ASHRAE Technical Committee 5.6

MINUTES

TC 5.6 Control of Fire and Smoke | **Hotel Hilton Americas- Houston**
Monday June 25, 2018 | **Houston, TX**

1. Introductions

Voting Members Present	Voting Members Absent	Ex-Members and Additional Attendance
Josiah Wiley	John Klote	Troy Goldschmidt
Bill Webb		James Green
Valentina Nedelcu		Steven Rogers
James Buckley		Cheng (Kevin) Chang
Stephen Carey		Julian Rochester
Matthew Davy		Tim Orris
Yuan Li		Duncan Phillips
Peter McDonnell		Paul Turnbull
Yoon Ko		Brandon Seubert
		Marty Gissel
		Dahai Qi
		Steven Strege
		Larry Smith
		Delaine Deer
		Duane Smith
		Byron B Hagan
		Phil Trafton
		Jane Miller
		Jerry Kettler
		Josh Greene

These draft minutes have not been approved and are not the official, approved record until approved by this committee.

2. Identification of Voting Members

There was a quorum (9 voting members present). The attendees went around the room and introduced themselves.

3. Chairman's Remarks

The Chair, Josiah Wiley reported on the ASHRAE authoring portal and new ASHRAE technology portal. The Section 5 Head, Larry Smith also thanked the attendees for coming to Houston and reported on topics including people actively participating in meetings instead of just being bystanders and asked the group to consider the question "Why are you here?" His email is sh5@ashrae.net. Additional information is included at the end of these minutes.

4. **Approval of Minutes from January 2018 (Chicago)**

MOTION TC 5.6-2018

Moved by: Paul Turnbull
Seconded: Matthew Davy

Move that the minutes from the previous meeting held on January 22, 2018 be approved.

Motion Carried

5. **Subcommittee Reports:**

- Research – Paul Turnbull

The work statement 1644 (Smoke Control in long atria) has been conditionally approved by RAC. It will be going out to bid in September, 2018.

- Program – Valentia Nedelcu

Paul Turnbull Chaired Session 11 today titled *Life Safety System Design*. The full program report is shown below:

Current Meeting Programs and other Sessions of interest:

Conference Paper Session 11. Life Safety System Design

Monday, June 25 11:00-12:00AM, Room: 371CF, (3), GRBCC
TC 5.6 – Control of Fire and Smoke
Chair: Paul Turnbull, Siemens Industry
1. CFD Modeling of Flammable Refrigerant Leaks Inside Machine Rooms: Emergency Ventilation Rate for Different Size Chillers. Shiling Zhang, Ph.D.
2. A New Look at Door Opening Forces in Smoke Control Systems. John Klote, Ph.D
3. Design Considerations for Modulating Stair Pressurization Systems. Steven M. Strege

Future Conference Locations

Year	Winter	Annual
2018		Jun 23-27 – Houston, TX
2019	Jan 12-16 – Atlanta, GA	Jun 22-26 – Kansas City, MO
2020	Feb. 1–5 – Orlando, FL	June 27–July 1 – Austin, TX
2021	Jan 23-27 – Chicago, IL	June 26-30 - Phoenix, AZ

Future Conferences Timelines

Atlanta Winter Conference, January 12-16, 2019
http://www.ashrae.org/atlanta
a. Conference Papers are due July 9
b. Seminar, Forum, Debate, Panel and Workshop proposals are due August 3
c. Program notifications go out September 14
d. Web site opens for presentation uploads on November 30
e. All presentations due online January 4, 2019

Track 2: HVAC& R Fundamentals and Applications Rick Hermans, herma015@umn.edu

Kansas City Annual Conference, June 2019:

http://www.ashrae.org/kansascity

a. Conference Paper Abstracts, Technical Papers and Paper Session requests due August 21, 2018

b. Conference Papers due November 30, 2018

Announcements/Communications: CEC information for Technical Committees**.**

2019 Annual Conference Research Summit Call for Papers.
The 2019 Annual Conference in Kansas City, MO features a call for Papers for the Research Summit track. Abstracts are due August 21, 2018. Melanie Derby is the Research Summit Trach Chair (derbym@ksu.edu)

Student Authors Recognized at 2018 Annual Conference.
Starting at the 2017 Winter Conference, CEC began recognizing student papers.
Four students will be recognized with CEC student paper awards at the 2018 Annual Conference.

Program statistics for Houston
For a total of 108 available slots: were presented Seminars 72, Workshops 7, Panel 1 (withdrawn), Forums 4, Debates 1, Conference Paper Sessions 20 (67 papers), Technical Papers 4 sessions.

- **Review and update proposed programs for future conferences.**

During the Meeting each of the proposed programs and topics was reviewed.

Other future proposed programs.
On our list of future proposed programs, we have:

- **(Conference)**- Smoke Control in Secure Facilities.
  Collaboration with TC 9.4 Justice Facilities. Peter McDonnell is the liaison with TC 9.4
  Peter has submitted the abstracts and they have been accepted for a conference format.

  No scheduled to a conference yet.

- **(Confence/Seminar)-** Smoke Control Technologies.
  Focus will be on various case studies and designs implemented in other parts of the globe.
  John Klote has proposed a paper comparing CFD analyses of two different atrium smoke control systems. A possible title: CFD Analysis of Atrium Smoke Control- An Evolving Technology.
  A number of other possible speakers with interest on this topic were mentioned: Steve Strege, Bill Webb, Frank Mills.

Other future program topics.

- Balcony Spill Plumes- Proposed by John Klote
- How the location of the elevated elevator cars in the building influences pressure distribution and how it affects the smoke control. Proposed by William Black
- Green Building Technology- Fire Safety concerns/issues with Solar Panels. Proposed by Leon Wang

- **New topics**
  No new topics were proposed.

