

**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 February 24, 2016

TC/TG/TRG TITLE Duct Design

DATE OF MEETING January 26, 2016 LOCATION Orlando, FL

MEMBERS PRESENT	TERM TO	MEMBERS ABSENT	YEAR APPTD	EX-OFFICIO MEMBERS AND ADDITIONAL ATTENDANCE
Bob Reid, Chair	6/30/17	Johnny Andersson	MNQ	Cindy Bittel (CM)
Tim Eorgan, Vice Chair	6/30/18			John Constantinide (CM)
Scott Hobbs, Sec.	6/30/18			Robert Hassler (CM)
Herman Behls	6/30/17			Bruce Meyers (CM)
Pat Brooks	6/30/19			Larry Smith (CM)
Wesley Davis (Conference Call)	6/30/16			Mark Smith (CM)
David Dias	6/30/19			William Smith (CM)
Kevin Gebke	6/30/17			Chris VanRite (CM)
John Hamilton	6/30/19			Gert Jensen (PCM)
Steve Idem	6/30/16			Jerry Sipes (PCM)
Ralph Koerber	6/30/16			Eric Adams (G)
Gary Miller	6/30/16			John Bade (G)
Vikram Murthy	MNQ			Mark Hooks (G)
Bill Stout	6/30/17			Eli Howard (G)
Craig Wray	6/30/17			Rod Koop (G)
				David Krupa (G)
				Mark Owen, Staff (G)
				Ken Peet, TAC (G)
				Perry Pimili (G)
				Kezhen Shen (G)
				Perry Tuggle (G)

MNQ = 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	Dr. Thomas Lawrence
2017 Handbook Liaison (Fundamentals)	Larry Akers
2016 Handbook Liaison (Systems & Equipment)	Annette Dwyer
Research Liaison	David John
Standards Liaison	Arsen Melikov
ALI/PDC	Cameron Labunski
Chapter Tech Transfer	James Arnold
Staff Liaison	Mike Vaughn

**AMERICAN SOCIETY OF HEATING, REFRIGERATION
AND AIR-CONDITIONING ENGINEERS**

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

ASHRAE Winter Conference, Orlando, FL.

TC 5.2 Duct Design

**Tuesday, January 26, 2016
Time: 3:30-6:00 PM**

Location: Lake Monroe A (L) Hilton

- 1) **Call to Order**
- 2) **Introductions and Attendance**
 - a) Introduction of people present
 - b) Quorum established: 15 of 16 voting members present.
 - c) There were no corrections/additions to the approved agenda.
- 3) **Atlanta (June 2015) Meeting Minutes**
 - a) Minutes from the Atlanta meeting were approved by electronic ballot October 7, 2015 9-0-0 CV.
- 4) **Special Announcements**
 - a) 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.”
 - b) 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.
- 5) **Section Head Report**
 - a) Please update your on-line ASHRAE bio.
 - b) TAC Section 5 Chair Ken Peet to spearhead (organize) a section meeting to work on common technical issues.
- 6) **Chairs report (Bob Reid)**
 - a) Erik Emblem passed away 30 September 2015. A moment of silence was held and David Diaz described contributions of Erik to ASHRAE and the industry.
 - b) Roster updates due February 1st -- Please review roster and give changes to the Chair.
 - c) Proposed change in scope initiative was rejected by TAC July 1, 2015.
 - d) Acknowledge Provisional Corresponding Members (PCM). The current PCMs of TC 5.2 are (1) Gert Jensen (KE Fibertec), (2) Jerry Sipes (Price Industries), and (3) Marc Sorge (Greenheck Fan Co.).

- e) Historian (Open)
 - Primary job is to keep track of research. Past research by TC 5.2 can be found under the Function tab on our website. See Exhibit 1 for summary since 1966.
- f) Honors and Awards (Steve Idem)
 - None. Last award was 2013 for research to Herman Behls.

