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 January 26, 2015

TC/TG/TRG TITLE Duct Design

DATE OF MEETING January 26, 2015 LOCATION Chicago, IL

MEMBERS PRESENT	Term To	Members Absent	Term To	EX-OFFICIO MEMBERS AND ADDITIONAL ATTENDANCE
Larry Smith	6/30/15	J. Andersson*	6/30/18	Kent Anderson, CM
Tim Eorgan	6/30/18			Patrick Brooks, CM
Herman Behls	6/30/17			David Diaz (CM)
Wesley Davis	6/30/16			John Hamilton, CM
Kevin Gebke	6/30/17			Robert Hassler, CM
Scott Hobbs	6/30/18			Edward Koop, CM
Steve Idem	6/30/16			Bruce Meyer, CM
Ralph Koerber	6/30/16			Bob Reid, CM
Gary Miller	6/30/16			Michael Resetar, CM
Vikram Murthy*	6/30/17			Bill Smith, CM
Mark Smith	6/30/15			Mark Terzigni, CM
Bill Stout	6/30/17			Chris Van Rite, CM
Craig Wray	6/30/17			John Babe, G
				Michael Bejrowski, G
				Charles Cottrell, G
				Luis Escobar, G
				Gus Farris, G
				Gert Jensen, G
				David John, G
				Mark Hooks, G
				Tim Manz, G
				Shawn O Hara, G
				Julian Rochester, G
				Mark Owens, G
				Ken Peet, G
				Curtis Peter, G
				Perry Philp, G
				P. Siddharth, G
				Jerry Sipes, G
				Jack Stegall, G
				Steve Taylor, G
				Steve Walton, G
				Lauren Zelinski, G

*** Member Non-Quorum**
CM = 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, Seattle, WA.

TC 5.2 Duct Design

Tuesday, January 26, 2015
Time: 3:30-6:00 PM

Location: Palmer House -- Logan

1) **Call to order:** Chairman Larry Smith called the meeting to order at 3:30 PM
   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. Member and Guest Introductions (12 VM, 1 Member Non-Quorum)
      b1. 12 CM
      b2. 21 Guest
      b3. 4 YEA Members
   c. Quorum was met.
   d. Approve agenda – additions and/or corrections
   e. Minutes from the Seattle meeting were approved August 18, 2014 12/0/0/0 by electronic ballot
   f. Section 5 report
      f1. CEC (Conference and Expositions Committee) will commence to incorporate technical sessions, forums, etc. to be conducted at the technical conferences that will be advertised in the conference guide as long as a minimum standard is achieved
      f2. Please update your ASHRAE bio
2) **Subcommittee Reports**
   a. **Membership** (roster changes effective July 1, 2015)
      a1. Chair – Bob Reid
      a2. Vice Chair – Tim Eorgan
      a3. Secretary – Scott Hobbs (to be confirmed)
      a4. Roll off as voting member:
          (1) Larry Smith
          (2) Mark Smith
      a5. New Voting Members
          (1) David Diaz
          (2) John Hamilton
          (3) Bob Reid
          (4) Pat Brooks
      a6. New Corresponding Members
          (1) Patrick Chinoda – Hartzell
   b. **Honors and Awards** (Steve Idem)
      None
   c. **Handbook** (Kevin Gebke)
      c1. 2016 Handbook – Duct Construction chapter

(1) Please comment on chapter and send comments to Kevin Gebke (kgebke@ductsox.com).

c2. 2017 Handbook – Duct Design chapter

(1) No comments received.

d. **Programs** (Steve Idem)

d1. On Monday, 1/26/2015, a seminar sponsored and conducted by TC 5.2 entitled 'Installation and Code Requirements for Flexible Air Duct and Flexible Air Connectors' was conducted during the Duct Design Guide Subcommittee meeting. The speakers were Dr. Charlie Culp, John Hamilton, and Ralph Koerber.

