NFPA®

91

Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids

2020

NFPA®

IMPORTANT NOTICES AND DISCLAIMERS CONCERNING NFPA® STANDARDS

NFPA® codes, standards, recommended practices, and guides ("NFPA Standards"), of which the document contained herein is one, are developed through a consensus standards development process approved by the American National Standards Institute. This process brings together volunteers representing varied viewpoints and interests to achieve consensus on fire and other safety issues. While the NFPA administers the process and establishes rules to promote fairness in the development of consensus, it does not independently test, evaluate, or verify the accuracy of any information or the soundness of any judgments contained in NFPA Standards.

The NFPA disclaims liability for any personal injury, property, or other damages of any nature whatsoever, whether special, indirect, consequential or compensatory, directly or indirectly resulting from the publication, use of, or reliance on NFPA Standards. The NFPA also makes no guaranty or warranty as to the accuracy or completeness of any information published herein.

In issuing and making NFPA Standards available, the NFPA is not undertaking to render professional or other services for or on behalf of any person or entity. Nor is the NFPA undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances.

The NFPA has no power, nor does it undertake, to police or enforce compliance with the contents of NFPA Standards. Nor does the NFPA list, certify, test, or inspect products, designs, or installations for compliance with this document. Any certification or other statement of compliance with the requirements of this document shall not be attributable to the NFPA and is solely the responsibility of the certifier or maker of the statement.

REVISION SYMBOLS IDENTIFYING CHANGES FROM THE PREVIOUS EDITION

Text revisions are shaded. A Δ before a section number indicates that words within that section were deleted and a Δ to the left of a table or figure number indicates a revision to an existing table or figure. When a chapter was heavily revised, the entire chapter is marked throughout with the Δ symbol. Where one or more sections were deleted, a • is placed between the remaining sections. Chapters, annexes, sections, figures, and tables that are new are indicated with an ***N***.

Note that these indicators are a guide. Rearrangement of sections may not be captured in the markup, but users can view complete revision details in the First and Second Draft Reports located in the archived revision information section of each code at www.nfpa.org/docinfo. Any subsequent changes from the NFPA Technical Meeting, Tentative Interim Amendments, and Errata are also located there.

REMINDER: UPDATING OF NFPA STANDARDS

Users of NFPA codes, standards, recommended practices, and guides ("NFPA Standards") should be aware that these documents may be superseded at any time by the issuance of a new edition, may be amended with the issuance of Tentative Interim Amendments (TIAs), or be corrected by Errata. It is intended that through regular revisions and amendments, participants in the NFPA standards development process consider the then-current and available information on incidents, materials, technologies, innovations, and methods as these develop over time and that NFPA Standards reflect this consideration. Therefore, any previous edition of this document no longer represents the current NFPA Standard on the subject matter addressed. NFPA encourages the use of the most current edition of any NFPA Standard [as it may be amended by TIA(s) or Errata] to take advantage of current experience and understanding. An official NFPA Standard at any point in time consists of the current edition of the document, including any issued TIAs and Errata then in effect.

To determine whether an NFPA Standard has been amended through the issuance of TIAs or corrected by Errata, visit the "Codes & Standards" section at www.nfpa.org.

ISBN: 978-145592551-3 (PDF)

ADDITIONAL IMPORTANT NOTICES AND DISCLAIMERS CONCERNING NFPA® STANDARDS

Updating of NFPA Standards

Users of NFPA codes, standards, recommended practices, and guides ("NFPA Standards") should be aware that these documents may be superseded at any time by the issuance of a new edition, may be amended with the issuance of Tentative Interim Amendments (TIAs), or be corrected by Errata. It is intended that through regular revisions and amendments, participants in the NFPA standards development process consider the then-current and available information on incidents, materials, technologies, innovations, and methods as these develop over time and that NFPA Standards reflect this consideration. Therefore, any previous edition of this document no longer represents the current NFPA Standard on the subject matter addressed. NFPA encourages the use of the most current edition of any NFPA Standard [as it may be amended by TIA(s) or Errata] to take advantage of current experience and understanding. An official NFPA Standard at any point in time consists of the current edition of the document, including any issued TIAs and Errata then in effect.

To determine whether an NFPA Standard has been amended through the issuance of TIAs or corrected by Errata, visit the "Codes & Standards" section at www.nfpa.org.

Interpretations of NFPA Standards

A statement, written or oral, that is not processed in accordance with Section 6 of the Regulations Governing the Development of NFPA Standards shall not be considered the official position of NFPA or any of its Committees and shall not be considered to be, nor be relied upon as, a Formal Interpretation.

Patents

The NFPA does not take any position with respect to the validity of any patent rights referenced in, related to, or asserted in connection with an NFPA Standard. The users of NFPA Standards bear the sole responsibility for determining the validity of any such patent rights, as well as the risk of infringement of such rights, and the NFPA disclaims liability for the infringement of any patent resulting from the use of or reliance on NFPA Standards.

NFPA adheres to the policy of the American National Standards Institute (ANSI) regarding the inclusion of patents in American National Standards ("the ANSI Patent Policy"), and hereby gives the following notice pursuant to that policy:

NOTICE: The user's attention is called to the possibility that compliance with an NFPA Standard may require use of an invention covered by patent rights. NFPA takes no position as to the validity of any such patent rights or as to whether such patent rights constitute or include essential patent claims under the ANSI Patent Policy. If, in connection with the ANSI Patent Policy, a patent holder has filed a statement of willingness to grant licenses under these rights on reasonable and nondiscriminatory terms and conditions to applicants desiring to obtain such a license, copies of such filed statements can be obtained, on request, from NFPA. For further information, contact the NFPA at the address listed below.

Law and Regulations

Users of NFPA Standards should consult applicable federal, state, and local laws and regulations. NFPA does not, by the publication of its codes, standards, recommended practices, and guides, intend to urge action that is not in compliance with applicable laws, and these documents may not be construed as doing so.

Copyrights

NFPA Standards are copyrighted. They are made available for a wide variety of both public and private uses. These include both use, by reference, in laws and regulations, and use in private self-regulation, standardization, and the promotion of safe practices and methods. By making these documents available for use and adoption by public authorities and private users, the NFPA does not waive any rights in copyright to these documents.

Use of NFPA Standards for regulatory purposes should be accomplished through adoption by reference. The term "adoption by reference" means the citing of title, edition, and publishing information only. Any deletions, additions, and changes desired by the adopting authority should be noted separately in the adopting instrument. In order to assist NFPA in following the uses made of its documents, adopting authorities are requested to notify the NFPA (Attention: Secretary, Standards Council) in writing of such use. For technical assistance and questions concerning adoption of NFPA Standards, contact NFPA at the address below.

For Further Information

All questions or other communications relating to NFPA Standards and all requests for information on NFPA procedures governing its codes and standards development process, including information on the procedures for requesting Formal Interpretations, for proposing Tentative Interim Amendments, and for proposing revisions to NFPA standards during regular revision cycles, should be sent to NFPA headquarters, addressed to the attention of the Secretary, Standards Council, NFPA, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101; email: stds_admin@nfpa.org.

For more information about NFPA, visit the NFPA website at www.nfpa.org. All NFPA codes and standards can be viewed at no cost at www.nfpa.org/docinfo.

NFPA® 91

Standard for

Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids

2020 Edition

This edition of NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids,* was prepared by the Technical Committee on Handling and Conveying of Dusts, Vapors, and Gases and released by the Correlating Committee on Combustible Dusts. It was issued by the Standards Council on November 4, 2019, with an effective date of November 24, 2019, and supersedes all previous editions.

This edition of NFPA 91 was approved as an American National Standard on November 24, 2019.

Origin and Development of NFPA 91

The National Fire Protection Association as early as 1899 recognized the hazards of blower and exhaust systems. Since 1900, the NFPA Committee on Blower Systems has given continuing attention to the subject. Following World War II, revisions and additions to the standard were recommended by the NFPA Committee on Blower Systems to cover various new developments in the protection of dust collecting systems and stock and refuse conveying systems, and were adopted by the NFPA at its Annual Meetings in 1946, 1947, 1948, and 1949. Editorially revised editions were published in 1959 and 1961. In 1972, Section 200 (Chapter 2) was expanded, and a new Section 500 (Chapter 5), covering systems involving plastic materials, was added. In the 1973 edition, Section 400 (Chapter 4) was completely revised. The 1983 edition was completely updated to conform with the NFPA *Manual of Style* and incorporated minor revisions in each chapter.

The 1990 edition included minor revisions to Chapter 2 including a new Figure 2-8 and Table 2-8(b). Changes were made to recognize NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals,* and to remove conflicts with that standard. These changes included moving Section 5-2 and Figures 5-2 through 5-5 to Appendix A.

The Technical Committee on Blower Systems completely revised the standard for the 1992 edition, including a new title and new scope. The previous title had been *Standard for the Installation of Blower and Exhaust Systems for Dust, Stock, and Vapor Removal or Conveying*. Chapters 3 and 4 from the 1990 edition were deleted with some requirements from those chapters included in the revised and reorganized Chapter 2 and new Chapters 5, 6, and 7.

Minor changes were made to all chapters in the 1995 edition. The Committee clarified their intent that ducts can be round, oval, or rectangular. A new figure was added to show access openings for different shapes of ducts, and a new table was added in the appendix to show duct velocities for types of materials conveyed.

The 1999 edition incorporated a new scope limiting the applicability of this document to noncombustible particulate solids. The Committee on Handling and Conveying of Dusts, Vapors, and Gases became responsible for NFPA 91 and made changes consistent with the committee's other documents, NFPA 650, *Standard for Pneumatic Conveying Systems for Handling Combustible Particulate Solids,* and NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids,* that address combustible particulate solids.

In the 2004 revision, the Committee completed changes according to the Manual of Style for NFPA Technical Committee Documents and the conditions under which flammable concentrations can exceed 25 percent of the lower flammable limit (LFL) were expanded to match provisions in other NFPA documents. The design requirements for duct hanging and bracing and fire protection requirements for ducting were also updated.

The 2010 edition contained extensive revisions to Chapter 4 on exhaust system design and construction. These revisions brought requirements from the complementary document on pneumatic conveying systems, NFPA 654, to this standard for correlation and consistency. The Committee also added a new chapter on Air–Material Separators (Chapter 7) using concepts from NFPA 654. Chapter 9 was revised to be made retroactive and to establish requirements for testing frequency. Other changes were made make the standard consistent with the *Manual of Style for NFPA Technical Committee Documents*.

The 2015 edition included a revision to both the document title and the scope to remove confusion for users of NFPA 91 when designing pneumatic conveying, duct systems, or air moving devices for application within the commodity-specific combustible dust standards. With the revisions, the standard applied to particulate solids, whether combustible or noncombustible. The committee used information provided by a FM Global data sheet to include alternative methods in two applications: (1) protecting ducts that pass through fire barriers so as to maintain the fire resistance rating of the barrier and (2) strengthening ducts where sprinklers are installed and discharge within the ducts system in order to maintain support for the ducting with the accumulated weight of the discharge water. The committee added and revised definitions for consistency with the commodity-specific combustible dust standards. The committee also reviewed and updated extracted material in accordance with the *Manual of Style for NFPA Technical Committee Documents*.

The 2020 edition includes requirements for nonconductive system components and a revision to the concentration threshold for flammable or combustible materials requiring spark-resistant fans and blowers.