7) **Subcommittee Reports**

- a) Handbook (Herman Behls)
 - i) 2016 Handbook: HVAC Systems and Equipment -- Chapter 18 “Duct Construction”
 - Approved by TC 16-0-0 (16).
 - Submitted to ASHRAE staff 4 January 2016.
 - Contributors to be listed in Handbook: Herman Behls, Craig Wray, and Ralph Koerber.
 - ii) 2017 Handbook: Fundamentals – Chapter 21 “Duct Design”
 - Comments due by St. Louis meeting (June 2016). Send comments to Herman Behls
- a) Membership (Cindy Bittel)
 - The following voting members roll-off roster to become corresponding members for 2016-2017: (1) Wes Davis, (2) Steve Idem, (3) Ralph Koerber, and (5) Garry Miller.
 - Larry Smith and Mark Smith wish to be voting members 2016-2017.
- b) Programs (Steve Idem):
 - A seminar entitled “Study to Identify CFD Models for Use in Determining HVAC Duct Fitting Loss Coefficients” was held on 25 January 2016. The speakers were Dr. Stephen Idem and Dr. Ahmad Sleiti. Experimental and CFD modeling results from RP-1682 were presented.
- c) Duct Design Guide (Pat Brooks and Herman Behls)
 - i) Herman Behls will complete a draft for ASHRAE editors by 1 July 2016.
 - ii) Behls discussed content of the “Fan Selection” chapter, and made a motion to remove the chapter from the Duct Design Guide (DDG), and provide an introduction of the subject and point to fan selection references. Seconded by Bill Stout. Motion approved 14-0-0-1 (not present) CNV. Craig Wray to prepare subject material.
 - iii) Herman Behls made a motion to remove the “Air Dispersion Systems” chapter from the DDG, Seconded by Craig Wray. Discussion, Kevin Gebke stated he revised chapter and resolved all comments by manufacturers, Behls never received because sent to wrong email address. Motion failed 14-0-0-1 CNV, Behls to review material sent by Gebke.
 - iv) Herman Behls made a motion to remove the Fundamentals of Acoustics and point to the material by Mark Schaffer (A Practical Guide to Noise and Vibration Control for HVAC Systems) which is an ASHRAE publication, Seconded by Pat Brooks. Discussion. Motioned passed 14-0-0-1 CNV.
 - v) Ductsize Program Users Manual and program received from Elite Software Development Inc. (Bill Smith) for review.
 - vi) ASHRAE has set up an FTP site for the Duct Design Guide

Site address: <http://files.ashrae.org/>

Username: tc5.2ddg

Password: DDG@dmin1

- d) Duct Fitting Database (Herman Behls)
- i) Version 6.00.05 submitted 12 January 2016 to John Downey for release. Major changes are:
 1. Added CD11-3, Straight Duct, Round, Velocity Limited
 2. Added CD3-22, Elbow, Flexible, r/D=1.0
 3. Added CD3-23, Elbow, Flexible, r/D=1.5
 - ii) With the release of the Internet (Online) version of the DFDB at the Orlando meeting (January 2016) Steve Comstock, Director of Publications, clarified the publication policy of the Standalone DFDB, Online DFDB, and DFDB Phone App (see Exhibit 2).
 - 1 Last Standalone DFDB for purchase will be 6.00.04.
 - 2 Standalone DFDB 6.00.04 will be updated to 6.00.05.
 - 3 First issue of the Internet DFDB is 6.00.04 [released at the 2016 ASHRAE Winter Conference (Orlando)].
 - 4 All purchasers of the Standalone 6.00.04 DFDB will receive a complimentary copy of the Online DFDB.
 - 5 All purchasers of the Online 6.00.04 DFDB will receive a complimentary copy of the 6.00.05 setup.exe file.
 - 6 Online 6.00.05 DFDB purchasers will receive a complementary Standalone DFDB.
 - 7 All future updates will be to the Online DFDB only.
- e) Codes and Standards Interaction (Ralph Koerber)
- See Exhibit 3 for Koerber's report.
- f) ASHRAE Learning Institute (ALI) (Pat Brooks)
- Cindy Michaels, Managing Editor of Special Publications, Cindy referred me to Karen Murray of the Education Department.
 - Will provide details when the Duct Design Guide is submitted to the ASHRAE editor.
- g) Webmaster (John Constantidine)
- i) TC 5.2 Website: <https://tc0502.ashraetcs.org/>
 - ii) TC 5.2 Website was reorganized by ASHRAE and all comments received have been incorporated. Send additional comments to John Constantidine.
- h) Special Publication – Flex Duct Calculator (Herman Behls / Steve Idem)
- i) Herman Behls made a motion to approve the ASHRAE/ADI calculator for publication. Motion seconded by Steve Idem. Discussion: Calculator passed around room. Steve Idem stated that the calculator is accurate within 5%. Behls stated that all editorial comments have been resolved and incorporated. Motion approved 14-0-0-1 CNV.
 - ii) In addition to the ASHRAE/ADI calculator, ADI retained the original ADI calculator. The ASHRAE/ADI calculator is SI & I-P. The ADI calculator is I-P with graphics on the other side with a pocket for business cards. Herman Behls requested to Chris VanRite that the I-P wheel and scales be the same as the ASHRAE/ADI calculator.
- i) Liaison Reports
- i) 90.1 (Mark Smith) -- Nothing to report.