e. **Duct Design Guide** (Pat Brooks)

e1. The subcommittee met on Monday for about 2 hours. Kevin Gebke needs to resolve comments with vendors on Chapter 9, Air Dispersion Systems. Herman Behls needs to update the sample problems for the equal friction design and static regain design. Pat Brooks will do the design in I-P units, then later in SI units. That is expected to be done by the end of March. Herman will reorganize the chapters since we have deleted some and make sure the reference to chapter sections is updated. He also will edit the Acoustical Chapter 11 to make it easier to use. We expect to send a draft of the design guide to Publications by the June meeting or just after.

f. Duct Fitting Database (DFDB) (Herman Behls)

f1. Version 6.00.04 issued 18 December 3014.

f2. All research results for flat oval fittings incorporated (elbows, tees and transitions).

f3. All DFDB inquiries have been resolved.

f4. Steve Comstock is to issue a contract to John Downey to put the DFDB on the Internet.

g. **Code Interaction** (Ralph Koerber)

g1. See Exhibit 1 for report.

h. **ASHRAE Learning Institute** (ALI) (Pat Brooks)

h1. No action until the Duct Design Guide is published.

i. **Webmaster** (Mark Smith)

i1. The TC 5.2 website is current. The presentations from the Annual Meeting have been added to the website and the roster has been updated. He will work with the committee to add the presentations from the Winter Meeting.

j. **Research** (Herman Behls)

j1. RP-1682, Study to Identify CFD Models to Determine HVAC Duct Fitting Loss Coefficients

(1) Contractor: Embry-Riddle University, Principal Investigator: Dr. Ahmad Sleiti; Sub-Contractor: Tennessee Technological University, Dr. Steve Idem

(2) PMS: Herman Behls (Chair) with Kevin Gebke, Larry Smith, Dr. Emir Sirbubalo, and Craig Wray.

(3) A progress report was presented on Sunday, 1/25/2015 during the Research Subcommittee meeting by Dr. Idem. Tare pressure loss measurements of the 8 in. diameter straight duct, as well as all pressure loss testing of single elbows and two close-coupled elbows (Z- and U-configurations), has been completed. Regarding the CFD modeling, the following was reported: results for numerical grid requirement for near wall treatment, numerical grid convergence requirements, detailed discussion of capabilities and limitations of each model, ability of predicting wall roughness, computational time requirements and computational resources requirements. CFD modeling of the 8 in. diameter cases is 50% completed, and detailed discussion of the

results is still being finalized and will be reported in the next reporting period.

j2. **Work Statements and RTARs**

(1) WS-1758, CFD Modeling and Laboratory Testing of Converging Flow Flat Oval Tees to Determine Loss Coefficients (Steve Idem). Scope discussed and it was noted that WS-1758 will sent email to David John (RAC Liaison), and TC 5.2 voting members for comments and approval.

(2) CFD Modeling and Laboratory Title: Cost Effectiveness of HVAC System Air Leakage Tests during Operation (MTG.HPAS #028) (Jeff Boldt and Herman Behls)

- **Purpose:** To determine the economics (pay-back period) for leakage testing both new and existing non-residential HVAC systems. Systems are to be tested in compliance with ASHRAE Standard 215P, Method of Test to Determine Leakage Airflows and Fractional Leakage of Operating Air-Handling Systems.

(3) Field tests to validate the SPC 215P MOT (Larry Smith)

(4) RTAR-1674, Determine the Absolute Roughness of a Phenolic Duct Material (Mark Terzigni)

k. Standards

k1. SMACNA/ASHRAE Co-sponsored Standard (BSR-SMACNA 023) – System Air Leakage Test Standard (Mark Modera/Jeff Boldt)

(1) Mark Terzigni gave a verbal report. We are currently working on obtaining leakage rates/classes for some commonly used accessories such as volume dampers and fire dampers.

k2. SPC 120-2008R (Kevin Gebke). First and second public review completed. Third public review ends 2 March 2015.

k3. SPC 126-2008R (Kevin Gebke). SPC voted approval for second public review. Approval for public review by SMACNA's BOD pending.

k4. SPC 215P MOT to Determine Leakage Airflows and Fractional Leakage of Operating Air Handling Systems (Craig Wray)

(1) Activity: First meeting conducted at Seattle (30 June 2014). Meetings since than have been held 31 July, 27 Aug, 8 Oct, 19 Nov, 8 Dec, and 26 Jan 2015.