Correlating Committee on Combustible Dusts

Kevin Kreitman, *Chair*
Albany Fire Department, OR [E]

Chris Aiken, Cargill, Inc., MN [U]

Matthew J. Bujewski, MJB Risk Consulting, MO [SE]

John M. Cholin, J. M. Cholin Consultants Inc., NJ [SE]

Gregory F. Creswell, Cambridge-Lee Industries, PA [M]

Scott G. Davis, GexCon US, MD [SE]

Walter L. Frank, Frank Risk Solutions, Inc., DE [SE]

Robert C. Gombar, Baker Engineering & Risk Consultants, Inc., MD [U]
Rep. US Beet Sugar Association

John A. LeBlanc, FM Global, MA [I]
Rep. FM Global

Arthur P. Mattos, Jr., TUV SUD America Inc./Global Risk Consultants, NC [SE]

Jack E. Osborn, Airdusco, Inc., TN [M]

Jeffrey R. Roberts, AXA XL/Global Asset Protection Services, LLC, MS [I]

Bill Stevenson, CV Technology, Inc., FL [M]

Alternates

Christopher D. Headen, Cargill, Inc., MN [U]
(Alt. to Chris Aiken)

Jason Krbec, CV Technology, Inc., FL [M]
(Alt. to Bill Stevenson)

Adam Morrison, Fike Corporation, MO [M]
(Voting Alt.)

Nonvoting

Brad D. Burridge, Novelis, Inc., KY [U]
Rep. TC on Fundamentals of Combustible Dusts

Mark W. Drake, Liberty Mutual, KS [I]
Rep. TC on Combustible Metals and Metal Dusts

William R. Hamilton, US Department of Labor, DC [E]

Timothy J. Myers, Exponent, Inc., MA [SE]
Rep. TC on Agricultural Dusts

Jason P. Reason, Seam Group/Lewellyn Technology, IN [SE]
Rep. TC on Wood and Cellulosic Materials Processing

Mark L. Runyon, Marsh Risk Consulting, OR [I]
Rep. TC on Handling and Conveying of Dusts, Vapors, and Gases

Laura E. Moreno, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the hazard identification, prevention, control, and extinguishment of fires and explosions in the design, construction, installation, operation, and maintenance of facilities and systems used in manufacturing, processing, recycling, handling, conveying, or storing combustible particulate solids, combustible metals, or hybrid mixtures.

Technical Committee on Handling and Conveying of Dusts, Vapors, and Gases

Mark L. Runyon, *Chair*
Marsh Risk Consulting, OR [I]

Brice Chastain, Georgia-Pacific LLC, SC [U]
John M. Cholin, J. M. Cholin Consultants Inc., NJ [SE]
Ashok Ghose Dastidar, Fauske & Associates, LLC, IL [SE]
Burke Desautels, IEP Technologies/Hoerbiger, MA [M]
Tony DiLucido, Zurich Risk Engineering Services, PA [I]
Larry D. Floyd, BASF, AL [U]
Walter L. Frank, Frank Risk Solutions, Inc., DE [SE]
Stephen T. Greeson, HSB Professional Loss Control, TX [I]
Paul F. Hart, American International Group, Inc. (AIG), IL [I]
Jerry J. Jennett, Georgia Gulf Sulfur Corporation, GA [U]
James F. Koch, Dow Corning Corporation, MI [U]
Rep. American Chemistry Council
Eric P. Maynard, Jenike Johanson Inc., NH [SE]
Bruce McLelland, Fike Corporation, MO [M]
Jack E. Osborn, Airdusco, Inc., TN [M]
Philip J. Parsons, Baker Engineering & Risk Consultants, Inc., TX [SE]
Richard Pehrson, Pehrson Fire PC, MN [E]
Rep. International Fire Marshals Association
Jason P. Reason, Lewellyn Technology, IN [SE]
Ali Reza, Exponent, Inc., CA [SE]
James L. Roberts, Fluor Enterprises, Inc., SC [SE]
Samuel A. Rodgers, Honeywell, Inc., VA [U]
Andrew Ryerson, FM Global, MA [I]
Rep. FM Global
Thomas C. Scherpa, DuPont, NH [U]
Bill Stevenson, CV Technology, Inc., FL [M]
Jeffery W. Sutton, TUV SUD America Inc./Global Risk Consultants Corporation, MN [SE]
Robert D. Taylor, PRB Coal Users Group, IN [U]
Tony L. Thomas, Flamex, Inc., NC [M]
Erdem A. Ural, Loss Prevention Science & Technologies, Inc., MA [SE]

Alternates

Randal R. Davis, IEP Technologies/HOERBIGER, MA [M]
(Alt. to Burke Desautels)
John A. Donner, Dominion Energy, VA [U]
(Alt. to Robert D. Taylor)
Randall Dunlap, Georgia Gulf Sulfur Corporation, GA [U]
(Alt. to Jerry J. Jennett)
Eric Jandrain, Georgia-Pacific LLC, WI [U]
(Alt. to Brice Chastain)
James Karnesky, Exponent, Inc., CA [SE]
(Alt. to Ali Reza)
David C. Kirby, Baker Engineering & Risk Consultants, Inc., WV [SE]
(Alt. to Philip J. Parsons)
Jason Krbec, CV Technology, Inc., FL [M]
(Alt. to Bill Stevenson)
Robert D. Shafto, Zurich Insurance, MI [I]
(Alt. to Tony DiLucido)
Samantha Shriver, Dow Chemical, MI [U]
(Alt. to James F. Koch)
Jérôme R. Taveau, Fike Corporation, MO [M]
(Alt. to Bruce McLelland)
Eric R. Winter, The DuPont Company, Inc., NJ [U]
(Alt. to Thomas C. Sherpa)

Nonvoting

William R. Hamilton, US Department of Labor, DC [E]

Laura E. Moreno, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the prevention, control, and extinguishment of fires and explosions in the design, construction, installation, operation, and maintenance of facilities and systems processing or conveying flammable or combustible dusts, gases, vapors, and mists.

Contents

NFPA 91

Standard for

Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids

2020 Edition

IMPORTANT NOTE: This NFPA document is made available for use subject to important notices and legal disclaimers. These notices and disclaimers appear in all publications containing this document and may be found under the heading "Important Notices and Disclaimers Concerning NFPA Standards." They can also be viewed at www.nfpa.org/disclaimers or obtained on request from NFPA.

UPDATES, ALERTS, AND FUTURE EDITIONS: New editions of NFPA codes, standards, recommended practices, and guides (i.e., NFPA Standards) are released on scheduled revision cycles. This edition may be superseded by a later one, or it may be amended outside of its scheduled revision cycle through the issuance of Tentative Interim Amendments (TIAs). An official NFPA Standard at any point in time consists of the current edition of the document, together with all TIAs and Errata in effect. To verify that this document is the current edition or to determine if it has been amended by TIAs or Errata, please consult the National Fire Codes® Subscription Service or the "List of NFPA Codes & Standards" at www.nfpa.org/docinfo. In addition to TIAs and Errata, the document information pages also include the option to sign up for alerts for individual documents and to be involved in the development of the next edition.

NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced and extracted publications can be found in Chapter 2 and Annex B.

Chapter 1 Administration

1.1* Scope.

1.1.1 This standard provides minimum requirements for the design, construction, installation, operation, testing, and maintenance of exhaust systems for air conveying of vapors, gases, mists, and particulate solids as they relate to fire and/or explosion prevention, except as modified or amplified by other applicable NFPA standards.

1.1.2 This standard does not cover exhaust systems for conveying combustible particulate solids that are covered in other NFPA standards *(see A.1.1)*.

1.2 Purpose. The purpose of this standard is to provide technical requirements for exhaust systems that will achieve the following results:

(1) Provide safety to life and property from fires and explosions
(2) Minimize the damage in the event that such fires and explosions occur

1.3 Retroactivity. The provisions of this standard reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this standard at the time the standard was issued.

1.3.1 Unless otherwise specified, the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Where specified, the provisions of this standard shall be retroactive.

1.3.2 In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this standard deemed appropriate.

1.3.3 The retroactive requirements of this standard shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction, and only where it is clearly evident that a reasonable degree of safety is provided.

1.4 Equivalency. Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard.

1.4.1 Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.4.2 The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

N **1.5 Units of Measurement.** Where extracted text contains values expressed in only one system of units, the values in the extracted text have been retained without conversion to preserve the values established by the responsible technical committee in the source document.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,* 2020 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work,* 2019 edition.

NFPA 68, *Standard on Explosion Protection by Deflagration Venting,* 2018 edition.

NFPA 69, *Standard on Explosion Prevention Systems,* 2019 edition.

NFPA 70®, *National Electrical Code®*, 2020 edition.

NFPA 86, *Standard for Ovens and Furnaces,* 2019 edition.

NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls,* 2018 edition.

NFPA 259, *Standard Test Method for Potential Heat of Building Materials,* 2018 edition.

NFPA 780, *Standard for the Installation of Lightning Protection Systems,* 2020 edition.

2.3 Other Publications.

N **2.3.1 AMCA Publications.** Air Movement and Control Association International, Inc., 30 West University Drive, Arlington Heights, IL 60004-1893. www.amca.org

AMCA 99-0401-86, *Classification for Spark Resistant Construction*, 1986.

2.3.2 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials,* 2017a.

ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C,* 2016a.

ASTM E2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750°C,* 2016.

ASTM E2965, *Standard Test for Determination of Low Levels of Heat Release Rate for Materials and Products Using an Oxygen Combustion Calorimeter*, 2017.

2.3.3 SMACNA Publications. Sheet Metal and Air Conditioning Contractors' National Association, 4201 Lafayette Center Drive, Chantilly, VA 20151-1219.

SMACNA 1108, *Accepted Industry Practice for Industrial Duct Construction,* 2008.

SMACNA 1378, *Thermoplastic Duct (PVC) Construction Manual,* 2nd edition, 1995.

SMACNA 1520, *Round Industrial Duct Construction Standard,* 2013 (ANSI/SMACNA 005-2013).

SMACNA 1546, *Thermoset FRP Duct Construction Manual,* 2016 (ANSI/SMACNA 011-2017).

SMACNA 1922, *Rectangular Industrial Duct Construction Standard,* 2004 (ANSI/SMACNA 002-2011).

Δ **2.3.4 UL Publications.** Underwriters Laboratories Inc., 333 Pfingsten Rd, Northbrook, IL 60062-2096.

UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials,* 2008, revised 2018.

2.3.5 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

Δ **2.4 References for Extracts in Mandatory Sections.**

NFPA 30, *Flammable and Combustible Liquids Code,* 2018 edition.

NFPA 652, *Standard on the Fundamentals of Combustible Dust,* 2019 edition.

NFPA 5000®, Building Construction and Safety Code®, 2018 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary,* 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

N **3.2.6 Standard.** An NFPA Standard, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase "standards development process" or "standards development activities," the term "standards" includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions.

Δ **3.3.1* Air–Material Separator (AMS).** A device designed to separate the conveying air from the material being conveyed. [**652,** 2019]

Δ **3.3.2* Air-Moving Device.** A power-driven fan, blower, or other device that establishes an airflow by moving a given volume of air per unit time. [**652,** 2019]

Δ **3.3.3* Centralized Vacuum Cleaning System.** A fixed-pipe system utilizing variable-volume negative-pressure (i.e., vacuum) air flows from remotely located hose connection stations to allow the removal of dust accumulations from surfaces and conveying those dusts to an air-material separator (AMS). [**652,** 2019]

3.3.4 Duct. Pipes, tubes, or other enclosures used for the purpose of pneumatically conveying materials.

Δ **3.3.5* Dust Collection System.** A combination of equipment designed to capture, contain, and pneumatically convey fugitive dust to an air-material separator (AMS) in order to remove the dust from the process equipment or surrounding area. [**652,** 2019]

3.3.6* Exhaust System. An air-conveying system for moving materials from a source to a point of discharge.

