



First Revision No. 1-NFPA 77-2016 [Chapter 2]

Chapter 2 Referenced Publications

2.1 General.

The documents or portions thereof listed in this chapter are referenced within this recommended practice and should be considered part of the recommendations of this document.

2.2 NFPA Publications.

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

NFPA 30, *Flammable and Combustible Liquids Code*, 2012 2018 edition.

NFPA 69, *Standard on Explosion Prevention Systems*, 2008 2014 edition.

NFPA 70[®], *National Electrical Code*[®], 2014 2017 edition.

NFPA 495, *Explosive Materials Code*, 2013 2018 edition.

NFPA 496, *Standard for Purged and Pressurized Enclosures for Electrical Equipment*, 2013 2017 edition.

NFPA 498, *Standard for Safe Havens and Interchange Lots for Vehicles Transporting Explosives*, 2013 2018 edition.

NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*, 2013 2017 edition.

NFPA 1124, *Code for the Manufacture, Transportation, Storage, and Retail Sales of Fireworks and Pyrotechnic Articles*, 2013 2017 edition.

NFPA 1125, *Code for the Manufacture of Model Rocket and High Power Rocket Motors*, 2012 2017 edition.

2.3 Other Publications.

2.3.1 AIChE Publications.

American Institute of Chemical Engineers, 3 Park Avenue, New York, NY 10016-5901.

Britton, L. G., "Using Heats of Oxidation to Evaluate Flammability Hazards," *Process Safety Progress*, Vol. 21, No. 1, March 2002.

Britton, L. G., "Using Material Data in Static Hazard Assessment," *Plant/Operations Progress*, April 1992, pp. 56–70.

2.3.2 API Publications.

American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005.

API RP 2003, *Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents*, 7th edition, 2008.

2.3.3 ASTM Publications.

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

ASTM ~~D 257~~ D257, *Standard Test Methods for DC Resistance or Conductance of Insulating Materials*, 2007 2014.

ASTM ~~E 502~~ E502, *Standard Test Method for Selection and Use of ASTM Standards for the Determination of Flash Point of Chemicals by Closed Cup Methods*, 1994 2007, reapproved 2013.

2.3.4 CENELEC BSI Publications.

European Committee for Electrotechnical Standardization, Rue de Stassartstraat, 35, B-1050 Brussels, Belgium. BSI Group, 12950 Worldgate Drive, Suite 800, Herdon, VA 20170.

BS EN 61241-2-2, *Electrical Apparatus for Use in the Presence of Combustible Dust — Part 2: Test Methods; Section 2: Method for Determining the Electrical Resistivity of Dust in Layers*, International Electrotechnical Commission, Brussels, 1996.

GENELEC TR 50504, *Electrostatics — Code of Practice for the Avoidance of Hazards Due to Static Electricity*, 2003.

BS PD CLC/TR 60079-32-1, *Explosive Atmospheres Part 32-1: Electrostatic Hazards, Guidance*, 2013, Corrigendum, 2015.

2.3.5 Elsevier Publications.

Elsevier NV, Radarweg 29, Amsterdam 1043, Netherlands.

Britton, L. G. and Smith, J. A., "Static Hazards of the VAST," *Journal of Loss Prevention in the Process Industries*, Vol. 25, pp. 309–328, 2012.

2.3.6 IEC Publications.

International Electrotechnical Commission, 3, rue de Varembe, P.O. Box 131, CH-1211 Geneva 20, Switzerland.

IEC 61241-2-3, *Electrical apparatus for use in the presence of combustible dust — Part 2: Test methods — Section 3: Method for determining minimum ignition energy of dust/air mixtures*, 1994.

IEC 61340-4-4, *Electrostatics — Part 4-4: Standard test methods for specific applications — Electrostatic classification of flexible intermediate bulk containers (FIBC)*, 2005 2014.

2.3.7 IME Publications.

Institute of Makers of Explosives, ~~4120 Nineteenth Street~~ 1120 19th St, NW, Suite 310, Washington, DC 20036-3605.

~~Safety Library Publication No. 3~~, IME SLP 3, *Suggested Code of Regulations for the Manufacture, Transportation, Storage, Sale, Possession, and Use of Explosive Materials*, 2009 2015.

~~Safety Library Publication No. 17~~ IME SLP 17, *Safety in the Transportation, Storage, Handling, and Use of Commercial Explosive Materials*, 2011 2015.

2.3.8 JIS Publications.

Japan Industrial Standards, 1-3-1 Kasumigaseki, Chiyoda-ku, Tokyo 100-8901, Japan.