- ii) SSPC 189.1 (Scott Hobbs) -- Nothing to report.
 - iii) SPC 215P (Craig Wray) – MOT to Determine Leakage Airflows and Fractional Leakage of Operating Air Handling Systems remains on schedule with a possible vote for Publication Public Review during Spring 2016.
- j) Research (Behls)
- i) RTAR by TC 5.3, Series and Parallel Fans, seeks co-sponsorship with 5.2 (Patrick Chinoda / Steve Idem)
 - Rejected by RAC, June 2015.
 - RTAR to be revised and resubmitted.
 - ii) RTAR-1674 -- Determine the Absolute Roughness of Phenolic Duct.
 - Conditionally approved June 2015 by RAC with two comments.
 - Film was shown how phenolic duct is fabricated.
 - David John (Section 5 RAC Liaison) approved resolution of comments.
 - Presentation of SMACNA's Phenolic Duct Construction Standards by Mark Terzigni can be found at www.smacnamw.org/files/fetch/Tech-Seminar-QR/PDCS-PPT.pdf
 - Bob Reid is working with phenolic duct manufacturers to get a manufacturer to provide ducts in scope assembled at researcher's lab at no cost to ASHRAE or the researcher.
 - iii) RP-1682- Study to Identify CFD Models to Determine HVAC Duct Fitting Loss Coefficients (Steve Idem, Dr. Ahmad Sleiti)
 - Contractor is to request a no-cost time extension to April to complete project.
 - The Principal Investigators presented the results of their research in a seminar held the previous day at the TC subcommittee meetings.
- k) Standards
- i) SMACNA/ASHRAE Co-sponsored Standard (BSR-SMACNA 023) (Mark Terzigni, Mark Modera, Jeff Boldt)
 - Eli Howard stated subject standard will be completed this year. So far, there has been no involvement by ASHRAE's representatives Mark Modera and Jeff Boldt.
 - ii) SPC 120-2008R (Kevin Gebke). Public review ends 8 February 2016.
 - iii) SPC 126-2008R (Kevin Gebke). Standard 126's public review was completed 26 January 2016. There was one supportive comment about the mixture of SI and I-P units in two places.
 - iv) SPC 215P MOT to Determine Leakage Airflows and Fractional Leakage of Operating Air Handling Systems (Craig Wray). SPC 215P remains on schedule with a possible vote for Publication Public Review during spring 2016.
- l) Review of ASHRAE's Technical Services Department "Technical FAQ's" (Reid)
Reviewers needed for the following Frequently Asked Questions (FAQ):
- What is ASHRAE's recommendation regarding duct cleaning?
 - What is ASHRAE's position on the use of internal duct lining?
 - Does ASHRAE have recommendations for return air plenum design?
 - What is ASHRAE's position on the use of fiberglass internal insulation in ducts or fiberglass duct board?
- 8) **Deadlines**
- Seminar, Forum & Workshop proposals for the upcoming meeting in St. Louis are due February 8, 2016
- 9) **Old Business**
- Ductwork Master Specification Review Meeting (Larry Smith)
(Meeting was scheduled for 1:00-2:00 PM Tuesday, January 26, 2016 at Spring Lake (L) Hilton with representatives of ARCOM/Masterspec to discuss a review/collaboration

with TC 5.2 to seek consistency between common specifications and current ASHRAE documents such as the Handbooks and Duct Design Guide.)

- Meeting cancelled because terms and conditions not met.
- Suggestion: Get involved on an individual basis.

10) **New Business**

None.

11) **Action Items**

TC 5.2 Action Items			
No.	Description	Assigned to	Status
1	Comparison of DFDB fittings vs. plasma machine libraries or current manufacture's catalog Purpose: Determine which popular fitting should be added to the DFDB.	Larry Smith & Herman Behls	Active (initiated Jan 2014)
2	New Subcommittee. Advocacy objectives for air distribution systems in existing and new buildings	John Hamilton Lead Dave Diaz Larry Smith Mark Smith	Active (Initiated January 2014)
3	Prepare the following FAQ for TC approval. • What is ASHRAE's recommendation regarding duct cleaning?	Not Assigned	Active (Initiated June 2015)
4	Prepare the following FAQ for TC approval. • What is ASHRAE's position on the use of internal duct lining	Not Assigned	Active (Initiated June 2015)
5	Prepare the following FAQ for TC approval. • Does ASHRAE have recommendations for return air plenum design?	Not Assigned	Active (Initiated June 2015)
6	Prepare the following FAQ for TC approval. • What is ASHRAE's position on the use of fiberglass internal insulation in ducts or fiberglass duct board?	Not Assigned	Active (Initiated June 2015)
7	RTAR – Cost to Seal Ductwork	Bob Reid (Lead), Neil Walsh, Pat Brooks,	Action (Initiated January 2016)
8.	<ul style="list-style-type: none"> • Add Historian position to roster • Fill Historian position 	Bob Reid (Chair)	Action (Initiated January 2016)