3.3.7* Explosion Hazard. In the context of this standard, an explosion hazard is a volume within the exhaust system that contains a combustible or flammable material at concentrations greater than 25 percent of the relevant lower flammable limit (LFL) at any time during startup, operation, shutdown, maintenance, or process upset.

3.3.8 Fire Barrier. A continuous membrane, either vertical or horizontal, such as a wall or floor assembly, that is designed and constructed with a specified resistance rating to limit the spread of fire and that will also restrict the movement of smoke. Such barriers can have protected openings.

3.3.9 Fire Damper. A device installed in an exhaust system designed to close automatically upon detection of heat to interrupt air flow and to restrict the passage of flame.

3.3.10 Limited Combustible (Material). See 4.1.2.

Δ **3.3.11* Lower Flammable Limit (LFL).** That concentration of a flammable vapor in air below which ignition will not occur. Also known as the lower explosive limit (LEL). [**30,** 2018]

N **3.3.12* Minimum Explosible Concentration (MEC).** The minimum concentration of a combustible dust suspended in air, measured in mass per unit volume, that will support a deflagration. [**652,** 2019]

3.3.13 Noncombustible (Material). See 4.1.1.

3.3.14* Noncombustible Particulate Solid. Any noncombustible solid material composed of distinct particles or pieces, regardless of size, shape, or chemical composition.

Δ **3.3.15* Pneumatic Conveying System.** An equipment system that transfers a controlled flow of solid particulate material from one location to another using air or other gases as the conveying medium, and that is comprised of the following components: a material feeding device; an enclosed ductwork, piping, or tubing network; an air-material separator; and an air-moving device. [**652,** 2019]

Chapter 4 Design and Construction

4.1 Terminology.

4.1.1* Noncombustible Material. [5000:7.1.4.1]

4.1.1.1 A material that complies with any one of the following shall be considered a noncombustible material. [**5000:**7.1.4.1.1]

(1)* The material, in the form in which it is used, and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat. [**5000:**7.1.4.1.1]

(2) The material is reported as passing ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C.* [**5000:**7.1.4.1.1]

(3) The material is reported as complying with the pass/fail criteria of ASTM E136 when tested in accordance with the test method and procedure in ASTM E2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750°C.* [**5000:**7.1.4.1.1]

4.1.1.2 Where the term *limited-combustible* is used in this standard, it shall also include the term *noncombustible.* [**5000:**7.1.4.1.2]

4.1.2* Limited-Combustible Material. A material shall be considered a limited-combustible material where both of the following conditions of 4.1.2(1) and 4.1.2(2) and the conditions of either 4.1.2.1 or 4.1.2.2 are met. [**5000:**7.1.4.2]

(1) The material does not comply with the requirements for a noncombustible material in accordance with 4.1.1. [**5000:**7.1.4.2]

(2) The material, in the form in which it is used, exhibits a potential heat value not exceeding 3500 Btu/lb (8141 kJ/kg), when tested in accordance with NFPA 259. [**5000:**7.1.4.2]

4.1.2.1 The material shall have a structural base of noncombustible material with a surfacing not exceeding a thickness of 1/8 in. (3.2 mm) where the surfacing exhibits a flame spread index not greater than 50 when tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials.* [**5000:**7.1.4.2.1]

4.1.2.2 The material shall be composed of materials that in the form and thickness used, neither exhibit a flame spread index greater than 25 nor evidence of continued progressive combustion when tested in accordance with ASTM E84 or ANSI/UL 723, and are of such composition that all surfaces that would be exposed by cutting through the material on any plane would neither exhibit a flame spread index greater than 25 nor exhibit evidence of continued progressive combustion when tested in accordance with ASTM E84 or ANSI/UL 723. [**5000:**7.1.4.2.2]

Δ **4.1.2.3** Materials shall be considered limited-combustible materials where tested in accordance with ASTM E2965, *Standard Test for Determination of Low Levels of Heat Release Rate for Materials and Products Using an Oxygen Combustion Calorimeter*, at an incident heat flux of 75 kW/m^2 for a 20-minute exposure, and both the following conditions are met:

(1) The peak heat release rate shall not exceed 150 kW/m^2 for longer than 10 seconds.

(2) The total heat released shall not exceed 8 MJ/m^2.

[**5000:**7.1.4.2.3]

N **4.1.2.4** Where the term *limited-combustible* is used in this standard, it shall also include the term *noncombustible.* [**5000:**7.1.4.2.4]

4.2 General Requirements.

4.2.1* The design and installation of exhaust systems shall be the responsibility of persons having a knowledge of these systems.

4.2.2* Incompatible materials shall not be conveyed in the same system.

4.2.2.1 Where more than one type of material is to be handled by a system, compatibility shall be verified by literature review or test.

4.2.2.2 Where incompatibility is found, provisions shall be made for cleaning the system prior to transporting a new material.

4.2.3 Unless the circumstances stipulated in 4.2.3.1, 4.2.3.2, or 4.2.3.3 exist, in systems conveying flammable vapors, gases, or mists, the concentration shall not exceed 25 percent of the LFL.

4.2.3.1 Higher concentrations shall be permitted if the exhaust system is designed and protected in accordance with NFPA 69, using one or more of the following techniques:

(1) Combustible concentration reduction
(2) Oxidant concentration reduction
(3) Deflagration suppression
(4) Deflagration pressure containment

4.2.3.2 Higher concentrations shall be permitted for ovens and furnaces designed and protected in accordance with NFPA 86.

4.2.3.3 Higher concentrations shall be permitted where deflagration venting is provided in accordance with NFPA 68.

4.2.4 The design of any exhaust system shall require knowledge of the physical and chemical properties and hazardous characteristics of the materials being conveyed.

4.2.5* Air-moving devices shall be sized to establish the velocity required to capture, control, and convey materials through the exhaust system.

4.2.6 Operations generating flames, sparks, or hot material such as from grinding wheels and welding shall not be manifolded into any exhaust system that air conveys flammable or combustible materials.

4.2.7 Magnetic Separations. Where required, magnetic separators shall be installed in accordance with Section 8.5.

4.2.8* System Plans.

4.2.8.1 Plans and specifications for new systems and systems to be modified shall be submitted to the authority having jurisdiction for approval prior to installation or modification.

4.2.8.2 The submittal shall provide information adequate to describe the hazard and to demonstrate safe performance of the system.

4.2.9 Fire dampers shall be permitted to be installed in exhaust systems in the following situations:

(1) Where ducts pass through fire barriers
(2) Where a collection system installed on the end of the system is protected with an automatic extinguishing system
(3) Where the duct system is protected with an automatic extinguishing system
(4) Where ducts have been listed with interrupters
(5) Where necessary to facilitate the control of smoke pursuant to the applicable NFPA standards

4.2.10 Fire dampers shall not be installed if the material being exhausted is toxic and if a risk evaluation indicates that the toxic hazard is greater than the fire hazard.

4.2.11 Exhaust ducts shall not pass through fire walls, as defined by NFPA 221.

4.2.12 Exhaust ducts passing through a fire barrier having a fire resistance rating of 2 hours or greater shall meet one of the following specifications:

(1) Wrapped or encased with listed or approved materials having a fire resistance rating equal to the fire barrier for 10 ft (3 m) of the duct on each side of the fire barrier including duct supports within this span
(2) Constructed of materials and supports having a minimum fire resistance rating equal to the fire barrier
(3) Enclosed with a shaft that is constructed of material having a fire resistance rating equal to the fire barrier for 10 ft (3 m) of the duct on each side of the fire barrier with no inlets to the duct within this distance, and the duct entry into and exit from the shaft is protected in accordance with 4.2.13

4.2.13 Exhaust ducts passing through fire barriers of any fire resistance rating shall be protected by sealing the space around the duct with listed or approved fire stopping having a fire resistance rating equal to the fire resistance rating of the fire barrier.

4.2.14 Unless the circumstances stipulated in 4.2.14.1 or 4.2.14.2 exist, fire detection and alarm systems shall not be interlocked to shut down air-moving devices.

4.2.14.1 Where shutdown is necessary for the effective operation of an automatic extinguishing system, it shall be permitted to interlock fire detection and alarm systems to shut down air-moving devices.

4.2.14.2 Where a documented risk analysis acceptable to the authority having jurisdiction shows that the risk of damage from fire and the products of combustion would be higher with air-moving devices operating, it shall be permitted to interlock fire detection and alarm systems to shut down air-moving devices.

4.3 Duct Material and Construction.

4.3.1 Unless the circumstances stipulated in 4.3.1.1 or 4.3.1.2 exist, duct material shall be noncombustible.

4.3.1.1 Combustible duct material, when protected in accordance with Chapter 9, shall be permitted to be used when the material being conveyed is incompatible with noncombustible construction materials.

4.3.1.2 Listed duct systems approved for use without automatic fire protection and not subject to combustible residue buildup shall be permitted to be used.

4.3.2 The duct construction shall conform to the following applicable Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) standards:

(1) SMACNA 1108, *Accepted Industry Practice for Industrial Duct Construction*
(2) SMACNA 1922, *Rectangular Industrial Duct Construction Standard*
(3) SMACNA 1520, *Round Industrial Duct Construction Standard*
(4) SMACNA 1378, *Thermoplastic Duct (PVC) Construction Manual*
(5) SMACNA 1546, *Thermoset FRP Duct Construction Manual*

4.3.3 Duct supports shall be designed to carry the weight of the duct system itself plus the anticipated weight of any conveyed materials.

4.3.4 If sprinkler protection is provided inside the duct system, then the duct supports shall also be designed to carry the anticipated weight of any accumulation of sprinkler discharge.

4.3.4.1* As an alternative to 4.3.4, it shall be permitted to provide low-point drains in the ducts in accordance with 4.3.4.1.1 through 4.3.4.1.4.

4.3.4.1.1 Where drainage would not cause water damage, friction-retained caps or equivalent drainage arrangements shall be used.

4.3.4.1.2* Where drainage would cause water damage, drainage discharge shall be consistent with requirements of the state and local building codes.

4.3.4.1.3 Where hazardous residue is present in the duct, drains shall be arranged for proper disposal of wastes in the drain water.

4.3.4.1.4 Drains shall be designed to minimize air leakage into the ducts.

4.3.4.2 Branch-duct inlets to the main horizontal ducts near the top of the main duct shall be located to lessen the possibility of sprinkler discharge flowing back through the branches and into critical processes.

4.3.5 Laps in duct construction shall be in the direction of airflow.

4.3.6 Condensate.

4.3.6.1 Joints in duct construction shall be liquidtight when the conveying system contains condensable vapors or liquids in suspension.

4.3.6.2 Provisions shall be made for drainage of condensate at low points in the duct.

4.4 Access.

4.4.1* A means shall be provided to inspect the system in accordance with Section 10.3.

4.4.2 The requirement of 4.4.1 shall not apply to ducts handling materials that do not create a condition requiring access into the duct.

4.4.3 Location and Size.

4.4.3.1 Access openings shall be located and sized to satisfy their intended purpose.

4.4.3.2 Where used, access openings shall be located on the tops or sides of the ducts.

4.4.4* Where access openings are used, the closures shall maintain the integrity of the duct system.

4.4.5 Where used, required openings or other penetrations shall be sealed, gasketed, or tightly fitted so that conveyed material does not escape.

4.5 Design Requirements.

4.5.1* An exhaust system shall be inherently balanced, or a means shall be provided for balancing the system.

