal is satisfied because ASHRAE Standard 130-2015 has a test for casing leakage.

(3) TC 5.2 did not initiate having certified leakage data in Standard 90.1. The subject Addendum X was initiated by the 90.1 mechanical subcommittee.

TC 5.6 (Control of Fire & Smoke)

TC 5.6 is concerned about TC 5.2's effect on fire and smoke dampers. We discussed the following:

(1) Dynamic Leakage. This leakage is controlled by a test in UL 555S. Dynamic leakage is the leakage through a closed smoke damper under condition defined in UL 555S. I said dynamic leakage of smoke dampers is not a concern because TC 5.2 is only concerned with casing leakage.
(2) TC 5.2 is only concerned with what the casing leakage is without affecting its UL rating.

TC 6.3 (Central Forced Heating and Cooling Systems)

It appears there is a conflict here. See underlined text in their scope below. TC 5.3 has the same problem because of the work "equipment." I am checking how equipment and ducts appears in the TC 6.3 chapters.

Scope. TC 6.3 is concerned with those central forced air systems used for residential and light commercial building comfort heating and cooling. Responsibility covers the design and performance of the entire system, including equipment, controls, ducts and the interactions of the system with building heating and cooling loads.