



# ADDENDA

**ASHRAE Addendum a to  
ASHRAE Guideline 28-2012**

# **Air Quality within Commercial Aircraft**

Approved by the ASHRAE Standards Committee on January 18, 2014, and by the ASHRAE Board of Directors on January 22, 2014.

These addenda were approved by a Standing Guideline Project Committee (SGPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the guideline. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE website ([www.ashrae.org](http://www.ashrae.org)) or in paper form from the Manager of Standards.

The latest edition of an ASHRAE Guideline may be purchased on the ASHRAE website ([www.ashrae.org](http://www.ashrae.org)) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: [orders@ashrae.org](mailto:orders@ashrae.org). Fax: 678-539-2129. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to [www.ashrae.org/permissions](http://www.ashrae.org/permissions).

**ASHRAE Standing Standard Project Committee 161**  
**Cognizant TC: TC 9.3, Transportation Air Conditioning**  
**SPLS Liaison: Steven J. Emmerich**

Steven J. Tochilin, <i>Chair</i> *	Waller S. Clements*	Byron W. Jones*
Paul A. Lebbin, <i>Vice Chair</i> *	Gary Steven Dutt*	Joshua B. Kelton*
Peggy Bendfeldt*	Richard B. Fox*	Michael Massoni*
Frank Martin Brehany*	John Mitchell Hall*	Judith Murawski*
Karen J. Bull*	Michael Holland*	Herbert Suitner*

\* Denotes members of voting status when the document was approved for publication

---

**ASHRAE STANDARDS COMMITTEE 2013–2014**

William F. Walter, <i>Chair</i>	David R. Conover	Malcolm D. Knight
Richard L. Hall, <i>Vice-Chair</i>	John F. Dunlap	Rick A. Larson
Karim Amrane	James W. Earley, Jr.	Mark P. Modera
Joseph R. Anderson	Steven J. Emmerich	Cyrus H. Nasser
James Dale Aswegan	Julie M. Ferguson	Janice C. Peterson
Charles S. Barnaby	Krishnan Gowri	Heather L. Platt
Steven F. Bruning	Cecily M. Grzywacz	Douglas T. Reindl
John A. Clark	Rita M. Harrold	Julia A. Keen, <i>BOD ExO</i>
Waller S. Clements	Adam W. Hinge	Thomas E. Werkema, Jr., <i>CO</i>
	Debra H. Kennoy	

Stephanie C. Reiniche, *Manager of Standards*

---

**SPECIAL NOTE**

This Guideline was developed under the auspices of ASHRAE. ASHRAE Guidelines are developed under a review process, identifying a guideline for the design, testing, application, or evaluation of a specific product, concept, or practice. As a guideline it is not definitive but encompasses areas where there may be a variety of approaches, none of which must be precisely correct. ASHRAE Guidelines are written to assist professionals in the area of concern and expertise of ASHRAE's Technical Committees and Task Groups.

ASHRAE Guidelines are prepared by project committees appointed specifically for the purpose of writing Guidelines. The project committee chair and vice-chair must be members of ASHRAE; while other committee members may or may not be ASHRAE members, all must be technically qualified in the subject area of the Guideline.

Development of ASHRAE Guidelines follows procedures similar to those for ASHRAE Standards except that (a) committee balance is desired but not required, (b) an effort is made to achieve consensus but consensus is not required, (c) Guidelines are not appealable, and (d) Guidelines are not submitted to ANSI for approval.

The Manager of Standards of ASHRAE should be contacted for:

- a. interpretation of the contents of this Guideline,
- b. participation in the next review of the Guideline,
- c. offering constructive criticism for improving the Guideline, or
- d. permission to reprint portions of the Guideline.

**DISCLAIMER**

ASHRAE uses its best efforts to promulgate Standards and Guidelines for the benefit of the public in light of available information and accepted industry practices. However, ASHRAE does not guarantee, certify, or assure the safety or performance of any products, components, or systems tested, installed, or operated in accordance with ASHRAE's Standards or Guidelines or that any tests conducted under its Standards or Guidelines will be nonhazardous or free from risk.

**ASHRAE INDUSTRIAL ADVERTISING POLICY ON STANDARDS**

ASHRAE Standards and Guidelines are established to assist industry and the public by offering a uniform method of testing for rating purposes, by suggesting safe practices in designing and installing equipment, by providing proper definitions of this equipment, and by providing other information that may serve to guide the industry. The creation of ASHRAE Standards and Guidelines is determined by the need for them, and conformance to them is completely voluntary.