4.5.2* The design of the system shall be documented, and the documentation shall include the following information:

(1) Data on the range of particulate size
(2) Concentration of particulate or dust in the conveyance air stream
(3) Potential for reaction between the transported particulates and the extinguishing media used to protect process equipment
(4) Conductivity of the particulates
(5) Concentration of flammable vapors or gases in the conveyance air stream
(6) Other physical and chemical properties that could affect the fire protection of the process

4.5.3 Existing systems shall not be modified without considering the effects of those changes on the system performance, including the redesign of the system to incorporate the proposed changes.

4.5.4 Where used, balancing devices shall be secured to prevent inadvertent adjustment or loss of transport velocity.

4.5.5 When dampers or louvers are used for weather or backdraft protection, they shall be located on the clean-air side of the filtration system.

4.5.6* Building components shall not be used as parts of a duct system.

4.5.7* Discharge shall terminate away from outside air intakes to prevent material from entering the air intakes.

4.5.8 The rate of airflow at each hood or other pickup point shall be designed so as to capture, convey, and control the material.

4.5.9* All ductwork shall be sized to provide the air volume and air velocity necessary to keep the duct interior clean and free of residual material. [**654:**9.3.3.2.6.6]

4.5.10 Hoods.

4.5.10.1 Materials shall be confined to and removed from the area where they are generated, by hoods or enclosures and an air-moving device.

4.5.10.2* When it is not possible for the process to be enclosed or hoods installed, local exhaust ventilation shall be permitted.

4.5.11 Duct liners that are combustible shall meet one of the following requirements:

(1) They shall be tested as part of a listed duct system that has been evaluated and found to be of low fire hazard not requiring automatic sprinkler protection to prevent fire spread.
(2) They shall have automatic sprinkler protection as required by Chapter 9.

4.5.12 Additional branch ducts shall not be added to an existing system without redesign of the system.

4.5.13 Branch ducts shall not be disconnected nor unused portions of the system be blanked off without provision for means to maintain required airflow.

4.5.14 Flexible ducts shall be permitted to be used only at inlets where movability or portability is required.

4.6 Hangers and Supports.

4.6.1 Duct supports shall be designed to carry the weight of the duct half filled with material.

4.6.2 Where sprinkler protection is provided or cleaning of the duct will be performed, the hanger's design shall include the weight of any expected liquid accumulation.

4.6.3 Duct supports shall be designed to prevent placing loads on connected equipment.

4.6.4 Hangers and supports exposed to corrosive atmospheres shall be resistant to the corrosive atmospheres.

4.6.5 To avoid vibration and stress on the duct, hangers and supports shall be securely fastened to the building or structure.

4.6.6 Hangers and supports shall be designed to allow for expansion and contraction.

4.7 Duct Installation.

4.7.1 General Requirements. Unless the conditions stipulated in 4.7.1.1 or 4.7.2 exist, all duct systems and system components shall have a clearance of at least 6 in. (152 mm) from stored combustible materials, and not less than ½ in. (13 mm) clearance from combustible construction.

4.7.1.1 Where stored combustible material or combustible construction is protected from ductwork by the use of materials or products listed for protection purposes, clearance shall be maintained in accordance with those listings.

4.7.2 Systems Conveying Combustible Materials. Unless the conditions stipulated in 4.7.2.1 exist, all duct systems and system components handling combustible materials shall have a clearance of not less than 18 in. (457 mm) from stored combustible materials or combustible construction.

4.7.2.1 When the ductwork system is operating at 140°F (60°C) or below and is equipped with an approved automatic extinguishing system designed for the specific hazard, the clearance shall be permitted to be reduced to 6 in. (152 mm) from combustible materials and ½ in. (13 mm) from combustible construction.

4.7.3 Clearance Increases. All duct systems and system components operating at temperatures above 140°F (60°C) shall have clearances from stored combustible materials or combustible construction not less than those listed in Table 4.7.3.

4.7.3.1 Ducts handling materials at temperatures in excess of 900°F (482°C) shall be lined with refractory material or the equivalent.

4.7.3.2 When stored combustible materials or combustible construction are protected from ductwork in accordance with 4.7.4, the clearance established in Table 4.7.3 shall be permitted to be reduced in accordance with Table 4.7.4, but not to less than specified in 4.7.1.

4.7.4 Clearance Reduction Methods. It shall be permitted to protect stored combustible material or combustible construction from ductwork in accordance with Table 4.7.4 and this section.

4.7.4.1 In no case shall the clearance between the duct and the combustible surface be reduced below that allowed in Table 4.7.4.

4.7.4.2 Spacers and ties for protection materials shall be of noncombustible material and shall not be installed on the duct side of the protection system.

4.7.4.3 Mineral wool batts (blanket or board) shall have a minimum density of 8 lb/ft^3 (130 kg/m^3) and have a minimum melting point of 1500°F (816°C).

4.7.4.4 Insulation board used as a part of a clearance reduction system shall meet the following criteria:

(1) Have a thermal conductivity of 1 Btu in./ft^2 hr °F (0.14 W/m^2 hr °C) or less
(2) Be formed of noncombustible material

4.7.4.5 With all clearance reduction systems, at least 1 in. (25.4 mm) clear space shall be provided between the duct and the thermal shield.

4.7.4.6 When using clearance reduction systems that include an air gap, at least 1 in. (25.4 mm) clear space shall be provided between the thermal shield and the combustible surface.

4.7.4.7 When using clearance reduction systems that include an air gap between the combustible surface and the selected means of protection, air circulation shall be provided by one of the methods in 4.7.4.7.1 through 4.7.4.7.3.

4.7.4.7.1 Air circulation shall be permitted to be provided by leaving all edges of the protecting system open with at least a 1 in. (25.4 mm) air gap.

Table 4.7.3 Basic Minimum Clearances to Unprotected Surfaces

	Largest Duct Dimension		Clearance	
Duct Gas Temperature	in.	mm	in.	mm
140°F–600°F (60°C–315°C) incl.	8	203	8	203
	>8	>203	12	305
>600°F–900°F (>315°C–482°C) incl.	8	203	18	457
	>8	>203	24	610
>900°F (>482°C)	All ducts lined with refractory		24	610

Table 4.7.4 Reduction of Duct Clearance with Specified Forms of Protection

	Maximum Allowable Reduction in Clearance (%)	
Form of Protection*	As Wall Protector or Vertical Surface	As Ceiling Protector or Horizontal Surface
3 ½ in. (90 mm) thick masonry wall without ventilated air space	33	None
½ in. (13 mm) thick noncombustible insulation board over 1 in. (25.4 mm) glass fiber or mineral wool batts without ventilated air space	50	33
0.024 in. (0.61 mm/24 gauge) sheet metal over 1 in. (25.4 mm) glass fiber or mineral wool batts reinforced with wire, or equivalent on rear face with at least a 1 in. (25.4 mm) air gap	66	66
3 ½ in. (90 mm) thick masonry wall with at least a 1 in. (25.4 mm) air gap	66	None
0.024 in. (0.61 mm/24 gauge) sheet metal with at least a 1 in. (25.4 mm) air gap	66	50
½ in. (13 mm) thick noncombustible insulation board with at least a 1 in. (25.4 mm) air gap	66	50
0.024 in. (0.61 mm/24 gauge) sheet metal with ventilated air space over at least 0.024 in. (0.61 mm/24 gauge) sheet metal with at least a 1 in. (25.4 mm) air gap	66	50
1 in. (25.4 mm) glass fiber or mineral wool batts sandwiched between two sheets of 0.024 in. (0.61 mm/24 gauge) sheet metal with at least a 1 in. (25.4) mm air gap	66	50

* Clearance reduction applied to and covering all combustible surfaces within the distance specified as required clearance with no protection in Table 4.7.3.

4.7.4.7.2 If the means of protection is mounted on a single flat wall away from corners, air circulation shall be permitted to be provided by one of the following:

(1) Leaving only the top and bottom edges open to circulation by maintaining the 1 in. (25.4 mm) air gap
(2) Leaving the top and both side edges open to circulation by maintaining the 1 in. (25.4 mm) air gap

4.7.4.7.3 Thermal shielding that covers two walls in a corner shall be permitted to be open at the top and bottom edges with at least a 1 in. (25.4 mm) air gap.

4.7.5 Measuring Clearances.

4.7.5.1 As shown in Figure 4.7.5.1, all clearances shall be measured from the outer surface of the combustible material to the nearest point on the outer surface of the duct, disregarding any intervening protection over the combustible material.

4.7.5.2 The minimum allowable clearance with protection provided, shown as dimension B in Figure 4.7.5.1, shall be calculated by using the following equation:

[4.7.5.2]

$$B = A \bullet \left(1 - \frac{R}{100}\right)$$

where:
B = minimum allowable clearance with protection
A = required clearance with no protection
R = maximum allowable clearance reduction in %

4.7.5.3 The protection applied to the construction using noncombustible materials shall extend far enough in each direction to make distance C in Figure 4.7.5.1, at least equal to the required clearance with no protection A.

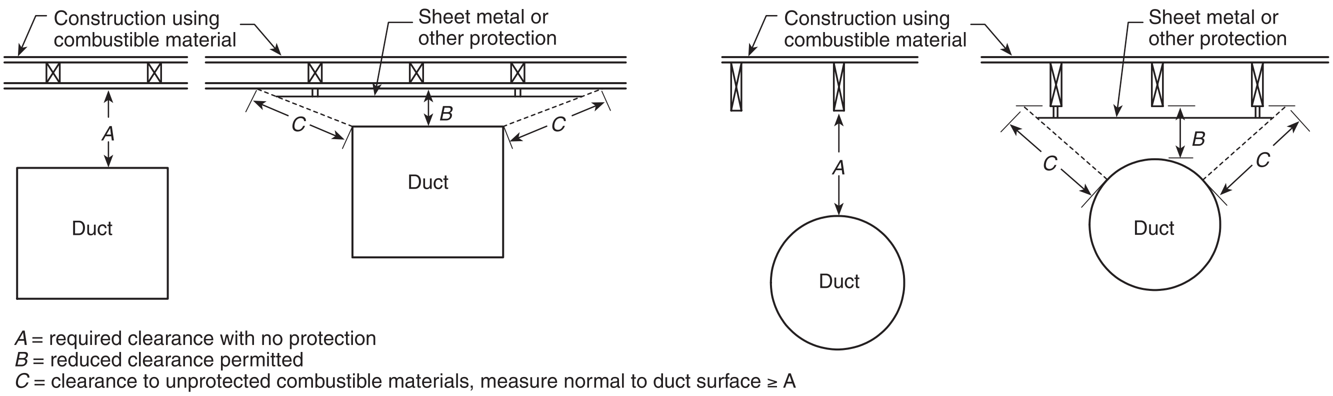

FIGURE 4.7.5.1 Extent of Protection Required to Reduce Clearances from Ducts.

Chapter 5 Corrosive Materials

5.1 General.

5.1.1 Exhaust systems utilizing plastic material shall be permitted to be used to convey nonflammable corrosives.

5.1.2 The choice of the material type shall be the responsibility of the design engineer.

5.1.3* All chemical-resistant plastics have properties and limitations that shall be considered in the design of a system.

5.1.4 The minimum standards of materials, construction, and workmanship in 5.1.4.1 through 5.1.4.3 shall be deemed necessary to ensure minimum fire hazard in the operation of these systems.

5.1.4.1 Plastic ducts shall be in accordance with 4.3.1 and 4.5.11.

5.1.4.2 All hoods and air-moving device surfaces that are part of the system shall have flame spread ratings at least equivalent to the flame spread rating of the material of the duct system.