- Handbook – John Klote

  Paul Turnbull reported (in John's absence) that the final revisions of the handbook chapter were sent to the TC and a new version came out at the end of May that reflects the changes that were made as a result of the comments received.

  MOTION TC 5.6-2018 **Moved by: Peyer McDonnell**
  Seconded: Bill Webb

  Move that the revised handbook chapter be approved.

  Motion Carried

  The results of the vote for the motion above was 10 in favor, none opposed. John Klote was unable to attend and gave his voting proxy to Paul Turnbull.

- Standards – Liaison needed

  There was no report.

- TC 5.6 Web Site

  The website will be updated by Josiah Wiley and Tim Orris with any new information.

- Smoke Management Software – Bill Webb / John Klote

  There were no problems reported with the software.

- Handbook of Smoke Control Engineering – John Klote

  There was no report.

6. **ASHRAE Guideline 1.5-2012**

   There was no report.

7. **Inter-Society Liaison Reports:**

- CIBSE (Chartered Institute of Building Services Engineers) – Liaison needed

  There was no report.

- NFPA 80 & 105 (Standard for Fire Doors and Fire Windows) – Liaison needed

  There was no report.

- NFPA 90A (Air Conditioning and Ventilating Systems) – Jim Buckley

  There was nothing new to report.

- NFPA 92 (Smoke Management) – Paul Turnbull

  The cycle of this document is current so there was nothing to report.

- UL and AMCA – Stephen Carey, Tim Orris

  AMCA Standard 500-D titled *Laboratory Methods of Testing Dampers for Rating* has been revised for 2018 and is currently in the approval process. Revisions to the document include:

  - Adding the use of orifice plates to measure airflow in some of the setups per ASHRAE 120-17.
  - Deleted unused definitions
  - Revised and defined when transformation pieces that can be used in a setup.
  - Made the inlet cone for ductwork optional for pressure drop tests

  AMCA launched their first Air System Engineering and Technology (ASET) Conference-Europe in Lyon, France, in February and ASET-US in San Antonio, Texas, in March. These events provided specialized in-depth technical education for engineers, architects, contractors, and commissioning providers, including the sessions "General Principles of Smoke Control" and "Design Tips for Fire and Smoke Barriers."

  On the publishing front, AMCA recently produced two new white papers: "Impact of Fire-Sprinkler Trade-offs on Occupant and Building Safety," by the Fire and Smoke Damper Marketing Task Force, and "Ceiling Dampers Explained," by the Damper Engineering Committee, both of which are available to download at no cost at www.amca.org/whitepapers.

  This year also has seen the publication of:

  - "Weighing Fire-Sprinkler Trade-offs on Occupant and Building Safety" in the March issue of *HPAC Engineering*.
  - "The Evolution of Motorized Life-Safety Dampers" in the May issue of *Snips*.
  - "Remote Fire- and Smoke-Damper Testing Nears" in the May issue of *HPAC Engineering*.

  In the summer issue of *Life Safety Digest*, look for the article "Fire, Smoke, and Combination Fire/Smoke Dampers."

AMCA committee members will be meeting with SMACNA Staff to discuss the need for a damper casing leakage certified ratings program.

- SFPE – Matt Davy

  It was reported that the annual conference will be held in Nashville this fall.

- SMACNA – Delaine Deer

  There was no report.

8. Old Business

There was no old business.

9. New Business

Jerry Kettler talked about the commissioning guidelines process. Using blower doors to test pressurized stairwells was also discussed.

10. Adjournment

The meeting was adjourned at 5:16 p.m.

Minutes recorded by,

Timothy J. Orris
TC 5.6 Secretary

Conferences and Expositions Committee Information Items for Technical Committees

2018 Annual Conference, Houston, Texas
This “handout” includes recent updates and upcoming deadlines in the preparation of the technical program for the Winter, Annual and Topical conferences. It is being provided in advance of the conference for your information so that it does not have to be presented during the onsite TC section breakfasts. CEC will provide a short update at the TC breakfasts and answer any questions. *Kevin Marple, 2017-2018 CEC Vice Chair, kmarple@benzco.com*

1. 2019 Annual Conference Research Summit Call for Papers

The 2019 Annual Conference in Kansas City, MO features a call for papers for the Research Summit track. Please consider submitting papers or groups of papers as entire sessions from your TC for the conference. Abstracts are due August 21, 2018. If you have any questions, please contact Melanie Derby, the Research Summit Track Chair at derbym@ksu.edu

2. Student Authors Recognized at 2018 Annual Conference

Starting at the 2017 Winter Conference, CEC began recognizing student papers. Certificates were awarded to students at their assigned conference paper session. Certificates in the categories *“Best Paper”* and *“Honorable Mention”* were presented to graduate candidates and PhD candidates.
Four students will be recognized with CEC student paper awards at the 2018 Annual Conference.

3. Program statistics for Houston; for a total of 108 available slots:

Conferences Papers
- 127 conference paper abstracts submitted, 105 approved
- 67 conference papers presented
- 20 Conference Paper Sessions

Technical Papers
- 21Technical papers received
- 14Technical papers presented
- 4 Technical Paper Sessions

Seminars
- 100 submitted
- 72 presented

Workshops
- 9 submitted
- 7 presented

Forums
- 11 submitted
- 4 presented

Debates
- 2 submitted
- 1 presented

Panels
- o 4 submitted
- o 1 scheduled (withdrawn)

4. 2019 ASHRAE Winter Conference in Atlanta, January 12-16: http://www.ashrae.org/atlanta
a. Conference Papers are due July 9
b. Seminar, Forum, Debate, Panel and Workshop proposals are due August 3
c. Program notifications go out September 14
d. Web site opens for presentation uploads on November 30
e. All presentations due online January 4, 2019
2019 Winter Conference Chair is Corey Metzger, corey.metzger@resourcece.com
Tracks and Track Chairs