12) **Adjournment (5:55 PM)**

Exhibit 1

TC 5.2 (Duct Design) Research Projects				
Project	Year	Contractor	Title	Paper
RP-2	1966	Kansas State University	Duct Heat Transfer	<ul style="list-style-type: none"> • “Heat Losses from Horizontal Ducts Carrying High Velocity Air” by Kent & Nevins (ASHRAE Transactions 1966, V. 72, Pt.1) • No Final Report
RP-79	1975	University of Texas	Oval Duct Loss Coefficients	<ul style="list-style-type: none"> • “Pressure Drop in Flat-Oval; Spiral Air Ducts” by Heyt & Diaz (ASHRAE Transactions 1975, V. 81, Pt.2)
RP-81	1978	University of Texas	Duct Design Information: A Critical Assessment of High Velocity	<ul style="list-style-type: none"> • “A Critical Assessment of High Velocity Duct Design Information” by Rick Eschman and Dr. Wayne Long, September 1968 (ASHRAE Transactions 1970, V. 76)
RP-176	1978	Tennessee Tech. University	Friction of Air Duct Liners	<ul style="list-style-type: none"> • “Flow Losses in Rectangular Ducts Lined with Fiberglass” by Dr. Swim (ASHRAE Transactions 1978, V. 84, Pt.2)
RP-245	1980	Tennessee Tech. University	Plastic Duct Friction	<ul style="list-style-type: none"> • “Friction Factor and Roughness for Airflow in Plastic Pipes” by Dr. Swim (ASHRAE Transactions 1982, V. 88, Pt.1)
RP-308	1982	ETL Laboratories	Duct Leakage	<ul style="list-style-type: none"> • ETL Report No. 459507: “Investigation of Duct Leakage”, January 1985 • No paper.
RP-383	1984	Tennessee Tech. University	Friction Chart	<ul style="list-style-type: none"> • “Resistance to Flow of Round Galvanized Ducts” by Dr. Griggs, Dr. Swim & G.H. Henderson. (ASHRAE Transactions 1987, V. 93, Pt.1, pp 3-16.)
RP-447	1985	Tennessee Tech. University	Duct Leakage: Measurement, Analysis and Prediction	<ul style="list-style-type: none"> • “Duct Leakage Measurement and Analysis” by Dr. William Swim & Dr. Edwin Griggs (ASHRAE Transactions 1995, V. 101, Pt.1: 274-291)
RP-516	1986	Fluor-Daniel Corp.	T-Method: Optimization and Simulation	<ul style="list-style-type: none"> • “Using the T-Method for Duct System Design” by Dr. Robert Tsal (ASHRAE Journal, March 1990) • “T-Method Duct Design, Part I: Optimization Theory” by Dr. Tsal (ASHRAE Transactions 1988, V. 94, Pt.2) • “T-Method Duct Design, Part II: Calculation Procedure and Economic Analysis” by Dr. Tsal (ASHRAE Transactions 1988, V. 94, Pt.2) • “T-Method Duct Design, Part III: Simulation” by Dr. Tsal (ASHRAE Transactions 1990, V. 96, Pt.2)

TC 5.2 (Duct Design) Research Projects				
Project	Year	Contractor	Title	Paper
RP-549	1987	Tennessee Tech. University	Rectangular Duct Friction	<ul style="list-style-type: none"> “Flow Characteristics in Rectangular Ducts” by Dr. E. Griggs (ASHRAE Transactions 1992, V. 98, Pt.1)
RP-551	1988	United McGill Corp.	Select Fitting Loss Coefficients	<ul style="list-style-type: none"> “New ASHRAE Local Loss Coefficients for HVAC Fittings” by P.J. Brooks (ASHRAE Transactions 1993, V. 99, Pt.2)
RP-574	1989	Oklahoma State University	Computerized Fitting Database & Data Verification	<ul style="list-style-type: none"> “Duct Fitting Data Enhancements and Data Base Development” by Dr. Delahoussaye and Dr. McQuiston (ASHRAE Transactions 1994, V. 100, Pt.1)
RP-641	1989	Netsal & Associates	T-Method: Optimization with Leakage	<ul style="list-style-type: none"> “T-Method Duct Design: Part IV – Duct Leakage Theory” by Dr. Robert Tsal (ASHRAE Transactions 1998, V. 104, Pt.2) “T-Method Duct Design: Part V – Duct Leakage Calculation Technique and Economics” by Dr. Robert Tsal (ASHRAE Transactions 1998, V. 104, Pt.2)
RP-690	1991-94	Tennessee Tech. University	Oval Duct Fitting Resistance	<ul style="list-style-type: none"> “Equivalent Round Diameter of Spiral Flat Oval Ducts” by Brad Townsend, Fariborz Khodabakhsh, and Steve Idem (ASHRAE Transactions 1994, V. 100, Pt.2) “Main Loss Coefficient Measurements for Flat Oval Tees and Laterals” by Dr. Stephen Idem (ASHRAE Transactions 2003, V. 109, Pt.1:456-461) “Loss Coefficient Measurements in Divided-Flow Flat Oval Fittings” by Brad Townsend, F. Khodabakhsh & S. Idem. (ASHRAE Transactions 1996, V. 102, Pt.2:151-158) “Influence of Area Ratio on Flat Oval Divided-Flow Fitting Loss Coefficients” by Dr. Idem & F. Khodabakhsh (HVAC&R Research, Vol. 5, No. 1:19-33. January 1999) “Loss Coefficient Measurements for Flat Oval Elbows and Transitions” by Brad Townsend, F. Khodabakhsh & S. Idem. (ASHRAE Transactions 1996, V. 102, Pt.2:159-169)
RP-732	1994-08	University of Pittsburgh	Modeling and Structural Testing of Flat Oval Ductwork	<ul style="list-style-type: none"> “Experimental Testing and Computational Modeling of Flat Oval Duct Deflection” by Dr. Patrick Smolinski & G.S. Palmer (ASHRAE Transactions 1996, V. 102, Pt.1)