In referring to this Standard or Guideline and in marking of equipment and in advertising, no claim shall be made, either stated or implied, that the product has been approved by ASHRAE.

(This foreword is not part of this guideline. It is merely informative.)

## FOREWORD

*This addendum provides a brief description of the use of flame retardants in the passenger cabin, as well as a short summary of some flame retardant exposure data collected on aircraft and a list of references for the user to review some of the related health hazard literature. This addendum represents a new stand-alone section intended for Guideline 28-2012.*

**Note:** In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strike through~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

### Addendum a to Guideline 28-2012

*Add a new Section 8.1.2.14 as follows.*

**8.1.2.14 Flame Retardants.** Halogenated flame retardants, such as polybrominated diphenyl ethers (PBDEs) and chlorinated tris (TDCPP), are organobromine and organochlorine compounds, widely used as flame retardants in foams, fabrics, carpets, electronics, molded plastics, and resins. They are used in residential and occupational environments, as well as in transportation vehicles, including aircraft. Flame retardant compounds can be released from treated compounds during the product's life cycle.

Many halogenated flame retardants are known to bioaccumulate. Published studies have identified them as disrupting hormones, interfering with reproduction and thyroid function and impairing the development of the nervous system (Chevrier 2010; Harley 2010; Herbstman 2010; Schreiber 2010; Darenud 2008; Herbstman 2008; Turyk 2008; Chao et al. 2007; Costa et al. 2007; Main et al. 2007; Hardell 2006). In 2009, the Environmental Protection Agency committed to summarize PBDE exposure hazards and outline the health risks and specific actions (EPA 2009).

Concentrations of flame retardants in the aircraft cabin air have yet to be adequately quantified. To date, only two small exploratory studies have investigated potential PBDE exposure in aircraft cabins, and none have investigated exposure to other types of flame retardants, such as, for example, TDCPP. One of these exploratory studies reported the presence of PBDEs in aircraft cabin dust (Christiansson 2008). That study also identified a small increase in the PBDE serum level of nine passengers after a round trip flight, although this increase cannot necessarily be attributed to exposure in the aircraft because of the opportunity of those passengers to have been exposed to nonaircraft sources between flights. In contrast, blood serum analyses of two frequent flyers did not show elevated PBDE levels as compared to the general population. The second study (Schechter 2010) measured some PBDEs in the blood of nine flight attendants and one pilot. The authors reported that PBDE blood levels of the subjects were comparable to those of the general public, although the presence of other flame retardants was not investigated.

Aircraft and interiors must meet regulatory standards intended to prevent the spread of fire on aircraft. The FAA has issued a performance standard for cabin materials that an ignited source must self-extinguish per requirements of 14 CFR Part 25 Appendix F, but it neither prescribes nor proscribes the use of any particular fire retardant.