Track 1: Systems and Equipment
Joe Firrantello, j.firrantello@gmail.com
Track 2: HVAC& R Fundamentals and Applications
Rick Hermans, herma015@umn.edu
Track 3: Refrigeration
Sonya Pouncy, sonya.pouncy@gmail.com
Track 4: Construction, Operation and Maintenance of High Performance Systems
Leticia De Oliveira Neves, leneves@gmail.com
Track 5: Common System Issues and Misapplications
Lee Riback, lee.riback@gmail.com
Track 6: The Convergence of Comfort, Indoor Air Quality and Energy Efficiency
Ashish Rakheja, ashish.rakheja@aeonconsultants.in
Track 7: Building Integrated Renewables and Natural Systems
Maggie Moninski, maggie.moninski@gmail.com
Track 8: The Engineer's Role in Architecture
Ashu Gupta, ashu.energy@gmail.com

5. 2019 ASHRAE Annual Conference in Kansas City, MO: www.ashrae.org/kansascity a. Conference Paper Abstracts, Technical Papers and Paper Session requests due August 21, 2018
b. Conference Papers due November 30, 2018

2019 Annual Conference Chair is Carrie Anne Monplaisir, carrie.monplaisir@gmail.com
Tracks and Track Chairs
Track 1: Systems & Equipment in the Built Environment
Kimberly Pierson, kdpwildcat@gmail.com
Track 2: Fundamentals and Applications
Gary Debes, gary.debes@comcast.net
Track 3: Optimization in HVAC&R
Vikrant Aute, vikrant@umd.edu
Track 4: Commissioning New & Existing Buildings
Raul Simonetti, raul.simonetti@carel.com
Track 5: Occupant Health & Safety
Chris Reinders-Caron, creinders@cannondesign.com
Track 6: Modeling Throughout the Building Life Cycle
Nivedita Jadhav, nivi2307@gmail.com
Track 7: Professional Development
Rich Rose, richr@mticontrols.com
Track 8: Research Summit

Bing Liu, bliu@neea.org
Track 9 (Mini-Track): Radiant Heating & Cooling Mini-Track
Devin Abellon, devin.abellon@yahoo.com

6. Potential Sources Bias Disclosure

In accordance with the ASHRAE Code of Ethics, speakers have been asked to fill out a potential sources bias disclosure document that will note affiliations/ involvement with any organizations with financial or commercial interest in the subject matter to be discussed.

7. TC Opportunities:

a. TC members who want to submit a program should consult the Track Chair for assistance in preparing a good abstract, learning objectives, and Q&A to help assure complete submission.

b. TCs and Sections are welcome to suggest new presentation formats (like how the Workshop was born). Best way to present material to benefit attendee is a goal.

c. TCs and Sections are encouraged to work with a track chair to put together a series of sessions that can be used as a mini-track.

d. Putting together an entire track of programs in cooperation with other TCs is also encouraged; keeping in mind that track subjects are typically determined 14-15 months prior to a conference.

8. CEC Announces a Call for Reviewers and Paper Session Chairs

ASHRAE has a number of conferences coming up that include papers, and CEC seeks your help in reviewing them. Additionally opportunities to chair a paper session are available. Specifically, there is an immediate need for reviewers and session chairs for the 2019 Winter Conference and various topical conferences. Please submit your interest in reviewing a paper or chairing a paper session using the online form: http://web.ashrae.org/cec_request/. Please contact Tiffany Cox, ASHRAE Assistant Manager, Conference Programs, at tcox@ashrae.org for more information.

9. Topical Conferences

ASHRAE's topical conferences are focused on a particular aspect of the industry and bring together professionals for networking and professional development. Two topical conferences are available for the remainder of 2018.
2018 Building Performance Analysis Conference and SimBuild, co-organized by ASHRAE and IBPSA-USA
http://www.ashrae.org/BuildPerform2018

September 26-28, 2018, Chicago, Illinois
The conference program includes peer-reviewed papers, non-paper presentations and new program format types as well as the fourth annual ASHRAE LowDown Showdown modeling competition with a record 14 teams competing.

The Third International Conference on Efficient Building Design
http://www.ashrae.org/Beirut2018
October 4–5, 2018, Beirut, Lebanon
The conference is to present advanced research on the topics of advanced building and bioclimatic designs for attaining occupant comfort and good environmental quality addressing systems and technologies adapted to the Arab region in both moderate and hot humid climates.

10. Program Types

Technical Paper Session:
These sessions present papers on current applications or procedures, as well as papers resulting from research on fundamental concepts and basic theory. Papers presented in these session have successfully completed a rigorous peer review. Forms for written comment are available at each session, and sent to respective authors for reply and publication in ASHRAE transactions, if received by a certain date.

Conference Paper Session:
These sessions present papers on current applications or procedures, as well as papers reporting on research in process. These papers differ from technical papers in that they are shorter in length and undergo a much less stringent peer review.

Seminar:
These sessions feature presentations on subjects of current interest. There are not papers attached to seminars.

Workshop:
These sessions enable technical committees and other ASHRAE committees to provide a series of short presentations on a topic requiring specific expertise. These short presentations are provided with an increased emphasis on audience participation and training in a specific set of skills. There are not papers attached to workshops.

Forum:
The sessions are “off-the-record” discussions held to promote a free exchange of ideas. Reporting of forums is limited to allow individuals to speak confidentially without concern of criticism. There are not papers attached to forums.