(2) A revised work plan was submitted to SPLS in December 2014 and was approved on Friday, January 23 during their meeting in Chicago. The planned completion date for the working draft is now June 30, 2015.

k5, Liaison Reports

(1) SPC 189.1**, Standard for the Design of High-Performance Green Buildings (Scott** Hobbs)

- Scott has completed and submitted the ASHRAE; Source of Bias/ Conflict of Interest statement of inclination, interest and affiliation in order to be able to actively participate in 189.1 and will not know until July if he's approved. Scott attended the 189.1, Working Group 7 dealing with energy efficiency and believes that this is the correct working group but will contact the chair to see if other working groups in 189.1 need TC 5.2 presence. This working group basically talked about Make-Up air efficiency and passive lighting.

(2) 90.1, **Energy Standard for Buildings Except Low-Rise Residential Buildings** (Craig Wray)

- Wray reported relevant TC 5.2 activities of interest to 90.1 during their meeting on Saturday, January 24: Duct Design Guide nearing completion, 1682-RP underway; SPC 215P underway; codes and standards interactions subcommittee has been formed. His term as a Consultant to 90.1 ends at the close of the Atlanta meeting (June 2015) and consequently he also will be stepping down then as the TC 5.2 Liaison to 90.1. A volunteer is sought to replace him in this role. Mark Smith volunteered and will submit an application to serve on 90.1.

- 90.1 is considering approving addenda for Publication Public Review (PPR) involving fan system control, efficiency, and power (Addenda AJ and AP); transfer air (Addendum U); and exhaust air heat recovery (Addenda AR and AW). These changes affect air system design. For further information, watch for ASHRAE Standards Actions announcements if these proposed addenda move forward for PR.

3) **MTG.EAS / MTG.HPAS, High Performance Air-Handling Systems for Buildings Except Low-Rise Residential Buildings** (Larry Smith)
   - MTG.HPAS was disbanded because its mission was completed.
   - 38 multi-disciplinary projects have been identified.

4) **Deadlines**
   - None

5) **Old Business**
   - None

6) **New Business**
   a. FAQ's – to be addressed by email ballot. Herman Behls volunteered to be the facilitator.
      a1. Change in scope for TC 5.2 (Larry Smith / Craig Wray / Herman Behls / Steve Idem)
   b. TC Scope Change
      b1. After much discussion among the 5.2 members and guests, the proposed 5.2 scope change was tabled by the following motion:
         - Motion by Larry Smith, 2nd by Mark Smith: Form a task group or committee of interested party to proposed changes to the 5.2 scope for TAC's approval.
         - Motion passed 13-0-0 (14).
      b2. Existing TC Scope: **Technical Committee 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.
      b3. Proposed Scope Change
         - Marked-Up: **Technical Committee 5.2** is concerned with the design, of duct systems focused on the characteristics and construction of all types of ductwork for the handling of air and other gases, ~~but does not include chimneys.~~ the pressure drop, air leakage, and related energy aspects related to the movement of air through ducts and connected equipment; excluding fans, and excluding air diffusion and conditioning of air within rooms and similarly treated spaces.

         - Clean Copy: **Technical Committee 5.2** is concerned with the design of duct systems focused on the characteristics and construction of all types of ductwork for the handling of air and other gases, the pressure drop, air leakage, and related energy aspects related to the movement of air through ducts and connected equipment; excluding fans, and excluding air diffusion and conditioning of air within rooms and similarly treated spaces.
      b4. Proposed RTAR -- Loss Coefficient Tables for Phenolic Duct and Fittings. Action was for Mark Terzizni to work with Herman Behls to develop an RTAR by 15 May (RAC deadline).