5.1.4.3 Where located in a multistory building or a concealed space, plastic duct materials shall be listed with an external smoke development rating of 50 or less, unless the duct system is located in an area protected by an automatic sprinkler system, or located in a 1-hour fire-rated enclosure.

Chapter 6 Air-Moving Devices

6.1 General.

6.1.1 Air-moving devices shall be constructed of noncombustible materials and shall be designed and installed to safely convey materials through the exhaust system.

6.1.2 Where the materials conveyed are not compatible with noncombustible materials, alternate materials of construction shall be permitted based upon a documented risk evaluation.

6.2* Flammable or Combustible Materials. Where flammable or combustible materials are conveyed at concentrations greater than or equal to 10 percent of either the MEC of the dust or the LFL of the vapor, fans and blowers shall be of Type A, B, or C spark-resistant construction per AMCA 99-0401-86, *Classification for Spark Resistant Construction*.

6.3 Clearance.

6.3.1 Clearance between the rotating element and the casing shall be provided to avoid friction that might lead to fire.

6.3.2 Allowances shall be made for expansion and loading to prevent contact between moving parts and the duct or housing.

6.4 Alignment. The rotating elements shall be mounted on a shaft designed to maintain proper alignment even when the blades or impeller are loaded.

6.5 Maintenance and Inspection.

6.5.1 Air-moving devices shall be located to permit ready access for inspection, lubrication, maintenance, cleaning, and repair.

6.5.2 Air-moving devices shall be placed on foundations or firmly secured to supports.

6.6 Location. Air-moving devices used in systems that air convey dust or vapors containing residue shall be located on the clean-air side of the filtration system.

6.7 Flexible Connections. Flexible connections shall be permitted in order to minimize the transmission of vibration.

Chapter 7 Air–Material Separators (Air Separation Devices)

7.1 General Requirements.

7.1.1 Air–material separators handling both noncombustible particulates as well as a flammable gas, vapor, or mist shall comply with the requirements of all relevant sections in this chapter.

7.1.2 The discharge system shall be designed to handle the maximum material flow attainable from the system.

7.1.3 Air–material separators shall be sized and selected to assure adequate system air flow under all anticipated design conditions.

7.1.4* All air–material separators shall be equipped with performance monitoring devices for verification of system performance per 7.1.2 and 7.1.3.

7.1.5 Materials of construction of the air–material separator shall not exceed the fire load for which the building compartment fire protection has been designed.

7.1.6 Location.

7.1.6.1 Where an explosion hazard exists within the air–material separator, air–material separators shall be located outside of buildings.

7.1.6.2 The requirement of 7.1.6.1 shall not apply to the following:

(1) Air–material separators equipped with explosion venting in accordance with NFPA 68
(2) Air–material separators equipped with explosion protection in accordance with NFPA 69
(3) Air–material separators with volumes less than 8 ft^3 (0.2 m^3)

7.1.7 Protection.

7.1.7.1 Where both an explosion hazard and a fire hazard exist in an air–material separator, provisions for protection for each type of hazard shall be provided.

7.1.7.2 The protection to be provided shall be permitted to be determined by a documented risk evaluation acceptable to the authority having jurisdiction.

7.1.8 Access. Access openings shall comply with Section 4.4.

7.1.9 Manifolding of Ducts. Where an explosion hazard exists, the requirements in 7.1.9.1 through 7.1.9.4 shall apply.

7.1.9.1 Manifolding of ducts to air–material separators shall not be permitted.

7.1.9.2 Ducts from a single piece of equipment or from multiple pieces of equipment interconnected on the same process stream shall be permitted to be manifolded.

7.1.9.3 Ducts from nonassociated pieces of equipment shall be permitted to be manifolded, provided that each duct is equipped with an isolation device prior to manifolding in accordance with NFPA 69.

7.1.9.4 Ducts for centralized vacuum cleaning systems shall be permitted to be manifolded.

7.1.10 Where lightning protection is provided, it shall be installed in accordance with NFPA 780.

7.2* Separators for Noncombustible Particulates.

7.2.1* Hopper bottoms shall be designed with a slope suitable for the material being collected.

7.2.2* The type of air–material separator shall be suitable for the particulates to be separated.

7.3 Separators for Flammable Gases, Vapors, and Mists.

7.3.1* The type of separator shall be suitable for the gas, vapor, or mist being separated from the air stream.

7.3.2 A means shall be in place to determine when the media must be replaced in order to provide suitable removal of the filtrate.

7.3.3 Where the conveying gas includes flammable gases or vapors in addition to the noncombustible particulates, air–material separators shall be constructed of noncombustible materials.

7.3.4 Filter media and filter media support frames shall be permitted to be constructed of combustible material.

7.3.5 All system components shall be conductive.

7.3.6 Nonconductive system components shall be permitted where a documented risk evaluation has determined the level of risk from electrostatic ignition and the risk evaluation is acceptable to the authority having jurisdiction.

Chapter 8 Ignition Sources

8.1 Electrical Equipment. All electrical equipment and installations shall comply with the requirements of *NFPA 70.*

8.2* Static Electricity.

8.2.1 All system components shall be conductive.

8.2.2* Bonding and grounding with a resistance of less than 1.0×10^6 ohms to ground shall be provided.

8.2.3* Nonconductive equipment shall be permitted to be used in accordance with the requirements of Chapter 5 and 8.2.3 and 8.2.3.1.

N **8.2.3.1** Nonconductive system components shall be permitted where all of the following conditions are met:

(1)* Hybrid mixtures and flammable gas/vapor atmospheres are not present.
(2)* Conductive particulate solids are not handled.
(3)* The nonconductive components do not result in isolation of conductive components from ground.
(4)* The breakdown strength across nonconductive sheets, coatings, or membranes does not exceed 4 kV, and the breakdown strength across nonconductive woven objects does not exceed 6 kV, when used in high surface charging processes.

[**652:**9.4.7.1.2]

8.2.4 Where belt drives are used, the belts shall be electrically conductive with a resistance of 1 megohm or less.

8.3 Manifolds. Operations generating flames, sparks, or hot material such as from grinding wheels and welding shall not be manifolded into any exhaust system that air conveys flammable or combustible materials.

8.4 Open Flames and Sparks. The requirements of 8.4.1 through 8.4.4 shall be applied retroactively.

8.4.1 Prior to the start of any hot work on a duct, the duct shall be investigated for the presence of combustible residue or flammable vapors.

8.4.2 Cutting and welding shall comply with the applicable requirements of NFPA 51B.

8.4.3 Grinding, chipping, and other operations that produce either sparks or open flame ignition sources shall be controlled by a hot work permit system in accordance with NFPA 51B.

8.4.4 Smoking shall be permitted only in designated areas.

8.5 Removal of Ferrous Materials.

8.5.1* Ferrous materials capable of igniting combustible material being conveyed shall be removed from the exhaust stream by magnetic separators of the permanent or electromagnetic type.

8.5.2 Where electromagnetic separators are used, provisions shall be made to indicate the loss of power to the electromagnetic separators.

8.5.3 Where electromagnetic separators are used, they shall be listed or approved.

8.6* Belt Drives. Belt drives shall be designed to stall without the belt slipping, or a safety device shall be provided to shut down the equipment if slippage occurs.

8.7* Bearings.

8.7.1 Roller or ball bearings shall be used on all processing and transfer equipment.

8.7.2 Bearings and drive components shall not be placed inside ducts unless they are protected or enclosed to prevent ignition of flammable materials.

8.7.3 Lubrication shall be performed in accordance with the manufacturer's recommendations.

8.7.4 Bushings shall be permitted to be used when an engineering evaluation shows that mechanical loads and speeds preclude ignition due to frictional heating.

8.8 Equipment. Equipment with moving parts shall be installed and maintained so that true alignment is maintained and clearance is provided to minimize friction.

Chapter 9 Fire Protection

9.1* General. Any portion of an exhaust system utilizing combustible components or having the potential for combustible residue buildup on the inside, where the duct cross-sectional area is greater than or equal to 75 in.^{2} (480 cm^2), shall be provided with an automatic extinguishing system within the duct and at the duct intake, hood, enclosure, or canopy.

9.1.1 Unless combustible residue buildup is present, an automatic extinguishing system shall not be required where ductwork is fabricated from listed limited combustible material.

9.2 Drainage. When a sprinkler system is installed, means shall be provided to prevent water accumulation in the duct or flow of water back to a process subject that could be damaged by water.

9.3 Testing and Inspection. Fire protection shall be tested and inspected in accordance with NFPA 25.

Chapter 10 Testing and Maintenance

10.1 Retroactivity. The requirements of Chapter 10 shall be applied retroactively.

10.2 General. Exhaust systems shall be tested, inspected, and maintained to ensure safe operating conditions.

10.2.1 The responsibility for maintenance shall be assigned to trained personnel who are capable of recognizing potential hazards.

10.2.2 Maintenance shall include the determination that special protection for duct systems is fully operable and that plant automatic sprinkler protection is in service.

10.3* System Test.

10.3.1 When installation of a new system is complete, the system shall be tested to demonstrate performance before acceptance by the user.

10.3.2 Modified systems shall be retested.

10.3.3 Test results shall be recorded and maintained for at least 2 years or two test cycles, whichever is greater.

10.3.4* Existing systems shall be tested annually by the user to demonstrate continued performance.

10.3.5 Where the manufacturer's requirements are more stringent or where conditions of service and documented past test results dictate, testing frequencies shall be permitted to be adjusted accordingly, but not to exceed every 2 years.

10.4* System Inspection.

10.4.1 All system components shall be inspected monthly.

10.4.2 When the manufacturer's requirements are more stringent or where conditions of service and documented past inspection results dictate, inspection frequencies shall be permitted to be adjusted accordingly, but not to exceed quarterly.

10.4.3 Inspection results shall be recorded and maintained for at least 2 years.

10.4.4 The user's operational and maintenance program shall include all of the manufacturer's listed procedures that are applicable to the equipment.

10.4.5 An operational and maintenance checklist shall be maintained.

10.4.6 Accumulations of conveyed materials and residues shall be removed from hoods and enclosures, ducts and fittings, and air-moving devices.

10.4.7 The ducts shall be checked for obstructions such as improperly adjusted dampers or shutters.

10.4.8 Filtration systems shall be inspected and filters cleaned or replaced as required.

10.4.9 Air-moving devices shall be inspected for belt tension and wear and lubrication.

10.4.10 Hoods and enclosures shall be inspected for proper confinement and removal of materials.

10.5 Cleanliness. Ductwork shall be examined periodically to determine adequacy of cleaning frequency.

10.6 Maintenance Program.

10.6.1 All system components shall be maintained in good operating condition.

10.6.2 A written maintenance program shall be established.

10.6.3 The program shall include any and all recommendations provided by the manufacturer.

10.6.4 All deficiencies found during testing and inspection shall be corrected.

10.6.5 Serious deficiencies shall require immediate attention.

10.7 Maintenance Log. An operational maintenance log shall be kept to document maintenance actions.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

Δ **A.1.1** The following NFPA standards contain information on the application of exhaust systems to specific industries or operations:

(1) NFPA 1
(2) NFPA 30
(3) NFPA 30B
(4) NFPA 32
(5) NFPA 33
(6) NFPA 34
(7) NFPA 35
(8) NFPA 36
(9) NFPA 45
(10) NFPA 61
(11) NFPA 68
(12) NFPA 85
(13) NFPA 86
(14) NFPA 92
(15) NFPA 96
(16) NFPA 120
(17) NFPA 204
(18) NFPA 211
(19) NFPA 303
(20) NFPA 318
(21) NFPA 409
(22) NFPA 484
(23) NFPA 654
(24) NFPA 655
(25) NFPA 664
(26) NFPA 801

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.1 Air–Material Separator (AMS). Examples include cyclones, bag filter houses, scrubbers, demisters, and electrostatic precipitators.