Panel Discussion:
Panel discussions can feature a broad range of subjects and explore different perspectives on industry related topics. This session format includes a panel of 3-4 speakers each addressing a facet of the session topic, followed by an interactive discussion lead by the session chair. Panel Discussions may be 60 minutes or 90 minutes in length and will be posted online in the Virtual Conference.

Debate:
Debates highlight hot-button issues commonly faced by our membership. Industry experts, either on teams or as individuals, argue opposing sides of an issue, concluding with position summaries and audience feedback. Debate sessions may be 60 minutes or 90 minutes in length and will be posted online in the Virtual Conference.

BY LARRY FELKER, BELIMO AMERICAS

Remote Fire- and Smoke-Damper Testing Nears

Approved for the 2019 editions of NFPA 80 and NFPA 105, remote testing can contain costs and increase safety

A specialist in fire and smoke dampers and actuators, Larry Felker is fire- and smoke-product manager for Belimo Americas. He is vice chair of Air Movement and Control Association (AMCA) International's Fire and Smoke Damper Task Force, a member of the International Code Council, the National Fire Protection Association, and the Society of Fire Protection Engineers, and a life member of ASHRAE. He is co-author of the book "Dampers and Airflow Control," published by ASHRAE Special Publications in 2010.

Periodic testing of fire and smoke dampers and associated controls is required by codes to ensure the devices will function as designed if/when needed. The International Building Code (IBC)[1] and International Fire Code (IFC)[2] establish frequency requirements (Table 1). NFPA 80, *Standard for Fire Doors and Other Opening Protectives*,[3] and NFPA 105, *Standard for Smoke Door Assemblies and Other Opening Protectives*,[4] detail testing requirements. At present, the standards require visual verification of life-safety-damper operation. The 2019 editions of the standards, however, will allow remote automated testing.

Remote-Testing Hardware and Software

Figure 1 shows basic wiring for a remotely tested smoke damper. When the damper is open, the green light is on; when it is closed, the red light is on. In Auto mode, the smoke-control-system relay manages the damper's position. The Close and Open manual switches can be used to override the damper, while the position lights can be used to determine the damper operated.

In an IBC Chapter 7-required damper, a smoke detector or relay from an area smoke-detection system is employed for automatic control. Override and position indication are not required. In an IBC Chapter 9-required damper, override and position indication are mandatory, and the connections are to the firefighters-smoke-control-system (FSCS) panel.

Figure 2 shows a networked system. The damper is a combination fire and smoke damper re-openable from the FSCS panel. Instead of hardwired connections, as in Figure 1, the alarm/smoke-control-panel network is used to carry digital signals. The panel display is the same in both systems.

Connections can be hardwired or networked. The central control can be a dedicated microprocessor-based panel, an alarm and smoke-control panel, or a UL 864[6] UUKL-listed building-automation system. The software for automatic testing resides in the smoke-control system. It sets

"Containment" Dampers (IBC and IFC Chapter 7)	
• Commissioning • End of first year • Every four years, excluding hospitals (every six years)	
"Smoke Control System" Dampers (IFC Chapter 9)	
Dedicated	**Non-dedicated**
• Commissioning • Semi-annually	• Commissioning • Annually
Fire-detection and Smoke-Control Systems (IBC and IFC Chapter 9)	
Dedicated	**Non-dedicated**
• Weekly self-test	• Not required

TABLE 1. Periodic testing requirements.[5]

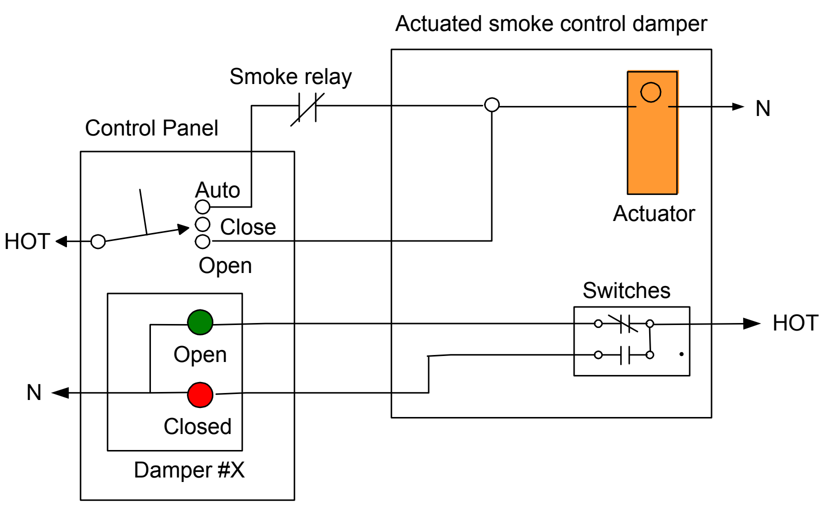

FIGURE 1. Override and position-indication controls (hardwired).