JIS B 9915, *Measuring Methods for Dust Resistivity (with Parallel Electrodes)*, Japan Industrial Standards, Tokyo, 1989.

2.3.9 U.S. Department of Defense Publications.

U.S. Government Printing Publishing Office, 732 North Capitol St NW, Washington, DC 20402 20401 .

Standard 4145.26M, *Contractors' Safety Manual for Ammunition and Explosives*.

Standard 6055.9, *Ammunition and Explosive Safety Standards*.

2.3.10 Other Publications.

~~BS 5958, *Code of Practice for Control of Undesirable Static Electricity* , Part 1, General Considerations, British Standards Institution, London, 1991.~~

Glor, M., *Electrostatic Hazards in Powder Handling*, Research Studies Press, Ltd., Letchworth, Hertfordshire, England, 1988.

International Safety Guide for Oil Tankers and Terminals (ISGOTT), 4th Edition, Witherby and Co., Ltd., London, 5th edition, 2006.

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

Pratt, T. H., *Electrostatic Ignitions of Fires and Explosions*, Burgoyne, Inc., Marietta, GA, 1997.

Walmsley, H. L., "Avoidance of Electrostatic Hazards in the Petroleum Industry," *Journal of Electrostatics*, Vol. 27, No. 1 and No. 2, Elsevier, New York, 1992.

2.4 References for Extracts in Recommendations Sections.

NFPA 30, *Flammable and Combustible Liquids Code*, 2012 2018 edition.

~~NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*, 2013 -edition.~~

Submitter Information Verification

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Submittal Date: Wed Oct 19 10:59:05 EDT 2016

Committee Statement

Committee Statement: Update references to current titles and editions.

Response Message:

Public Input No. 5-NFPA 77-2015 [Chapter 2]



First Revision No. 8-NFPA 77-2016 [Section No. 3.3.9]

3.3.9 Combustible Dust.

A For the purposes of this recommended practice, a combustible particulate solid that presents a fire or deflagration hazard when suspended in air or other oxidizing medium over a range of concentrations, regardless of particle size or shape. [654, -2013]

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Committee Statement

Committee Statement: The Committee does not agree with the definition of Combustible Dust in NFPA 654 and has decided to retain its current definition without the extract identifier. The Committee takes the position that the word "explosion" in NFPA 654's definition is too broad a concept to apply to the hazards of a combustible dust.

Response Message:



First Revision No. 4-NFPA 77-2016 [Section No. 3.3.22]

3.3.22 Grounding.

The process of ~~bonding one or more conductive objects~~ connecting a conductive object to the ground, so that ~~all objects are~~ the object is at zero (0) electrical potential; also referred to as *earthing*.

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Committee Statement

Committee Statement: This revision clarifies the definition of grounding by making it consistent with the definition of bonding.

Response Message:



First Revision No. 5-NFPA 77-2016 [Section No. 9.2.1.4(C)]

(C)

It is emphasized that bonding the tank to the fill stem is not sufficient; a majority of recorded explosions have occurred when it was believed the tank had been adequately bonded. The electrostatic potential that is responsible for the spark exists inside the tank on the surface of the liquid and cannot be removed by bonding. Measures to reduce this charge can be one or more of the following:

- (1) Avoid spark promoters. Conductive objects floating on the oil surface increase the charge of sparking to the tank wall. Metal gauge rods or other objects projecting into the vapor space can create a spark gap as the rising liquid level approaches the projection. A common precaution is to require that fill pipes (downspouts) reach as close to the bottom of the tank as practicable. Any operation such as sampling, taking oil temperature, or gauging that involves lowering a conductive object through an opening into the vapor space on the oil should be deferred until at least 1 minute after flow has ceased. This will permit any surface charge to relax.
- (2) Reduce the static generation by one or more of the following:
 - (a) Avoid splash filling and upward spraying of oil where bottom filling is used.
 - (b) Employ reduced fill rates at the start of filling through downspouts, until the end of the spout is submerged. Some consider 3 ft/sec (0.9 m/sec) to be a suitable precaution.
 - (c) Where filters are employed, provide relaxation time in the piping downstream from the filters. A ~~relation~~ relaxation time of 30 seconds is considered by some to be a suitable precaution.
- (3) Eliminate the flammable mixture before switch loadings by gas freeing or inerting.