Δ **A.3.3.2 Air-Moving Device.** An air-moving device is a fan or blower. A general description of each follows:

(1) Fans:
   (a) A wide range of devices that utilize an impeller, contained within a housing, that when rotated create air/gas flow by negative (vacuum) or positive differential pressure.
   (b) These devices are commonly used to create comparatively high air/gas volume flows at relatively low differential pressures.
   (c) These devices are typically used with ventilation and/or dust collection systems.
   (d) Examples are centrifugal fans, industrial fans, mixed or axial flow fans, and inline fans.

(2) Blowers:
   (a) A wide range of devices that utilize various-shaped rotating configurations, contained within a housing, that when rotated create air/gas flow by negative (vacuum) or positive differential pressure.
   (b) These devices are commonly used to create comparatively high differential pressures at comparatively low air/gas flows.
   (c) The most common uses of these devices are with pneumatic transfer, high-velocity, low volume (HVLV) dust collection, and vacuum cleaning systems.
   (d) Examples are positive displacement (PD) blowers, screw compressors, multi-stage centrifugal compressors/blowers, and regenerative blowers.

[**652,** 2019]

Δ **A.3.3.3 Centralized Vacuum Cleaning System.** This system normally consists of multiple hose connection stations hard-piped to an AMS located out of the hazardous area. Positive displacement or centrifugal AMDs can be used to provide the negative pressure air flow. The hoses and vacuum cleaning tools utilized with the system should be designed to be conductive or static-dissipative in order to minimize any risk of generating an ignition source. Low MIE materials should be given special consideration in the system design and use. A primary and secondary AMS separator combination (e.g., cyclone and filter receiver) can be used if large quantities of materials are involved. However, most filter receivers are capable of handling the high material loadings without the use of a cyclone. [**652,** 2019]

A.3.3.5 Dust Collection System. A typical dust collection system consists of the following:

(1) Hoods — devices designed to contain, capture, and control the airborne dusts by using an induced air flow in close proximity to the point of dust generation (local exhaust zone) to entrain fugitive airborne dusts.
(2) Ducting — piping, tubing, fabricated duct, etc., used to provide the controlled pathway from the hoods to the dust collector (AMS). Maintaining adequate duct velocity (usually 4000 fpm or higher) is a key factor in the proper functioning of the system.
(3) Dust collector — an AMS designed to filter the conveyed dusts from the conveying air stream. Usually these devices have automatic methods for cleaning the filter media to allow extended use without blinding. In some systems, a scrubber or similar device is used in place of the filter unit.
(4) Fan package — an AMD designed to induce the air flow through the entire system.

The system is designed to collect only suspended dusts at the point of generation and not dusts at rest on surfaces. The system is also not designed to convey large amounts of dusts as the system design does not include friction loss due to solids loading in the pressure drop calculation. Thus, material loading must be minimal compared to the volume or mass of air flow. [**654,** 2020]

A.3.3.6 Exhaust System. A system can consist of an air-moving device with ducting, connected to the inlet, the discharge, or both. More complicated systems can include ductwork, an air-moving device, control dampers, an air–material separator, noise attenuation, and pollution control equipment.

A.3.3.7 Explosion Hazard. A mist of flammable or combustible liquids has deflagration characteristics that are analogous to dusts. The lower flammable limit for dispersed liquid mists varies with droplet size in a manner that is analogous to particle size for dusts. The determination of these deflagration characteristics is complicated by droplet dispersion, coalescence, and settling. A typical LFL for a fine hydrocarbon mist is 40 g/m^3 to 50 g/m^3, which is approximately equal to the LFL for combustible hydrocarbon gases in air at room temperature. Mists of combustible liquids can be ignited at initial temperatures well below the flash point of the liquid. [**68:** B.2.6]

A.3.3.11 Lower Flammable Limit (LFL). Mixtures below this limit are said to be "too lean." [**329,** 2020]

N **A.3.3.12 Minimum Explosible Concentration (MEC).** Minimum explosible concentration is defined by the test procedure in ASTM E1515, *Standard Test Method for Minimum Explosible Concentration of Combustible Dusts*. MEC is equivalent to the lower flammable limit for flammable gases. Because it has been customary to limit the use of the lower flammable limit to flammable vapors and gases, an alternative term is necessary for combustible dusts. [**652,** 2019]

The MEC is dependent on many factors, including particulate size distribution, chemistry, moisture content, and shape. Consequently, designers and operators of processes that handle combustible particulate solids should consider those factors when applying existing MEC data. Often, the necessary MEC data can be obtained only by testing. [**652,** 2019]

A.3.3.14 Noncombustible Particulate Solid. Noncombustible particulate solids include dusts, fibers, fines, chips, chunks, flakes, and mixtures of these.

A.3.3.15 Pneumatic Conveying System. Pneumatic conveying systems include a wide range of equipment systems utilizing air or other gases to transport solid particles from one point to another. A typical system comprises the following:

(1) A device used to meter the material into the conveying air stream
(2) Piping, tubing, hose, etc., used to provide the closed pathway from the metering device to the AMS
(3) An AMS designed for the separation of comparatively large amounts of material from the conveying air/gas stream
(4) An additional metering device (typically a rotary airlock valve or similar device) that might be used to allow discharge of the separated material from the conveying air stream without affecting the differential pressure of the system
(5) An AMD designed to produce the necessary pressure differential and air/gas flow in the system (positive or negative)

A pneumatic conveying system requires the amount of material conveyed by the system to be considered as a major factor in the system pressure drop calculations. Both positive and negative (i.e., vacuum) differential pressure are used for pneumatic conveying. The decision of which is the best for a specific application should be based on a risk analysis, equipment layout, and other system operational and cost factors. Dense phase conveying can also be considered for the application, especially with more hazardous materials (e.g., low MIE). The inherent design and operational features of this approach can provide significant safety and operational advantages over other types of pneumatic conveying systems. [**654,** 2020]

A.4.1.1 The provisions of 4.1.1 do not require inherently noncombustible materials to be tested in order to be classified as noncombustible materials. [**5000:**A.7.1.4.1]

A.4.1.1.1(1) Examples of such materials include steel, concrete, masonry, and glass. [**5000:**A.7.1.4.1.1(1)]

A.4.1.2 Material subject to increase in combustibility or flame spread index beyond the limits herein established through the effects of age, moisture, or other atmospheric condition is considered combustible. (*See NFPA 259 and NFPA 220.*) [**5000:**A.7.1.4.2]

A.4.2.1 Users should refer to the current edition of ACGIH 2098, *Industrial Ventilation — A Manual of Recommended Practice for Design*, for the proper design of the system.

A.4.2.2 Materials, when mixed, should not create a fire, explosion, or health hazard. For additional information, see ASTM E2012, *Standard Guide for the Preparation of a Binary Chemical Compatibility Chart.*

Δ **A.4.2.5** Capture, control, and conveying of materials are achieved by inward airflow generated by the exhaust pickup or intake, the intake velocity, and the duct velocity.

Capture velocities should be high enough to maintain control of the material in order to accomplish the following:

(1) Convey the material to the intake opening
(2) Overcome thermal air currents from hot processes or heat-generating operations
(3) Overcome air currents caused by grinding wheels and belt conveyors
(4) Overcome air currents caused by dumping and filling operations
(5) Overcome air currents caused by items such as pedestal fans and other personnel cooling or heating devices.

Exhaust systems designed for gases, vapors, fumes, and fine dust particles (20 microns or less) require intake velocities high enough to offset air currents caused by room cross-drafts.

Duct velocities are determined by the type of material conveyed *(see Table A.4.2.5)*.

A.4.2.8 The design of the exhaust system should be coordinated with the architectural and structural designs. The plans and specifications should include a list of all equipment, giving manufacturer and type number. Plans should be drawn to an indicated scale and show all essential details as to location, construction, ventilation ductwork, volume of outside air at standard temperature and pressure introduced for safety ventilation, and control wiring diagrams. The details of the plan should also include the following:

(1) Name of owner and occupant
(2) Location, including street address
(3) Point of compass
(4) Ceiling construction
(5) Full height cross-section
(6) Location of fire walls
(7) Location of partitions
(8) Materials of duct construction

A.4.3.4.1 A 4 in. (102 mm) drain with a capacity of approximately 150 gpm (565 L/min) is typically used. Other sizes are acceptable when designed by knowledgeable contractors.

A.4.3.4.1.2 The preferred location for discharging the drain is outdoors or to an existing waste drainage system.

A.4.4.1 Access into ducts is required to perform intended inspection, to clean interior surfaces, and to service or replace devices located inside the duct.

Δ Table A.4.2.5 Range of Minimum Duct Design Velocities

Nature of Contaminant	Examples	Design Velocity	
		m/min	ft/min
Vapors, gases, smoke	All vapors, gases, and smoke	305–610*	1000–2000*
Fumes	Welding	610–763	2000–2500
Very fine light dust	Cotton lint, wood flour, litho powder	763–915	2500–3000
Dry dusts and powders	Fine rubber dust, phenol formaldehyde resin dust, jute lint, cotton dust, shavings (light), soap dust, leather shavings	915–1220	3000–4000
Average industrial dust	Grinding dust, buffing lint (dry), wool jute dust (shaker waste), coffee beans, shoe dust, granite dust, silica flour, general material handling, brick cutting, clay dust, foundry (general), limestone dust, packaging and weighing asbestos dust in textile industries	1068–1220	3500–4000
Heavy dusts	Sawdust (heavy and wet), metal turnings, foundry tumbling barrels and shake-out, sandblast dust, wood blocks, hog waste, brass turnings, cast-iron boring dust, lead dust	1220–1373	4000–4500
Heavy or moist dusts	Lead dusts with small chips, moist cement dust, asbestos chunks from transite pipe cutting machines, buffing lint (sticky), quick-lime dust	1373 and up	4500 and up

Notes:
(1) The designer also must consider sticky or wet residues or particles, electrostatic effects, and so forth.
(2) For further information, refer to ACGIH 2098, *Industrial Ventilation — A Manual of Recommended Practice for Design,* published by the American Conference of Governmental Industrial Hygienists (ACGIH).
*Any desired velocity (economic optimum velocity usually within this range).
Source: ACGIH 2098, *Industrial Ventilation — A Manual of Recommended Practice for Design.*

A.4.4.4 Closures should be constructed of compatible materials and provide equivalent or greater corrosion resistance and pressure rating equivalent to the duct.

Δ **A.4.5.1** "Inherently balanced" means the system has been designed using the velocity pressure method described in ACGIH 2098, *Industrial Ventilation — A Manual of Recommended Practice for Design*.

A.4.5.2 The design of the pneumatic conveying, dust collection, or centralized vacuum cleaning system should be coordinated with the architectural and structural designs. The plans and specifications should include a list of all equipment, specifying the manufacturer and type number, and the following information:

(1) Name of owner and occupant
(2) Location, including street address
(3) Point of compass
(4) Ceiling construction
(5) Full-height cross section
(6) Location of fire walls
(7) Location of partitions
(8) Materials of construction

Plans should be drawn to an indicated scale and show all essential details such as location, construction, ventilation ductwork, volume of outside air at standard temperature and pressure that is introduced for safety ventilation, and control wiring diagrams.