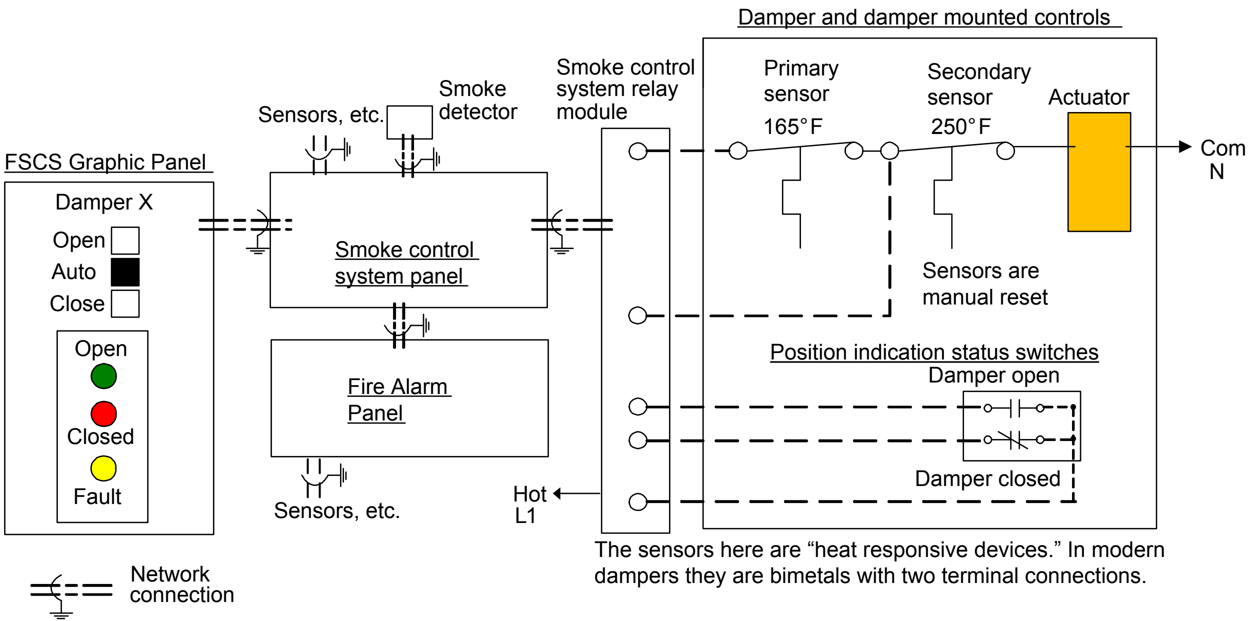

FIGURE 2. Networked fire-alarm and smoke-control-system architecture.

times and fan shutdown during testing, if needed, and generates an exception report if any defects are found.

Costs and Payback Periods

The installed cost of a network-module testing system or an actuator designed for testing is an estimated $200 per damper.

The outside-labor cost of visually inspecting and testing a damper varies with the number of dampers being tested and the market labor rate. Building age and occupancy also are important. For example, if asbestos is present, protective containment will be necessary when a ceiling is opened. Inspection and testing of a smoke or a combination fire/smoke damper is assumed to range from $50 to $100 per damper.

While commissioning/conformance testing should be performed visually, followup testing can be performed remotely at little or no cost. The simple-payback period for containment-damper testing per Chapter 7 of the IBC ranges from four years to 12 years ($200/$100 = two tests, years 1 and 4; $200/$50 = four tests, years 1-12). Certainly, a 25% return on investment (ROI) is attractive; an 8% ROI is not as attractive, unless other benefits, such as prevention of mold or fungal spread from opening ceilings, more assured and more frequent testing, and added life safety, exist.

Remote testing of dampers installed per Chapter 9 of the IBC has an immediate payback. Because override and position indication are required for smoke-control-system dampers (figures 1 and 2), controls required for remote testing must be installed per code.

FIGURE 3. Remote indication panel. (Photo courtesy of Greenheck)

Manual control of dampers from FSCS panels already is possible. See the FSCS graphics panel display in Figure 2; this can be used to test a damper. If a damper is dedicated to smoke control, two tests are required annually (Table 1), for an estimated savings of $50 to $100 the first year and $100 to $200 each year thereafter (calculated using $50 to $100 per damper and one to two tests per year). Instead of the cost of visual inspection, dampers can be closed and opened from a FSCS panel and indication lights monitored for correct indication. When the 2019 editions of NFPA 80 and NFPA 105 are adopted, this will meet the requirements for periodic testing.

Testing Inaccessible Dampers

Dampers often are buried behind ducts or are in otherwise difficult-to-reach places. Remote testing offers a major benefit in such cases. Figure 3 shows a discrete position-indication light assembly for damper testing. Such assemblies can be added in the

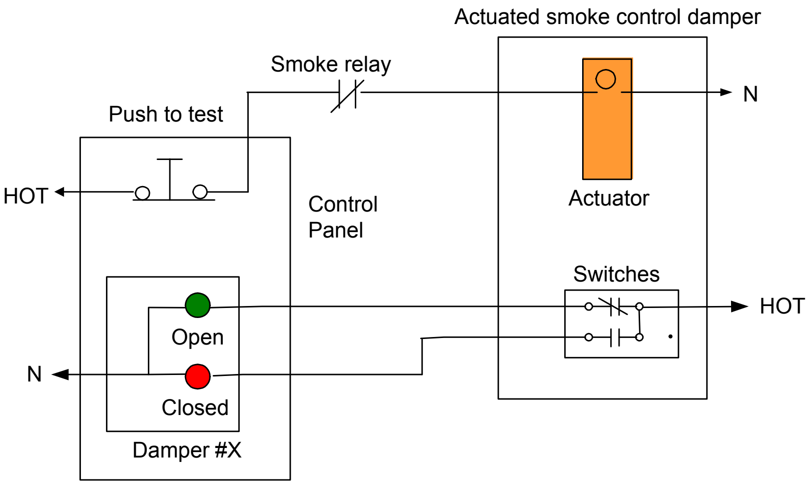

FIGURE 4. Wiring of damper actuator and remote indication panel.

field for existing dampers or specified by consultants for new projects.

Local wiring can be run to indication panels. A panel can be placed on a wall or in an equipment closet. Figure 4 shows wiring for a remote indicator. Switches can be of the damper-blade or actuator-auxiliary variety; either is permitted by codes.

A damper moving to the open or closed position upon command and returning to operation is the proof required. NFPA 80 and NFPA 105 do not specify the method used to confirm damper position. This could be demonstrated through sound, light through the damper blades, actuator drive time with current readings, actuator software switches, actuator potentiometers, or even cameras and LEDs inside the damper assembly. Only switches are time-tested, and their cost is the lowest.