*Add the following references to Section 9.*

## 9. REFERENCES

- Christiansson, A., L. Hovander, I. Athanassiadis, K. Jakobsson, and A. Bergman. 2008. Polybrominated diphenyl ethers in aircraft cabins—A source of human exposure? *Chemosphere* 73(10):1654–60.
- Chao, H.R., S.L. Wang, W.J. Lee, Y.F. Wang, and O. Papke 2007. Levels of polybrominated diphenyl ethers (PBDEs) in breast milk from central Taiwan and their relation to infant birth outcome and maternal menstruation effects. *Environment International* 33(2):239–45.
- Chevrier, J., K.G. Harley, A. Bradman, M. Gharbi, A. Sjödin, and B. Eskenazi. 2010. Polybrominated diphenyl ether flame retardants and thyroid hormone during pregnancy. *Environmental Health Perspectives* 118(10):1444–49.
- Costa, L.G., and G. Giordano. 2007. Developmental neurotoxicity of polybrominated diphenyl ether (PBDE) flame retardants. *Neurotoxicology* 28(6):1047–67.
- Darnerud, P.O. 2008. Brominated flame retardants as possible endocrine disrupters. *International Journal of Andrology* 31(2):152–60.
- EPA. 2009. EPA news release: EPA announces actions to address chemicals of concern, including phthalates: agency continues efforts to work for comprehensive reform of toxic substance laws. Environmental Protection Agency, Washington, DC.
- Hardell, L., B. Bavel, G. Lindstrom, M. Eriksson, and M. Carlberg. 2006. In utero exposure to persistent organic pollutants in relation to testicular cancer risk. *International Journal of Andrology* 29(1):228–34.
- Harley, K.G., A.R. Marks, J. Chevrier, A. Bradman, A. Sjödin, and B. Eskenazi. 2010. PBDE concentrations in women's serum and fecundability. *Environmental Health Perspectives* 118(5):699–704.
- Herbstman, T.B., A. Sjödin, M. Kurzon, S.A. Lederman, R.S. Jones, V. Rauh, L.L. Needham, D. Tang, M. Niedzwiecki, R.Y. Wang, and F. Perera. 2010. Prenatal exposures to PBDEs and neurodevelopment. *Environmental Health Perspectives* 118(5):712–19.
- Herbstman, J.B., A. Sjödin, B.J. Apelburg, F.R. Witter, R.U. Halden, D.G. Patterson, Jr., S.R. Panny, L.L. Needham, and L.R. Goldman. 2008. Birth delivery mode modified the associations between prenatal polychlorinated biphenyl (PCB) and polybrominated diphenyl ether (PBDE) and neonatal thyroid hormone levels. *Environmental Health Perspectives* 116:1376–82.
- Main, K.M., H. Kiviranta, H.E. Virtanen, E. Sundqvist, J.T. Tuomisto, T. Vartiainen, N.E. Skakkebaek, and J. Toppari. 2007. Flame retardants in placenta and breast milk

- and cryptorchidism in newborn boys. *Environmental Health Perspectives* 115(10):1519-26.
- Schechter, A., J. Colacino, D. Haffner, K. Patel, M. Opel, and O. Pöpke. 2010. Discussion of “Polybrominated diphenyl ethers in aircraft cabins—A source of human exposure?” By Anna Christiansson et al. [*Chemosphere* 2008 73(10) 1654–60]. *Chemosphere* 78(2):;206–8.
- Schreiber, T., K. Gassmann, C. Gotz, U. Hübenthal, M. Moors, G. Krause, H.F. Merk, N.H. Nguyen, T.S. Scanlan, J. Abel, C.R. Rose, and E. Fritsche. 2010. PBDEs induce developmental neurotoxicity in a human in vitro model: evidence for endocrine disruption. *Environmental Health Perspectives* 118(4):572–78.
- Turyk, M.E., V.W. Persky, P. Imm, L. Knobeloch, R. Chatterton, Jr., and H.A. Anderson. 2008. Hormone disruption by PBDEs in adult male sport fish consumers. *Environmental Health Perspectives* 116(12):1635–41.

## **POLICY STATEMENT DEFINING ASHRAE'S CONCERN FOR THE ENVIRONMENTAL IMPACT OF ITS ACTIVITIES**

ASHRAE is concerned with the impact of its members' activities on both the indoor and outdoor environment. ASHRAE's members will strive to minimize any possible deleterious effect on the indoor and outdoor environment of the systems and components in their responsibility while maximizing the beneficial effects these systems provide, consistent with accepted standards and the practical state of the art.

ASHRAE's short-range goal is to ensure that the systems and components within its scope do not impact the indoor and outdoor environment to a greater extent than specified by the standards and guidelines as established by itself and other responsible bodies.

As an ongoing goal, ASHRAE will, through its Standards Committee and extensive technical committee structure, continue to generate up-to-date standards and guidelines where appropriate and adopt, recommend, and promote those new and revised standards developed by other responsible organizations.

Through its *Handbook*, appropriate chapters will contain up-to-date standards and design considerations as the material is systematically revised.

ASHRAE will take the lead with respect to dissemination of environmental information of its primary interest and will seek out and disseminate information from other responsible organizations that is pertinent, as guides to updating standards and guidelines.

The effects of the design and selection of equipment and systems will be considered within the scope of the system's intended use and expected misuse. The disposal of hazardous materials, if any, will also be considered.

ASHRAE's primary concern for environmental impact will be at the site where equipment within ASHRAE's scope operates. However, energy source selection and the possible environmental impact due to the energy source and energy transportation will be considered where possible. Recommendations concerning energy source selection should be made by its members.