A.4.5.6 Building components include walls, floors, or roofs.

Δ **A.4.5.7** For duct systems containing flammable or combustible materials, an evaluation is necessary to determine adequate exhaust stack termination design. Information on stack height can be found in the *ASHRAE Fundamentals Handbook,* the "Airflow Around Buildings" chapter, or ACGIH 2098, *Industrial Ventilation — A Manual of Recommended Practice for Design*.

A.4.5.9 Dust collection systems and centralized vacuum cleaning systems handling combustible dusts usually use branched duct networks with multiple pickup points and variable material loading. In contrast, dilute phase and dense phase pneumatic conveying systems are typically linear systems with controlled infeed and consistent material loading. Dust collection systems for combustible dusts represent a significant increase in deflagration risk compared with most pneumatic conveying systems. A properly designed system is critical to minimizing that risk. For guidance on determining proper dust collection system design, refer to ACGIH *Industrial Ventilation: A Manual of Recommended Practice for Design*. [**654:**A.9.3.3.2.6.6]

A.4.5.10.2 When the materials cannot be enclosed at the source, a local exhaust ventilation system can be used. Because suction inlets have little directional effect beyond a few inches from the inlet, they should be located to sweep the air and minimize pockets that have no air movement. The location of the air makeup system ductwork and discharge points provides more uniform air movement.

When the materials are heavier than air, the inlets should be located near the floor. When the materials are lighter than air, the inlets should be located near the ceiling of the room or enclosure.

A.5.1.3 Properties that can affect the usability of plastic materials include, but are not limited to, the following:

(1) Thermal effects such as softening
(2) UV degradation
(3) Brittleness
(4) Static accumulation
(5) Combustibility

N **A.6.2** Some systems are designed to operate at concentrations that pose no fire or deflagration risk. Such systems include nuisance dust exhaust systems and the downstream side of the last AMS in the pneumatic conveying system. A threshold concentration limit of 10 percent of the LFL or MEC has been set to discriminate between such systems and other systems designed to operate at a significant flammable gas or vapor, mist, or combustible particulate solid loading. This limit ensures that normal variations in processing conditions do not result in the concentration approaching the LFL or MEC.

A.7.1.4 Performance monitoring devices include, but are not limited to, pressure differential gauges and transmitters, motor ammeters, and flow gauges.

A.7.2 Combustible particulate solids are outside the scope of this document. If the system is handling a combustible particulate solid, refer to NFPA 654.

A.7.2.1 The slope of the hopper bottom should address material properties such as material angle of repose, flow characteristics, moisture level, and material separator geometry. Proper slope angle will promote flow from the hopper by gravity alone.

A.7.2.2 Different particulates have different settling velocities, particle sizes, and shapes, which necessitate specific collection and separation technologies. It is important for the separator to be designed for the particulate.

A.7.3.1 Examples include oil mist separators, electrostatic separators, scrubbers, high efficiency air filtration units (roll or cartridge media), cyclonic separators, and others.

A.8.2 See NFPA 77, and the AIChE publications by Britton, *Avoiding Static Ignition Hazards in Chemical Operations*; and Pratt, *Electrostatic Ignitions of Fires and Explosions*.

A.8.2.2 Bonding minimizes the potential difference between conductive objects. Grounding minimizes the potential difference between objects and ground.

Using metal ducts with nonconductive plastic liners to convey mists and particulate solids can create the potential for electrostatic discharge sufficient to ignite conveyed materials or shock personnel.

A.8.2.3 PVC and other nonconductive duct materials can allow static accumulations and should be avoided. There are some conductive or static dissipative plastics that can be considered where corrosion resistance is required.

N **A.8.2.3.1(1)** This requirement is intended to prevent ignition of hybrid mixtures or flammable gas/vapor atmospheres by brush discharges from nonconductive surfaces. [**652:**A.9.4.7.1.2(1)]

N **A.8.2.3.1(2)** This requirement is intended to prevent ignition of combustible dusts by the isolation of conductive particulate solids where they can accumulate charge and create capacitive spark discharges to grounded conductive objects. [**652:**A.9.4.7.1.2(2)]

N **A.8.2.3.1(3)** This requirement is intended to prevent ignition of combustible dusts by capacitive sparks from isolated process equipment. [**652:**A.9.4.7.1.2(3)]

N **A.8.2.3.1(4)** This requirement is intended to prevent ignition of combustible dusts by propagating brush discharges. Pneumatic conveying is an example of a process operation that can generate high surface charging. [**652:**A.9.4.7.1.2(4)]

A.8.5.1 Magnets lose strength over time and should be replaced as necessary.

A.8.6 Transmission of power by direct drive should be used where possible in preference to belt or chain drives.

A.8.7 Consideration should be given to the potential for overheating caused by dust entry into bearings. Bearings should be located outside the exhaust stream where they are less exposed and more accessible for inspection and service. Where bearings are in contact with particulate solid streams, sealed or purged bearings are preferred.

Δ **A.9.1** For additional information on these topics, please see the following NFPA standards:

(1) NFPA 11
(2) NFPA 12
(3) NFPA 12A
(4) NFPA 13
(5) NFPA 15
(6) NFPA 17
(7) NFPA 17A
(8) NFPA 750
(9) NFPA 2001

A.10.3 The required procedure and the minimum data necessary for a thorough initial ventilation test are outlined as follows:

(1) Review the system specifications and drawings to determine the relative location and sizes of ducts, fittings, and associated system components.
(2) Inspect the system to determine that its installation is in accordance with the specifications and drawings, and check items such as fan rotation, belt slippage, damper settings, and thermal overload sizes of starters.
(3) Make a single-line drawing of the installed system and select and identify test locations.
(4) Measure the air volume, fan static pressure, motor rpm and amperes, and the temperature of the air in the system.
(5) Determine pressure drops across all components such as air-cleaning equipment.
(6) Record the test data and design specifications.
(7) Compare the test data with design specifications and determine if alterations or adjustments of the system are necessary to meet specifications.
(8) If alterations or adjustments are made, retest the system and record the final test data, noting any physical changes that were made on the sketch.
(9) Provide a permanent label indicating fan data such as static pressures, rpm, and motor current.

(10) Lock all dampers and mark positions with permanent marker.
(11) Retain test data sheets for the life of the system.

The field tests described in the preceding list pertain to air-handling characteristics only. At times it is necessary or desirable to conduct tests of the environment to determine if the system is providing the desired environmental control. In these cases, the services of a trained industrial hygienist would be required.

For some tests, moisture content of the air in the system or the ambient barometric pressure should be obtained.

All periodic measurements can also be made continuously by means of an operating console or other remote readout system.

The value of obtaining ventilation test data is noted in the following applications:

(1) To record the initial performance of the system and determine if it is functioning in accordance with specifications
(2) To determine the degree of compliance with applicable codes or trade association standards
(3) To provide data upon which to base any necessary changes in the system
(4) To obtain data to assist in the design of future systems
(5) To determine whether the system has sufficient capacity for additional ductwork or other alterations
(6) To obtain data through periodic checks to determine when maintenance or repairs are necessary

A.10.3.4 The following procedure should be followed for measurements needed to perform the periodic tests:

(1) Refer to the initial test data sheet for test locations.
(2) Inspect the system for physical damage (broken, corroded, collapsed duct, etc.) and correct operation of components (fan rotation, damper positions, air cleaner condition, etc.).
(3) Measure static pressure at the same locations used in the initial test.
(4) Compare measured static pressure recorded at the same locations used in the initial test to the initial pressure values.
(5) Make and record any corrections required.
(6) Recheck the system to verify performance if corrections have been made.

A.10.4 Inspection should include hoods; enclosures; ducts; duct connections; filtration system; blast gates locked in marked positions; access openings closed and secured; air-moving device inlets and outlets; air-moving device for belt tension, vibration, and lubrication; and termination and adjacent surfaces.

Annex B Informational References

B.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

B.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 1, *Fire Code*, 2018 edition.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*, 2016 edition.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 2018 edition.

NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*, 2018 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2019 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 2017 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, 2017 edition.

NFPA 17A, *Standard for Wet Chemical Extinguishing Systems*, 2017 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2018 edition.

NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*, 2019 edition.

NFPA 32, *Standard for Drycleaning Facilities*, 2016 edition.

NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*, 2018 edition.

NFPA 34, *Standard for Dipping, Coating, and Printing Processes Using Flammable or Combustible Liquids*, 2018 edition.

NFPA 35, *Standard for the Manufacture of Organic Coatings*, 2016 edition.

NFPA 36, *Standard for Solvent Extraction Plants*, 2017 edition.

NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*, 2019 edition.

NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities*, 2020 edition.

NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, 2018 edition.

NFPA 77, *Recommended Practice on Static Electricity*, 2019 edition.

NFPA 85, *Boiler and Combustion Systems Hazards Code*, 2019 edition.

NFPA 86, *Standard for Ovens and Furnaces*, 2019 edition.

NFPA 92, *Standard for Smoke Control Systems*, 2018 edition.

NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*, 2017 edition.

NFPA 120, *Standard for Fire Prevention and Control in Coal Mines*, 2020 edition.

NFPA 204, *Standard for Smoke and Heat Venting*, 2018 edition.

NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel–Burning Appliances*, 2019 edition.

NFPA 220, *Standard on Types of Building Construction*, 2018 edition.

NFPA 259, *Standard Test Method for Potential Heat of Building Materials*, 2018 edition.

NFPA 303, *Fire Protection Standard for Marinas and Boatyards*, 2016 edition.

NFPA 318, *Standard for the Protection of Semiconductor Fabrication Facilities*, 2018 edition.

NFPA 409, *Standard on Aircraft Hangars*, 2016 edition.

NFPA 484, *Standard for Combustible Metals*, 2019 edition.

NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*, 2020 edition.

NFPA 655, *Standard for Prevention of Sulfur Fires and Explosions*, 2017 edition.

NFPA 664, *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities*, 2020 edition.

NFPA 750, *Standard on Water Mist Fire Protection Systems*, 2019 edition.

NFPA 801, *Standard for Fire Protection for Facilities Handling Radioactive Materials*, 2019 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, 2018 edition.

B.1.2 Other Publications.

B.1.2.1 ACGIH Publications. American Conference of Governmental Industrial Hygienists, 1330 Kemper Meadow Drive, Cincinnati, OH 45240-1634.

ACGIH 2098, *Industrial Ventilation — A Manual of Recommended Practice for Design*, 29th edition, 2016.

B.1.2.2 AIChE Publications. American Institute of Chemical Engineers, 120 Wall Street, FL 23, New York, NY 10005-4020.

Britton, L.G., *Avoiding Static Ignition Hazards in Chemical Operations*, 1999.

Pratt, T. H., *Electrostatic Ignitions of Fires and Explosions*, 1997.

B.1.2.3 ASHRAE Publications. American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., 1791 Tullie Circle, N.E., Atlanta, GA 30329.

ASHRAE Fundamentals Handbook, 2017.

B.1.2.4 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM E2012, *Standard Guide for the Preparation of a Binary Chemical Compatibility Chart,* 2006, reapproved 2012.

B.2 Informational References. The following documents or portions thereof are listed here as informational resources only. They are not a part of the requirements of this document.

ACGIH 2106, *Industrial Ventilation — A Manual of Recommended Practice for Operation and Maintenance*, 2007.

B.3 References for Extracts in Informational Sections.

NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, 2018 edition.

NFPA 329, *Recommended Practice for Handling Releases of Flammable and Combustible Liquids and Gases*, 2020 edition.