TC 5.2 (Duct Design) Research Projects				
Project	Year	Contractor	Title	Paper
RP-854	1995	Penn State	Determination of Duct Fitting Analysis by Numerical Analysis	<ul style="list-style-type: none"> “Flow Modeling of Flat Oval Ductwork Elbows Using CFD” by Dr. Stanley Mumma (ASHRAE Transactions 1997, V. 103, Pt.1)
RP-916	1996-07	Penn State	Impact of Close Coupled Ductwork Fitting Arrangement on System Pressure Drop based upon CFD Analysis and Field Measurement	<ul style="list-style-type: none"> “Close Coupled Ductwork Fitting Pressure Drop” by Dr. Stanley Mumma (HVAC&R Research, Vol. 3, No. 2, April 1997)
RP-1132	2001	Tennessee Tech. University	Leakage of Ducted Air Terminals	<ul style="list-style-type: none"> “Leakage of Ducted Air Terminal Connections: Part 1 – Experimental Procedure and Data Reduction” by Dr. Stephen Idem (ASHRAE Transactions, 2003, V. 109, Pt.2) “Leakage of Ducted Air Terminal Connections: Part 2 – Experimental Results” (ASHRAE Transactions, 2003, V. 109, Pt.2)
RP-1157	2002	Ruskin Mfg. Co.	Flow Resistance and Modulating Characteristics of Control Dampers	<ul style="list-style-type: none"> “Flow Resistance Characteristics of Airflow Control Dampers” by Robert Van Becelaere & Dr. Sauer (HVAC&R Research, Vol. 11, No. 1, January 2005) Van Becelaere, R. and H.J. Sauer. 2004. Flow resistance and modulation characteristics of control dampers. (Final Report, RP-1157, June 2004)
Private Research Project	2003	Tennessee Tech. University		<ul style="list-style-type: none"> Pressure Loss Coefficient Measurements of Two Close-Coupled HVAC Elbows (HVAC&R Research, Vol. 11, No. 1, January 2005)
RP-1223	2008	Tennessee Tech. University	System Effects of Propeller Fans	<ul style="list-style-type: none"> “Aerodynamic Performance and System Effects of Propeller Fans” by M.N. Young, C. Darvennes & S. Idem (HVAC&R Research, Vol. 15, No. 2, March 2009: 231-254)

TC 5.2 (Duct Design) Research Projects

Project	Year	Contractor	Title	Paper
RP-1319	2007-08	Tennessee Tech. University	Laboratory Testing of Flat Oval Elbows to Determine Loss Coefficients	<ul style="list-style-type: none"> • “Influence of Aspect Ratio and Hydraulic Diameter on Flat Oval Elbow Loss Coefficients” by D. Kulkarni, S. Khaire & S. Idem (ASHRAE Transactions, 2009, V. 115, Pt.1) • “Measurements of Flat Oval Elbow Loss Coefficients” by D. Kulkarni, S. Khaire & S. Idem (ASHRAE Transactions, 2009, V. 115, Pt.1) • “Pressure Loss of Corrugated Spiral Duct” by D. Kulkarni, S. Khaire & S. Idem (ASHRAE Transactions, 2009, V. 115, Pt.1, pp 28-34.) • “Measured and Predicted Pressure Loss in Corrugated Spiral Duct” by D.C. Gibbs and S. Item (AB 10-002) • “Influence of Test Section Entrance Conditions on Straight Flat Oval Duct Apparent Relative Roughness” by S. Khaire and S. Idem (ASHRAE Transactions, 2010, V. 116, Pt.2)
Private Research Project	2010	Tennessee Tech. University		<ul style="list-style-type: none"> • “Flat Oval Duct Leakage Class Measurement” by D.C. Gibbs and S. Idem (ASHRAE Transactions, 2010, V. 116, Pt.2) • “Measured and Predicted Pressure Loss in Corrugated Spiral Duct” by D.C. Gibbs and S. Idem (Funded by SPIDA) (ASHRAE Transactions, 2010, V. 116, Pt.2)
RP-1333	2007-08	Texas A&M	HVAC Duct Efficiency Measurements	<ul style="list-style-type: none"> • “Pressure Losses in 12”, 14”, and 16” Non-Metallic Flexible Ducts with Compression and Sag” by C. Culp and D. Cantrill (ASHRAE Transactions, 2009, V. 115, Pt.1, pp 622-628) • “Static Pressure Losses in Nonmetallic Flexible Duct (6”, 8” & 10”)” by C. Culp and K. Weaver (ASHRAE Transactions, 2007, V. 113, Pt.2, pp 400-405) • “Comparative Analysis of CFD ΔP vs. Measured ΔP for Compressed Flexible Ducts” by A. Ugursal and C. Culp (ASHRAE Transactions, 2007, V. 113, Pt.1) • Culp, C. HVAC Flexible Duct Pressure Loss Measurements (Final Report, Texas A&M University, May 2011).