While Figure 4 shows a smoke damper, fire dampers can be actuated as well. Many curtain dampers are buried in walls behind ducts or grills and are inaccessible. An actuated fire damper allows remote testing.

Ease of Testing

Whether a local indicator panel or a FSCS graphics panel is used, testing will be simplified. Maintenance personnel can observe the light indication on local panels; for IBC Chapter 7 containment dampers, red is bad, and green is good. IBC Chapter 9 dampers must be connected to a FSCS panel; while some normally are closed, testing is just as simple.

Deferred maintenance is less likely with remote testing, as failure of an actuator results in a red "closed" light or LED indication. Maintenance staffers have little choice but to address any such problems.

Increasing Safety

Remote testing increases safety in several ways:

A. Problems can occur between periodic tests: Ducts can shift with seismic activity, corrosion can build up, and unexpected work above ceilings can result in hidden defects. With remote testing, dampers can be tested more frequently.

B. Remote damper testing reduces the need to breach ceiling membranes, which is of particular concern in health-care facilities. Breaches potentially expose patients and staff to infectious diseases or asbestos.

C. Remote testing reduces hazards to maintenance technicians, who do not need to climb on ladders to reach difficult-to-access areas. The need for lifts and containment equipment is avoided.

Control Reliability

Remote testing is more reliable than visual inspection after four (or six) years. Assuming auxiliary

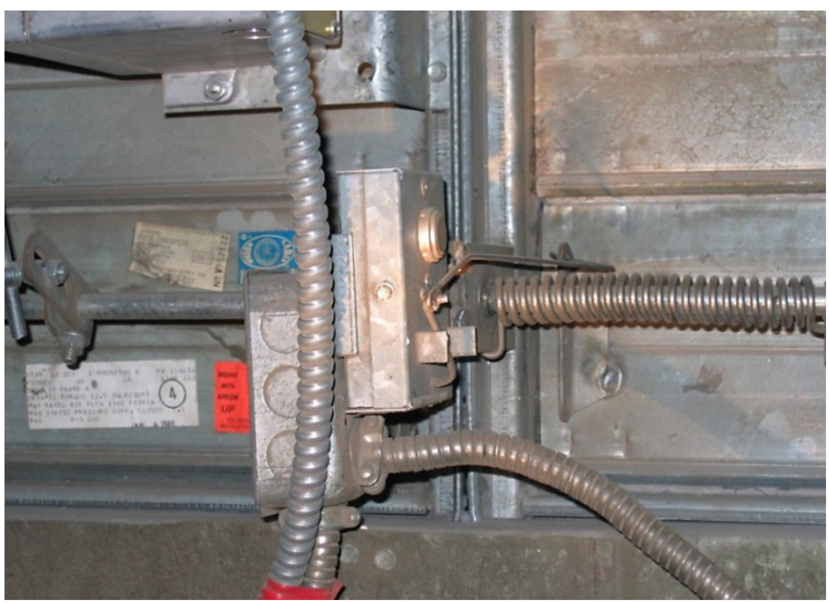

PHOTO A. Switches can perform for decades. Here, a 30-year-old damper-blade switch still functioning. (Photo c/o Ruskin) switches are employed, the absence of an indicator light is cause for a maintenance check.

The components used for remote indication—switches inside actuators, blade switches, magnetic switches—are well-known for being simple and reliable.

UL thoroughly tests dampers and actuators, including switches. UL 555S, *Standard for Smoke Dampers*,[7] requires dampers and actuators to be subjected to a six-month holding test and cycled 20,000 times (plus 100,000 10-degree movements, if modulating). Dampers and actuators are subjected to fire, hose-stream, salt-spray, and drop tests. A damper and actuator together are heated to 250°F or 350°F for a half-hour and subjected to the same elevated temperature for 15 minutes at 2,400 fpm and must close and open properly. Then, they are turned around, and the test is repeated with airflow in the opposite direction. Finally, there is an air-leakage test. The damper blade and actuator auxiliary switches are checked for operation and electrical continuity.

Whether actuator, damper-blade, or magnetic switches are used, the make and break points are not always precise enough to catch a 1- or 2-degree open gap when a damper should be closed. And neither are most technicians. Some external switches on certain older actuators shift with repeated operations.

Modern direct-coupled actuator clamps are cold-welded to damper shafts. When tightened, they make slipping nearly impossible. Once actuator switches are set and, if necessary, adjusted during field acceptance, they are not going to shift.

After decades of service, many switches continue to perform. Photo A shows a blade switch still functioning after 30 years. For this article, one manufacturer went through 15 years of data and found only two switch failures.[8] Another manufacturer's ISO 9001 records for actuator-switch failures over the last five years show two failures—out of 500,000 switch models sold in the United States.[9]

While a few dampers may not close 100% and provide Class 1 leakage performance, they still close to prevent most smoke and fire from passing and potentially still provide Class IV leakage performance. Those that are not inspected, or tested and sometimes fastened open, provide no protection at all.

Conclusion

While manual inspection and testing likely will remain the primary method of ensuring damper operation, remote testing is a reliable way to approach the need for inspections. Use of proven remote-testing technology can avoid cost and increase safety.

References

1) ICC. (2015). *International building code*. Country Club Hills, IL: International Code Council.

2) ICC. (2016). *International fire code*. Country Club Hills, IL: International Code Council.

3) NFPA. (2016). *Standard for fire doors and other opening protectives*. NFPA 80. Quincy, MA: National Fire Protection Association.

4) NFPA. (2016). *Standard for smoke door assemblies and other opening protectives*. NFPA 105. Quincy, MA: National Fire Protection Association.

5) Felker, L. (2014, October). Codes & damper testing. *ASHRAE Journal*, p. 76.