7) 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
4	Bob Reid to work with Ralph Koerber on making a recommendation to TC 5.2 regarding the language concerning flexible duct and duct connectors	Bob Reid	Active
5	Submit TC scope change to TAC	Larry Smith	Active

8) Adjournment (6:00 PM)

Motion by Mark Smith; 2nd by Chris Van Rite, 13-0-0.

EXHIBIT 1

ASHRAE TC5.2 Codes & Standards Interaction
Sub-Committee Meeting Minutes

Palmer House, Chicago
January 26, 2015

Present: Ralph Koerber
David Dias
John Hamilton
Perry Philp
Mark Smith

Absent: Kevin Gebke

Agenda:

Discuss proposals regarding flexible air ducts and air connectors

A. Eliminate verbiage “Flexible air ducts shall not be limited in length.”
B. Remove minimum metal thickness for ducts.
C. Eliminate the use of flex duct in inaccessible spaces.
D. Eliminate the use of air connectors in HVAC systems (previously withdrawn proposal sent to sub-committee for discussion).
E. Add current requirements when installing flex.
    1. Install flex duct fully extended. Do not install in the compressed state or use excess length.
    2. Install horizontal flex hangers at least every 4 feet (1.2 m).
    3. Install vertical flex duct hangers at least every 6 feet (1.8 m).
    4. Install flex duct so that sag does not exceed ½ in. per foot (42 mm per m) of support spacing.
    5. Use flex duct supports that are rigid and at 1.5 inch (38 mm) minimum wide (no cloth hangers). Hanger shall be of sufficient width to prevent any restriction of the internal diameter of the duct when the weight of the supported section rests on the hanger.
    6. Install flex duct so that bends exceed one duct diameter radius. Do not bend ducts across sharp corners such as pipes, wires, joists or trusses.
    7. Do not install non-metallic flex duct with screws penetrating the inside liner.
    8. All flex connections shall be attached to a 2 in. rigid collar with a bead. The flex must be pulled over at least 1 in. past the bead before fasten strap is affixed. Beads on connections are optional when using metal worm-gear clamps.
F. Limit length of installed flex to 5 feet.
G. Restrict the use of flex before VAV boxes.

Discussions & Recommendations:

A. Eliminate verbiage “Flexible air ducts shall not be limited in length.”
Ralph discussed the reason for current language as it relates to the 14 feet limitation for air connector length. For fire safety reasons, air connectors are limited in length while air ducts are not. Since there is a limit for one product and not the other, current code language points that out with the statement that .flexible air ducts shall not be limited in length.” The current code language concerns itself with fire safety and not energy efficiency.
Mark, John, and David expressed concern that this current language can allow an installer to use a full 25 feet duct where only 5 or 6 feet is needed.
It was also discussed that flex duct length will be addressed at a later time in the meeting and how to address the length of duct (Item F).

Sub-Committee Vote - 3 Yes, 2 No (vote to modify)

By majority vote, the sub-committee has voted to recommend that TC5.2 propose removal of verbiage in the IMC saying that “flexible air ducts are not limited in length”.
~~603.6.1.1 Duct length. Flexible air ducts shall not be limited in length.~~

B. Removal of minimum metal thickness for ducts.
Considering that the code allows for the use of up to 14 feet in length of air connector, John proposed that minimum thickness requirements for metal duct be removed for the last 14 feet of metal duct runs.
After brief discussion, the sub-committee elected to table this proposal for further discussion within the TC in relation to existing SMACNA standards and this proposal.

C. Eliminate the use of flex duct in inaccessible spaces.
The sub-committee discussed aspects of concern where flexible duct is not accessible such as duct cleaning, rodent infestation, and clamp deterioration. Since the Air Diffusion Council and flex manufacturers recommend replacement rather than cleaning of flex duct, should flex be allowed in inaccessible spaces? Since various studies have brought into question the longevity of non-metallic duct clamps, should flex connections be allowed in inaccessible spaces?