TC 5.2 (Duct Design) Research Projects				
Project	Year	Contractor	Title	Paper
RP-1488	2008	Tennessee Tech. University	Laboratory Testing of Flat Oval Junctions to Determine Loss Coefficients	<ul style="list-style-type: none"> “Measurements of Flat Oval Diverging Flow Fitting (Tees & Laterals) Loss Coefficients” by D.C. Gibbs and S. Idem. (ASHRAE Transactions, 2012, V. 118, Pt.1) “Laboratory Testing of Converging Flow Flat Oval Tees and Laterals to Determine Loss Coefficients” by D. Kulkarni, J. Cui, and S. Idem (HVAC&R Research, 2011, 17(5): 710-725)
Private Research Project	2011	Tennessee Tech. University	Laboratory Testing of Saddle Tap Tees to Determine Loss Coefficients	<ul style="list-style-type: none"> “Laboratory Testing of Saddle-Tap Tees to Determine Loss Coefficients” by A.N Nalla and S. Idem. (ASHRAE Transactions, 2012, V. 118, Pt.1)
RP-1493	2012	University of Colorado Boulder, and University of North Carolina Charlotte	CFD Shootout Contest - Prediction of Duct Fitting Losses	<p>1st Place: “A procedure for predicting pressure loss coefficients of duct fittings using computational fluid dynamics” by Wei Liu, Zhengwei Long, and Qingyan Chen. HVAC&R Research, 18(6): 1168-1181.</p> <p>2nd Place: “CFD analysis of pressure losses in flat-oval duct fittings” by Emir Sirbubalo (Sarajevo, Bosnia), Haris Lulic, and Milovan Gutovic – (DE-13-030).</p> <p>3rd Place: “Prediction of duct fitting losses using computational fluid dynamics” by Andy Manning, John Wilson, Nate Hanlon and Travis Mikjaniec. HVAC&R Research, 19:4, 400-411.</p> <p>“Computational fluid dynamics to predict duct fitting losses: Challenges and opportunities” by Ahmad Sleiti, John Zhai and S. Idem. HVAC&R Research, 19:1, 2-4.</p>
RP-1606	2011/14	University of Illinois	Laboratory Testing of Flat Oval Transitions to Determine Loss Coefficients	<ul style="list-style-type: none"> “Laboratory Testing of Flat Oval Transitions to Determine Loss Coefficients” by Y. Sun, S.E. Ford and Y. Zhang. (ASHRAE Transactions, 2015, V. 121, Pt.1)
Private Research Project	2012	Tennessee Tech. University	Laboratory Testing of a Fabric Air Dispersion System	<ul style="list-style-type: none"> “Laboratory Testing of a Fabric Air Dispersion System” by D Kulkarni, A.N. Nalla. S. Idem and K. Gebke. (ASHRAE Transactions, 2012, V. 118, Pt.2)
Private Research Project	2013	Tennessee Tech. University	Loss Coefficients of Bends in Fully Stretched Nonmetallic Flexible Ducts	<ul style="list-style-type: none"> “Pressure Loss in Fully Stretched Nonmetallic Flexible Duct with a Bend” by R.K, Hodges, D. Kulkarni, and S. Idem. (HVAC&R Research, 19:1, 87-100 (2013)