6) UL. (2014). *UL standard for safety control units and accessories for fire alarm systems*. UL 864. Northbrook, IL: UL.

7) UL. (2014). *Standard for smoke dampers*. UL 555S. Northbrook, IL: UL.

8) Personal communications. Greenheck Fan Corp., Schofield, WI.

9) Company records examined by author. BELIMO Automation AG, Hinwil, Switzerland, and Belimo Americas, Danbury, CT. HPAC

By Association

The evolution of motorized life-safety dampers

Motorized fire, smoke, and combination fire/smoke dampers and their testing requirements have come a long way since their introduction during the 1970s.

Originally, life-safety dampers were standard commercial control dampers with blade locks to hold them closed. They were Underwriter Laboratories-tested to the third edition of UL 555, the standard for fire dampers, and the first edition of UL 555S, a standard for smoke dampers. Testing consisted of fire, preconditioning and heat-degradation tests. Because Underwriters did not have a test procedure for actuators, damper manufacturers would list the actuator used in the test of their product. Actuators did not have to operate under fire conditions. Instead, a fusible link connected to the damper blades and a shaft connected to the actuator was used. During a fire event, the actuator would disconnect from the shaft, a spring would close the damper, and a locking device would secure the blades closed. Because of the fusible link, full access to a damper via an access door was required for visual inspection and testing.

In the ensuing years, major changes were made to improve the efficiency of motorized fire, smoke, and combination fire/smoke dampers. Today, they have their own UL 555S test requirements, and there is a new test standard for actuators and dynamic assembly operation.

Modern life-safety dampers are specially designed to operate during exposure to high temperatures and velocities. Also, instead of relying on fusible links and blade locks to close under fire conditions, they are designed with a jackshaft with a solid connection that locks the blades into position when the dampers are closed.

Life-safety actuators, meanwhile, have evolved from oil-filled, foot-mounted motors with complicated linkages subject to breaking to specially designed anti-slip, direct-coupled devices that have passed rigorous UL cycle and holding tests.

Updates

Standards UL555 and UL555S have been updated to meet today's building HVAC and smoke-evacuation systems. Current standards require damper and actuator assemblies to be cycle-tested for a minimum of 20,000 cycles and subjected to a heated-air dynamic-closure-and-operation test with a minimum temperature of 250°F, a minimum air velocity of 2,400 feet per minute, and a system pressure of 4.5 inches water gauge.

UL procedures include spontaneous inspections at manufacturers' facilities to ensure life-safety dampers are being built as tested, without modifications. Additionally, UL requires installation instructions to accompany each shipment of dampers, so contractors have the most up-to-date guidance.

With non-motorized dampers operating with fusible links, visual inspection is the only way to determine if an issue exists. With motorized dampers, because of the rigorous standards to which all must adhere prior to being shipped to a job site and the documented installation instructions from the manufacturer, after an initial visual inspection and visual commissioning of a building, remote testing is possible. Remote testing can be accomplished multiple ways:

Modern life-safety dampers are specially designed to operate during exposure to high temperatures and velocities.

- Control panel. A control panel can be hard-wired directly to a damper with a momentary push button.
- Computerized fire-alarm panel. Requirements for damper testing vary from country to country. For example, in Europe, some countries require testing as often as every 48 hours, performed by a computerized fire-alarm panel that notifies users if something is wrong.
- Remote control. Technology similar to that allowing us to control our homes with a hand-held device is available for testing UL-listed motorized dampers.

With remote-testing capabilities, intrusion into ceiling cavities to test dampers no longer is necessary, and the cost of testing can be reduced by up to $500 a damper.

Because of improved accuracy and reliability, reduced tolerances, and the development of specialized actuators and testing equipment, life-safety dampers no longer are glorified control dampers. They are specially designed devices that play a vital role in passive fire-protection systems, preventing the spread of fire and/or smoke through openings in walls, ceilings, floors, and partitions, protecting occupants and property.

This column was supplied by the Air Movement and Control Association International's Fire and Smoke Damper Task Force. ■

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Impact of Fire-Sprinkler Trade-offs on Occupant and Building Safety

Data show increased risk from overreliance on sprinklers, decline in passive fire protection.

Author's note: This article largely is adapted from the report "Analysis of the Impact of Trade-offs of Passive and Active Building Safety Features," prepared by PG Public Services and submitted to the National Association of State Fire Marshals Fire Research and Education Foundation in November 2017. For the full report, go to http://bit.ly/Sprinkler_Trade-offs.

In 1994, the three regional model-building-code groups in the United States—Building Officials and Code Administrators (BOCA) International, the International Conference of Building Officials (ICBO), and Southern Building Code Congress International (SBCCI)—combined forces, forming the International Code Council (ICC) with the intent to develop a single comprehensive code system. Six years later, the International Codes (I-Codes)—a synthesis of the BOCA National Building Code (BNBC), ICBO's Uniform Building Code (UBC), and SBCCI's Standard Building Code (SBC)—were adopted.

In developing the I-Codes, the ICC retained many of the trade-offs in the three legacy codes. A trade-off is the forgoing of one benefit in exchange for another. In fire-protection engineering, the concept has been traced[1] to 1973, with publication of the National Commission on Fire Prevention and Control report "America Burning," which advocates a reduction of fireproofing requirements in exchange for the installation of automatic fire-sprinkler systems. Nearly half a century later, the allowance of trade-offs in exchange for the installation of fire-sprinkler systems is common practice.