Sub-Committee Vote - 3 Yes, 2 No

After discussion, the sub-committee elected to compromise by proposing language that would continue to allow flex in inaccessible spaces if the flex manufacturer sanctioned the cleaning of flex duct.
The sub-committee has voted to recommend that TC 5.2 propose language allowing flexible duct in inaccessible spaces if the duct can be cleaned.
<u>603.6.5 Flexible air ducts and air connectors may be installed in inaccessible spaces if the duct manufacturer sanctions cleaning of the flex duct following NADCA practices</u>.

As companion to the above, the sub-committee included discussion regarding the use of non-metallic mechanical fasteners in inaccessible spaces.

D. Eliminate the use of air connectors in HVAC systems.
The sub-committee discussed the previous proposal (later withdrawn pending discussion) to eliminate air connectors within the building codes. Until 2012, air connectors were not allowed per the UMC although they have been included and allowed within the IMC for many years. Various types of connectors were discussed (insulated, non-insulated, reinforced, fabric type, metal, etc.). End use of air connectors was discussed (last few feet of duct run versus as entire duct system) as-well-as the perceived pros and cons of eliminating or keeping them in the codes. The sub-committee discussed the response from NFPA regarding why the flame penetration test is not

required for air connectors and also the response that NFPA is not aware of any issues of fire safety when air connectors are used per the code.

Sub-Committee Vote - 2 Yes, 2 No, 1 to “move forward” for further discussion at the TC.

With no majority consensus expected, the sub-committee has voted to move this topic forward for continued discussion within the full TC 5.2 Committee.

E. Add current requirements into the code books when installing flex.

1. Install flex duct fully extended. Do not install in the compressed state or use excess length.
   Sub-committee Vote - Yes
2. Install horizontal flex hangers at least every 4 feet (1.2 m).
   Sub-committee Vote - Yes
3. Install vertical flex duct hangers at least every 6 feet (1.8 m).
   Sub-committee Vote – Yes
4. Install flex duct so that sag does not exceed ½ in. per foot (42 mm per m) of support spacing.
   Sub-committee Vote - Yes
5. Use flex duct supports that are rigid and at 1.5 inch (38 mm) minimum wide (no cloth hangers). Hanger shall be of sufficient width to prevent any restriction of the internal diameter of the duct when the weight of the supported section rests on the hanger.
   Sub-committee Vote - Yes, with modification -
   <u>Flexible duct supports shall be minimum 1-1/2 in. (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</u>.
6. Install flex duct so that bends equal or exceed one duct diameter bend radius (based on inside duct diameter). Do not bend ducts across sharp corners such as pipes, wires, joists or trusses.
   Sub-committee Vote - Yes
7. Do not install non-metallic flex duct with screws penetrating the inside liner.
   Sub-committee Vote - Yes, with modification
   <u>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.</u>
8. All flex connections shall be attached to a 2 in. rigid collar with a bead. The flex must be pulled over at least 1 in. past the bead before fasten strap is affixed. Beads on connections are optional when using metal worm-gear clamps.
   Sub-committee Vote - Yes, with modification
   <u>Fittings used in combination with flexible air ducts and air connectors shall have a 2 in. (50 mm) minimum rigid collar with a bead. Flexible duct inner cores shall be installed at least 1 in. (25 mm) on to the fitting prior to taping and application of the mechanical fastener past the bead.</u>

F. Limit length of installed flex to 5 feet.

Sub-Committee Initial Vote - 3 Yes, 2 No

It was discussed that this proposal would not be consistent with any known ASHRAE standard or publication. The Handbook recommends maximum 6 feet installed length as good practice and

excludes residential construction, thus this appeared to be as far as should be proposed to maintain consistency.

Previous discussion also indicated that a hard length limit for flexible duct would not allow option for use of longer length duct in a properly engineered system where longer lengths were specifically called for.

As a compromise, the sub-committee has voted to recommend that TC5.2 propose the following language for the IMC (this also addresses the first proposal to eliminate the verbiage “flex ducts shall not be limited in length”).

Flexible air ducts and air connectors shall be limited to 6 feet maximum installed length unless the system has been specifically engineered for longer lengths.