TC 5.2 (Duct Design) Research Projects				
Project	Year	Contractor	Title	Paper
Private Research Project	2014	Tennessee Tech. University and Behls & Associates	Predicted Pressure Loss in Low Pressure Wire-Wound Flexible Ducts	<ul style="list-style-type: none"> “Predicted Pressure Loss in Low Pressure Wire-Wound Flexible Ducts” by S. Idem and H. Behls. (CH-15-09: ASHRAE Transactions, 2015, V. 121, Pt.1)
Private Research Project	2014	Tennessee Tech. University	Pressure and Velocity Variation in a Fabric Air Dispersion System	<ul style="list-style-type: none"> J. Leverette, K. Gebke and S. Item. 2014. Pressure and velocity variation in a fabric air dispersion system. HVAC&R Research, 20:8, 862-874, DOI: 10.1080/10789669.2014.957592. http://dx.doi.org/10.1080/10789669.2014.957592
Private Research Project	2015	Tennessee Tech. University	Flexible Duct Loss Coefficients	<ul style="list-style-type: none"> Kulkarni, D. and S. Idem. 2015. Loss coefficients of bends in fully stretched nonmetallic flexible ducts. Science and Technology for the Built Environment 21, 413-419. ASHRAE

Exhibit 2

Email 4 Feb 16 from Steve Comstock to Herman Behls, John Downey, Mark Owen & Chris Walter:

There seems to be a lot of confusion about the Duct Fitting Data Base project.

Let me try to tie down all the loose ends. One good thing about an online subscription product, we can make changes if a fix is needed.

- 1) We are no longer producing the CD. CD technology is rapidly phasing out for “cloud” based solutions. We can’t justify the maintenance of two products. Any review or changes should be made to the online version. That is our product of record.
- 2) The online version is available for purchase in our bookstore. We believed the work to be done and therefore gave the go ahead for release and promotion.
- 3) I understand you have sent corrections to John Downey and John is making the corrections. We will make sure you see those. We can send a notice to customer saying we have made revisions to their online product when the fixes are rolled out.
- 4) The App is a separate product, developed based on the CD product as it existed at the time and is not synched with the newer online product. We have a conundrum here. Sales of the product are not great but are steady. We have still not recovered development cost even though I believe we have been selling it for 5 years. At the same time our membership is demanding more apps from ASHRAE. The situation is that the project does not justify investment to go back and revise it, yet at the same time we do not want to diminish our app offerings. What we will do then is make sure our descriptions are clear the results are approximations and the product only has a limited number of fittings. We will use the app to drive customers to the full, current, online product. The descriptions will emphasize that. I will discuss lowering the price with that developer and the description.

Steve Comstock, Director of Publications

Exhibit 3

Codes and Standards Interaction Subcommittee Report

1. IAPMO Duct Task Group

Scope of Task Group is to review Chapter 6 of the 2015 Uniform Mechanical Code (UMC) and provide recommendations to the UMC Technical Committee before January 4th, 2016. Task Group held over 15 hours of teleconferenced meetings to review recommendations on all aspects of duct systems. Aspects of interest to TC 5.2 are

- a. Air Duct limitation of 5 feet for commercial applications. Task Group recommended the limitation be changed to 6 feet to match ASHRAE recommendation in Handbook. Also, recommended an exception allowing longer lengths when the system is engineered for longer lengths.
- b. The Task Group recommended the UMC once-again prohibit the use of Air Connectors.
- c. The Task Group recommended appropriate language to add Phenolic Ducts constructed per SMACNA “Phenolic Duct Construction Standards.”
- d. The Task Group recommended the addition of ten flexible duct installation requirements (taken from the recommendations previously made by TC 5.2 Codes & Standards Interaction subcommittee) to help improve installations.
 1. Ducts shall be installed using the minimum required length to make the connection.
 2. Horizontal duct runs shall be supported at not more than 4 feet (1219 mm) intervals.
 3. Vertical risers shall be supported at not more than 6 feet (1829 mm) intervals.
 4. Sag between support hangers shall not exceed 1/2 inch (12.7 mm) per foot (305 mm) of support spacing.
 5. Supports shall be rigid and shall be not less than 1-1/2 inches (38 mm) wide at point of contact with the duct surface.
 6. Duct bends shall be not less than one duct diameter bend radius.
 7. Screws shall not penetrate the inner liner of non-metallic flexible ducts unless permitted in accordance with the manufacturer’s installation instructions.
 8. Fittings for attaching non-metallic ducts shall be beaded and have a collar length of not less than 2 inches (51 mm) for attaching the duct. Exception: A bead shall not be required where metal worm-gear clamps are used or where attaching metallic ducts using screws in accordance with the manufacturer’s installation instructions.
 9. Duct inner liner shall be installed at not less than 1 inch on the collar and past the bead prior to the application of the tape and mechanical fastener. Where mastic is used instead of tape, the mastic shall be applied in accordance the mastic manufacturer’s instructions.
 10. Duct outer vapor barriers shall be secured using 2 wraps of approved tape. A mechanical fastener shall be permitted to be used in place of, or in combination with, the tape.