NFPA 652, *Standard on the Fundamentals of Combustible Dust*, 2019 edition

NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*, 2020 edition.

NFPA 5000®, *Building Construction and Safety Code®*, 2018 edition.

Index

Sequence of Events for the Standards Development Process

Once the current edition is published, a Standard is opened for Public Input.

Step 1 – Input Stage

- Input accepted from the public or other committees for consideration to develop the First Draft
- Technical Committee holds First Draft Meeting to revise Standard (23 weeks); Technical Committee(s) with Correlating Committee (10 weeks)
- Technical Committee ballots on First Draft (12 weeks); Technical Committee(s) with Correlating Committee (11 weeks)
- Correlating Committee First Draft Meeting (9 weeks)
- Correlating Committee ballots on First Draft (5 weeks)
- First Draft Report posted on the document information page

Step 2 – Comment Stage

- Public Comments accepted on First Draft (10 weeks) following posting of First Draft Report
- If Standard does not receive Public Comments and the Technical Committee chooses not to hold a Second Draft meeting, the Standard becomes a Consent Standard and is sent directly to the Standards Council for issuance (see Step 4) or
- Technical Committee holds Second Draft Meeting (21 weeks); Technical Committee(s) with Correlating Committee (7 weeks)
- Technical Committee ballots on Second Draft (11 weeks); Technical Committee(s) with Correlating Committee (10 weeks)
- Correlating Committee Second Draft Meeting (9 weeks)
- Correlating Committee ballots on Second Draft (8 weeks)
- Second Draft Report posted on the document information page

Step 3 – NFPA Technical Meeting

- Notice of Intent to Make a Motion (NITMAM) accepted (5 weeks) following the posting of Second Draft Report
- NITMAMs are reviewed and valid motions are certified by the Motions Committee for presentation at the NFPA Technical Meeting
- NFPA membership meets each June at the NFPA Technical Meeting to act on Standards with “Certified Amending Motions” (certified NITMAMs)
- Committee(s) vote on any successful amendments to the Technical Committee Reports made by the NFPA membership at the NFPA Technical Meeting

Step 4 – Council Appeals and Issuance of Standard

- Notification of intent to file an appeal to the Standards Council on Technical Meeting action must be filed within 20 days of the NFPA Technical Meeting
- Standards Council decides, based on all evidence, whether to issue the standard or to take other action

Notes:

1. Time periods are approximate; refer to published schedules for actual dates.
2. Annual revision cycle documents with certified amending motions take approximately 101 weeks to complete.
3. Fall revision cycle documents receiving certified amending motions take approximately 141 weeks to complete.

Committee Membership Classifications[1,2,3,4]

The following classifications apply to Committee members and represent their principal interest in the activity of the Committee.

1. M *Manufacturer:* A representative of a maker or marketer of a product, assembly, or system, or portion thereof, that is affected by the standard.
2. U *User:* A representative of an entity that is subject to the provisions of the standard or that voluntarily uses the standard.
3. IM *Installer/Maintainer:* A representative of an entity that is in the business of installing or maintaining a product, assembly, or system affected by the standard.
4. L *Labor:* A labor representative or employee concerned with safety in the workplace.
5. RT *Applied Research/Testing Laboratory:* A representative of an independent testing laboratory or independent applied research organization that promulgates and/or enforces standards.
6. E *Enforcing Authority:* A representative of an agency or an organization that promulgates and/or enforces standards.
7. I *Insurance:* A representative of an insurance company, broker, agent, bureau, or inspection agency.
8. C *Consumer:* A person who is or represents the ultimate purchaser of a product, system, or service affected by the standard, but who is not included in (2).
9. SE *Special Expert:* A person not representing (1) through (8) and who has special expertise in the scope of the standard or portion thereof.

NOTE 1: “Standard” connotes code, standard, recommended practice, or guide.

NOTE 2: A representative includes an employee.

NOTE 3: While these classifications will be used by the Standards Council to achieve a balance for Technical Committees, the Standards Council may determine that new classifications of member or unique interests need representation in order to foster the best possible Committee deliberations on any project. In this connection, the Standards Council may make such appointments as it deems appropriate in the public interest, such as the classification of “Utilities” in the National Electrical Code Committee.

NOTE 4: Representatives of subsidiaries of any group are generally considered to have the same classification as the parent organization.

Submitting Public Input / Public Comment Through the Online Submission System

Following publication of the current edition of an NFPA standard, the development of the next edition begins and the standard is open for Public Input.

Submit a Public Input

NFPA accepts Public Input on documents through our online submission system at www.nfpa.org. To use the online submission system:

- Choose a document from the List of NFPA codes & standards or filter by Development Stage for "codes accepting public input."
- Once you are on the document page, select the "Next Edition" tab.
- Choose the link "The next edition of this standard is now open for Public Input." You will be asked to sign in or create a free online account with NFPA before using this system.
- Follow the online instructions to submit your Public Input (see www.nfpa.org/publicinput for detailed instructions).
- Once a Public Input is saved or submitted in the system, it can be located on the "My Profile" page by selecting the "My Public Inputs/Comments/NITMAMs" section.

Submit a Public Comment

Once the First Draft Report becomes available there is a Public Comment period. Any objections or further related changes to the content of the First Draft must be submitted at the Comment Stage. To submit a Public Comment follow the same steps as previously explained for the submission of Public Input.

Other Resources Available on the Document Information Pages

Header: View document title and scope, access to our codes and standards or NFCSS subscription, and sign up to receive email alerts.

Current & Prior Editions	Research current and previous edition information.
Next Edition	Follow the committee's progress in the processing of a standard in its next revision cycle.
Technical Committee	View current committee rosters or apply to a committee.
Ask a Technical Question	For members, officials, and AHJs to submit standards questions to NFPA staff. Our Technical Questions Service provides a convenient way to receive timely and consistent technical assistance when you need to know more about NFPA standards relevant to your work.
News	Provides links to available articles and research and statistical reports related to our standards.
Purchase Products & Training	Discover and purchase the latest products and training.
Related Products	View related publications, training, and other resources available for purchase.

Information on the NFPA Standards Development Process

I. Applicable Regulations. The primary rules governing the processing of NFPA standards (codes, standards, recommended practices, and guides) are the NFPA *Regulations Governing the Development of NFPA Standards (Regs)*. Other applicable rules include NFPA *Bylaws*, NFPA *Technical Meeting Convention Rules*, NFPA *Guide for the Conduct of Participants in the NFPA Standards Development Process*, and the NFPA *Regulations Governing Petitions to the Board of Directors from Decisions of the Standards Council*. Most of these rules and regulations are contained in the *NFPA Standards Directory*. For copies of the *Directory*, contact Codes and Standards Administration at NFPA headquarters; all these documents are also available on the NFPA website at "www.nfpa.org/regs."

The following is general information on the NFPA process. All participants, however, should refer to the actual rules and regulations for a full understanding of this process and for the criteria that govern participation.

II. Technical Committee Report. The Technical Committee Report is defined as "the Report of the responsible Committee(s), in accordance with the Regulations, in preparation of a new or revised NFPA Standard." The Technical Committee Report is in two parts and consists of the First Draft Report and the Second Draft Report. (See *Regs* at Section 1.4.)

III. Step 1: First Draft Report. The First Draft Report is defined as "Part one of the Technical Committee Report, which documents the Input Stage." The First Draft Report consists of the First Draft, Public Input, Committee Input, Committee and Correlating Committee Statements, Correlating Notes, and Ballot Statements. (See *Regs* at 4.2.5.2 and Section 4.3.) Any objection to an action in the First Draft Report must be raised through the filing of an appropriate Comment for consideration in the Second Draft Report or the objection will be considered resolved. [See *Regs* at 4.3.1(b).]

IV. Step 2: Second Draft Report. The Second Draft Report is defined as "Part two of the Technical Committee Report, which documents the Comment Stage." The Second Draft Report consists of the Second Draft, Public Comments with corresponding Committee Actions and Committee Statements, Correlating Notes and their respective Committee Statements, Committee Comments, Correlating Revisions, and Ballot Statements. (See *Regs* at 4.2.5.2 and Section 4.4.) The First Draft Report and the Second Draft Report together constitute the Technical Committee Report. Any outstanding objection following the Second Draft Report must be raised through an appropriate Amending Motion at the NFPA Technical Meeting or the objection will be considered resolved. [See *Regs* at 4.4.1(b).]

V. Step 3a: Action at NFPA Technical Meeting. Following the publication of the Second Draft Report, there is a period during which those wishing to make proper Amending Motions on the Technical Committee Reports must signal their intention by submitting a Notice of Intent to Make a Motion (NITMAM). (See *Regs* at 4.5.2.) Standards that receive notice of proper Amending Motions (Certified Amending Motions) will be presented for action at the annual June NFPA Technical Meeting. At the meeting, the NFPA membership can consider and act on these Certified Amending Motions as well as Follow-up Amending Motions, that is, motions that become necessary as a result of a previous successful Amending Motion. (See 4.5.3.2 through 4.5.3.6 and Table 1, Columns 1-3 of *Regs* for a summary of the available Amending Motions and who may make them.) Any outstanding objection following action at an NFPA Technical Meeting (and any further Technical Committee consideration following successful Amending Motions, see *Regs* at 4.5.3.7 through 4.6.5) must be raised through an appeal to the Standards Council or it will be considered to be resolved.

VI. Step 3b: Documents Forwarded Directly to the Council. Where no NITMAM is received and certified in accordance with the *Technical Meeting Convention Rules*, the standard is forwarded directly to the Standards Council for action on issuance. Objections are deemed to be resolved for these documents. (See *Regs* at 4.5.2.5.)

VII. Step 4a: Council Appeals. Anyone can appeal to the Standards Council concerning procedural or substantive matters related to the development, content, or issuance of any document of the NFPA or on matters within the purview of the authority of the Council, as established by the *Bylaws* and as determined by the Board of Directors. Such appeals must be in written form and filed with the Secretary of the Standards Council (see *Regs* at Section 1.6). Time constraints for filing an appeal must be in accordance with 1.6.2 of the *Regs*. Objections are deemed to be resolved if not pursued at this level.

VIII. Step 4b: Document Issuance. The Standards Council is the issuer of all documents (see Article 8 of *Bylaws*). The Council acts on the issuance of a document presented for action at an NFPA Technical Meeting within 75 days from the date of the recommendation from the NFPA Technical Meeting, unless this period is extended by the Council (see *Regs* at 4.7.2). For documents forwarded directly to the Standards Council, the Council acts on the issuance of the document at its next scheduled meeting, or at such other meeting as the Council may determine (see *Regs* at 4.5.2.5 and 4.7.4).

IX. Petitions to the Board of Directors. The Standards Council has been delegated the responsibility for the administration of the codes and standards development process and the issuance of documents. However, where extraordinary circumstances requiring the intervention of the Board of Directors exist, the Board of Directors may take any action necessary to fulfill its obligations to preserve the integrity of the codes and standards development process and to protect the interests of the NFPA. The rules for petitioning the Board of Directors can be found in the *Regulations Governing Petitions to the Board of Directors from Decisions of the Standards Council* and in Section 1.7 of the *Regs*.

X. For More Information. The program for the NFPA Technical Meeting (as well as the NFPA website as information becomes available) should be consulted for the date on which each report scheduled for consideration at the meeting will be presented. To view the First Draft Report and Second Draft Report as well as information on NFPA rules and for up-to-date information on schedules and deadlines for processing NFPA documents, check the NFPA website (www.nfpa.org/docinfo) or contact NFPA Codes & Standards Administration at (617) 984-7246.