Exception: Residential applications.

G. Restrict the use of flex before VAV boxes.
Sub-Committee Vote - Yes
The sub-committee has voted to recommend that TC5.2 propose the following language for the IMC -
Flexible air ducts and air connectors shall not be installed upstream of VAV boxes.

Following is a summary of the sub-committee recommendations to full TC5.2 for proposals to the ICC IMC, with substantiations -

- ~~**603.6.1.1 Duct length**. Flexible air ducts shall not be limited in length~~.
  Substantiation - The current wording in the code can be miss-interpreted to allow for unlimited length of flexible duct without regard to using the minimum length needed to make a proper connection.

- **603.6.5** Flexible air ducts and air connectors may be installed in inaccessible spaces if the duct manufacturer sanctions cleaning of the flex duct following NADCA practices.

  Substantiation - Any duct installed in an inaccessible space should be able to be cleaned following acceptable industry practices.

- **603.6.5.1** Mechanical fasteners used with flexible ducts in inaccessible spaces shall be metal worm-gear clamps. Non-metallic fasteners are not allowed.
  Substantiation - Various studies have brought into question the longevity of non-metallic duct clamps making them unacceptable for use in inaccessible spaces.

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

  Substantiation - This information is currently part of the industry installation instructions and therefore already inferred by the code. Placing this text within the code language brings it to the forefront and will thus improve installation.

- **603.6.7** Install flex duct so that bends equal or exceed one duct diameter bend radius (based on inside duct diameter). Do not bend ducts across sharp corners such as pipes, wires, joists or trusses.

  Substantiation - This information is currently part of the industry installation instructions and therefore already inferred by the code. Placing this text within the code language brings it to the forefront and will thus improve installation.

- **603.6.8** Flexible air ducts and air connectors shall be limited to 6 feet maximum installed length unless the system has been specifically engineered for longer lengths.
  Exception: Residential applications.
  Substantiation - 2013 ASHRAE Handbook, Fundamentals, Chapter 21, Duct Design, recommends in commercial applications that flexible duct be limited to 6 feet maximum, fully stretched. Flexible ducts exhibit considerable variation in pressure loss because of different manufacturing, materials, inner liner non-uniformities, and installation practices (compression over full length of duct). Minimizing installed length in commercial applications, unless the system was engineered to allow longer lengths, can limit this variability and improve building duct system performance.

- **603.6.9** Flexible air ducts and air connectors shall not be installed upstream of VAV boxes.
  Substantiation - VAV flow station sensors cannot get consistent readings when non-smooth duct surfaces such as flex duct are used upstream of the VAV box. Linear air flow is needed for the flow station to read properly and prevent the VAV from “hunting.”

- **603.9.1** 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.

Substantiation - Except for specific types of flexible duct inner cores designed to be installed using sheet metal screws, flex duct manufacturers do not recommend the use of screws when installing non-metallic flexible duct. The UL181B Standard does not address the use of sheet metal screws as part of the closure system for use with flexible air ducts.

- **603.9.2** Fittings used in combination with flexible air ducts and air connectors shall have a 2 in. (50 mm) minimum rigid collar with a bead. Flexible duct inner cores shall be installed at least 1in. on to the fitting prior to taping and application of the mechanical fastener past the bead.

  Substantiation - This information is currently part of the industry installation instructions and therefore already inferred by the code. Placing this text within the code language brings it to the forefront and will thus improve installation. The UL181B Standard addresses the use of fittings with 2 in. collars and a bead when using tape, mastic, and non-metallic mechanical fasteners approved per the standard.

- **603.10.1** Flexible air ducts and air connectors shall be supported at intervals not to exceed 4 feet (1219 mm) when installed horizontal and 6 feet (1829 mm) when installed as vertical risers. Flexible duct supports shall be minimum 1-1/2 in. (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.

  Substantiation - This information is currently part of the industry installation instructions and therefore already inferred by the code. Placing this text within the code language brings it to the forefront and will thus improve installation.