The Task Group had a lot of discussion regarding the use of building materials (i.e. framing members and gypsum board) for supply and return ducts without specific requirements for performance and moisture mitigation like other duct materials. No decision was made by the Task Group.

An action item was initiated for the Codes & Standards Interaction subcommittee for review of use of building materials for duct construction in regards to potential addition to the Duct Construction chapter of the HVAC Systems and Equipment Handbook.

Other recommendations from Task Group members could not be included in the proposals to the UMC Technical Committee (TC) as the Task Group ran out of time before the January 4th deadline. Members were urged to make these proposals on an individual basis directly to IAPMO.

2. NFPA 90A and 90B

Koerber reviewed with the NFPA Technical Committee (TC) during the October 15th First Draft meeting for the 2018 standards Larry Smith's concern with respect to the intent of Air Connector language in 90A & 90B. As a result, NFPA TC included proposals as follows to the First Draft revisions of applicable sections of NFPA 90A & 90B.

From NFPA 90A:

4.3.2 Air Connectors.

4.3.2.1 Air connectors shall be permitted to be used as ~~are~~ limited-use, flexible air ducts that shall not be required to conform to the provisions for air ducts where they meet the requirements of 4.3.2.1.1 through 4.3.2.1.57.

4.3.2.1.1 Air connectors shall conform to the requirements for Class 0 or Class 1 air connectors when tested in accordance with ANSI/UL 181, Standard for Safety Factory-Made Air Ducts and Air Connectors.

4.3.2.1.2 Class 0 or Class 1 air connectors shall not be used for ducts containing air at temperatures in excess of 121°C (250°F).

4.3.2.1.3 Air connector runs shall not exceed 4.27 m (14 ft.) in length.

4.3.2.1.4 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.

4.3.2.1.5 Air connectors shall not pass through floors.

4.3.2.1.6 An air connector shall not be interrupted by a short collar or any other fitting on one side and then connected to another air connector on the other side when penetrating (a) a floor or (b) a wall, partition or enclosure of a vertical shaft that is required to have a fire resistance rating of 1 hour.

4.3.2.1.7 Multiple air connector runs shall not be spliced together to exceed the length limitation in 4.3.2.1.3.

4.3.2.2 Vibration isolation connectors in duct systems shall be made of materials having a maximum flame spread index of 25 and a maximum smoke developed index of 50.

4.3.2.3 Wiring shall not be installed in air connectors.

From NFPA 90A:

4.1.2 Air Connectors. Air connectors shall be permitted to be used as ~~are~~ limited-use flexible air ducts that shall not be required to conform to the requirements for air ducts provided they meet the following requirements:

- (1) Air connectors shall conform to the requirements for Class 0 or Class 1 air connectors when tested in accordance with ANSI/UL 181.
- (2) Class 0 or Class 1 air connectors shall not be used in ducts containing air at temperatures in excess of 121°C (250°F).
- (3) An air connector run shall not exceed 4.3 m (14 ft.) in length.
- (4) 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.
- (5) Air connectors shall not pass through floors.
- (6) An air connector shall not be interrupted by a short collar or any other fitting on one side and then connected to another air connector on the other side when penetrating (a) a floor or (b) a wall, partition or enclosure of a vertical shaft that is required to have a fire resistance rating of 1 hour.
- (7) Multiple air connector runs shall not be spliced together to exceed the length limitation in 4.1.2 (3).

3. UL181

The following questions submitted by Larry Smith (TC Chair) were brought by Koerber to the UL Standards Technical Panel for consideration.

a. Proposal to UL for a marking change for Air Ducts and Air Connectors such that the listing mark can be identifiable from a distance of 20 feet (especially Air Connectors).

Response: UL indicated that this label requirement would be inconsistent with any other labeling requirement for other products listed and labeled for building use.

However, any and all proposals or initiation of discussions can be made through UL's Collaborative Standards Development System. Any person(s) can make proposals using the UL CSDS process as described on the web site <http://csds.ul.com/Home/Default.aspx>. Anyone can create a user account and participate in the proposal or discussion process along with the Standards Technical Panel.

b. Proposal to UL regarding the frequency of listing mark labels as required by the UL181 Standard. The standard requires a label at least every 10 feet or fraction thereof if the product is manufactured less than 10 feet in length. When products are cut to length in the field this could lead to a length of duct installed without a label. It is recommended that the label requirements for Air Ducts and Air Connectors be every 3 feet. Most manufacturers of insulated Air Ducts already apply the label every three feet as this makes it consistent with the R-value labeling requirement.

Response: UL indicated that there have not been any issues reported from AHJ's (Authority having Jurisdiction) regarding the labeling requirement in the UL181 Standard; however, again this discussion or proposal can be initiated and handled through the CSDS process as referenced above.