When installed correctly throughout a building and maintained properly, sprinklers are reported effective in 87 percent of the fires large enough to activate them. Yet the introduction of fire-sprinkler trade-offs had much more to do with cost savings—sprinklers are said to be more cost-effective than other fire-protection systems—than performance.[1]

To determine if the adoption of sprinkler and other trade-offs is impacting the overall safety of buildings, the National Association of State Fire Marshals (NASFM) Fire Research and Education Foundation initiated Project FAIL-SAFE (Factually Analyzing Integrated Layers of Safety Against Fire's Effects).

The NASFM Foundation commissioned Worcester Polytechnic Institute (WPI) to conduct a literature review,[1] through which three major sprinkler trade-offs—building size/egress, unprotected opening area (UOA), and fire-resistance rating (FRR)—were identified. WPI then evaluated those sprinkler trade-offs using computer modeling.[2]

Literature Review

Major findings from the literature review include:

- Many provisions in current prescribed codes are empirical.
- Many sprinkler trade-offs are scientifically baseless.
- Sprinkler trade-offs for FRR are only partly supported by research using probabilistic risk-analysis methods.
- Sprinkler trade-offs for exterior-wall UOA could be verified implicitly with fire tests designed to study interactions between sprinklers and smoke-layer behaviors.
- Sprinkler trade-offs for travel distance/dead-end length potentially are not well-founded, as sprinklers fail to improve the tenability criterion of visibility.
- Sprinkler trade-offs could be detrimental to the disaster resilience of buildings.
- While sprinklers may be beneficial to firefighter safety by reducing the risk of a fully developed fire/flashover, sprinkler trade-offs can put firefighters at greater risk in the event sprinklers fail.

Building-Risk Analysis

The NASFM Foundation's Risk Evaluation MATRIX is an online application used to index fire and life-safety risk based on building characteristics. Evaluations are based on a numerical scoring system encompassing 23 safety parameters, which are combined into three aggregate safety metrics: fire safety, means of egress, and general safety.

Fire and building inspectors were engaged to gather and input into MATRIX data for a wide variety of buildings across the United States. The buildings varied by age, occupancy, construction, height, and size and included a variety of active building-protection features. The data were cross-referenced with the codes under which the buildings were designed and built.

Analysis. Using data collected through MATRIX, PG Public Services analyzed changes in parameters following adoption of the I-Codes and identified those that were statistically significant. Additionally, PG Public Services analyzed impacts on fire-safety, means-of-egress, and general-safety scores to determine if adoption of the I-Codes resulted in statistically significant changes.

Findings. PG Public Services grouped buildings into one of two classes based on the code under which they were built—either legacy (BNBC, UBC, SBC, other) or I-Codes. Mean safety parameters and safety scores were compared using the Student's t-test.

Within the sample set, two safety parameters were found to have undergone statistically significant changes with the adoption of the I-Codes:

- The means-of-egress-capacity score increased from an average of 0.32 to an average of 4.
- The standpipe score decreased from an average of 0.60 to an average of -4.4.

Though they were found not to be statistically significant, appreciable declines were observed with the scores for several other safety parameters:

- Building area, 9.70 to -3.20 (132.8-percent decline).
- Compartmentation, 12.40 to 11.40 (8.1-percent decline).
- Tenant- and dwelling-unit separation, 0.23 to 0.18 (20-percent decline).
- Smoke control, 2.60 to 1.70 (34.5-percent decline).
- Maximum exit-access travel distance, 11.60 to 8.10 (30.1-percent decline).

Appreciable-though-not-statistically-significant increases were seen with the scores for:

- Building height, 1.65 to 2.55 (54.7-percent increase).
- Corridor walls, -0.50 to 0.00 (100-percent increase).
- Automatic fire detection, -5.23 to -1.45 (72.2-percent increase).
- Fire-alarm systems, 0.86 to 4.91 (468.4-percent increase).
- Elevator control, -0.13 to 2.00 (1,700-percent increase).
- Means-of-egress control lighting, 1.36 to 2.27 (66.7-percent increase).
- Automatic sprinklers, -0.18 to 2.91 (1,700-percent increase).

The increases and decreases in these scores, which may become statistically significant as more data are collected, are indicative of changes in structural tradeoffs—in particular, trade-offs of passive building features, such as compartmentation, tenant/dwelling separation, and travel distance, in exchange for active building features, such as automatic fire detection, fire-alarm systems, and automatic sprinklers.

Lastly, though they were found not to be statistically significant, appreciable declines in all three aggregate safety metrics were seen. Average fire-safety scores decreased by 23.4 percent, average means-of-egress scores decreased by 18.4 percent, and general-safety scores decreased by 13.2 percent.

Summary

Based on an initial data sample, the adoption of the I-Codes has had a statistically significant impact on building safety. In particular, means-of-egress capacity has improved, while standpipe safety has declined.

Notable changes in other safety parameters indicate a shift in structural trade-offs with the adoption of the I-Codes. In particular, passive building features are being traded off in exchange for active building features, including automatic sprinklers. Most sprinkler trade-offs are put forward based on descriptive explanations lacking scientific quantitative analysis. Without support from technical research, potential risks of sprinkler trade-offs are unknown.

All of the aggregate building-safety metrics—fire safety, means of egress, and general safety—have decreased since the I-Codes were adopted. More data is required to determine the root causes of these declines, if the declines are statistically significant, and the impacts of specific variables. HPAC

References

1) Dembsey, N.A., Meacham, B.J., & Wang, H. (2017). *A literature review of sprinkler trade-offs*. Maitland, FL: National Association of State Fire Marshals. Available at http://bit.ly/Lit_Review

2) Dembsey, N.A., Meacham, B.J., Wang, H., & Kamath, P. (2017). *Fire modeling results for sprinkler trade-offs related to building size/egress, unprotected opening areas and fire resistance ratings for selected R-2 occupancies*. Maitland, FL: National Association of State Fire Marshals. Available at http://bit.ly/FAIL-SAFE_modeling

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