[~~30:~~ A.28.11.3]

Supplemental Information

File Name

FR_5.docx

Description

Shows correct numbering and track changes - FOR STAFF USE

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Submitter Full Name: Janna Shapiro

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Submittal Date: Thu Oct 20 12:37:33 EDT 2016

Committee Statement

Committee Statement: This is a correction to the misspelling of the word "relaxation". The extract reference has been removed because this correction has not been made to the source document.

Response Message:

[Public Input No. 43-NFPA 77-2015 \[Section No. 9.2.1.4\(C\)\]](#)



First Revision No. 11-NFPA 77-2016 [Section No. 15.4.3 [Excluding any Sub-Sections]]

Powders are can be divided into three the following groups:

- (1) Low-resistivity powders have volume resistivities of up to 10^6 less than 10^5 ohm-m, including metals, coal dust, and carbon black.
- (2) Medium-resistivity powders have volume resistivities between 10^6 equal to or greater than 10^5 ohm-m and 10^{10} but less than 10^9 ohm-m, including many organic powders and agricultural products.
- (3) High-resistivity powders have volume resistivities above 10^{10} equal to or greater than 10^9 ohm-m, including organic powders, synthetic polymers, and quartz.

Supplemental Information

<u>File Name</u>	<u>Description</u>
FR-11_A.15.4.3.docx	New Annex text

Submitter Information Verification

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Committee Statement

Committee Statement: This revision correlates with accepted international standards.

Response Message:

A.15.4.3

The values shown in 15.4.3 are taken from Table 1 of BS PD CLC/TR 60079-32-1, *Explosive Atmospheres Part 32-1: Electrostatic Hazards, Guidance*.



First Revision No. 13-NFPA 77-2016 [Section No. 15.5.4.1]

15.5.4.1

Where powders that have resistivities greater than about 10^9 ohm-m are put into grounded conductive containers, they usually dissipate their charges by conduction at a rate slower than that of the charge accumulated in the loading process. The charge is therefore compacted, and discharges occur from the bulking point (where the particles first contact the heap) to the walls of the container. These discharges are referred to as *bulking brush discharges*.

Experience indicates that these discharges are not capable of igniting dusts having MIEs greater than ~~20 mJ~~ 25 mJ. However, such discharges have been attributed to explosions of dusts having MIEs less than ~~20 mJ~~ 25 mJ.

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Committee Statement

Committee Statement: This revision is made to be consistent with 15.6.

Response Message:



First Revision No. 12-NFPA 77-2016 [Section No. A.3.3.18]

A.3.3.18 Dissipative.

Typically, a dissipative material is one having a surface resistivity between 10^5 and 10^9 equal to or greater than 10^5 but less than 10^9 ohms per square or a volume resistivity between 10^5 and 10^9 equal to or greater than 10^5 but less than 10^9 ohm-meters. Some applications might require different resistivities, while the intent is to dissipate charge.

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Committee Statement

Committee Statement: This revision is made to be consistent with FR 11.

Response Message:



First Revision No. 6-NFPA 77-2016 [Section No. F.3.1]

F.3.1

Liquids that have relaxation time constants ranging from 0.36 sec down to 0.002 sec (equivalent to a conductivity range between 50 pS/m and 10^4 pS/m for typical hydrocarbons having dielectric constants of about 2) are considered ~~conductive~~ semiconductive. Examples include crude oil and butyl acetate.

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Committee Statement

Committee Statement: This is a correction to the term "conductive". The section is about semiconductive liquids.

Response Message:

[Public Input No. 42-NFPA 77-2015 \[Section No. F.3.1\]](#)



First Revision No. 7-NFPA 77-2016 [Section No. F.4.1]

F.4.1

Liquids that have relaxation time constants of less than 0.002 sec (equivalent to a conductivity greater than 10^4 pS/m for typical hydrocarbons having dielectric constants of about 2) are considered ~~highly~~ conductive. These liquids tend not to accumulate charge, except where handling conditions isolate them from ground. Such conditions include complete isolation in the form of a droplet suspended in air, partial isolation by suspension in another liquid, and containment in a plastic or other highly resistive container.

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Committee Statement

Committee Statement: This revision is made for consistency with Table B.2.

Response Message:



First Revision No. 14-NFPA 77-2016 [Chapter I]

Annex I Bibliography

I.1 Referenced Publications.

The documents or portions thereof listed in this annex are referenced within the informational sections of this recommended practice and are not part of the recommendations of this document unless also listed in Chapter 2 for other reasons.

Cross, J. A., *Electrostatics: Principles, Problems and Applications*, Adam Hilger, Bristol, England, UK, 1987 [ISBN 0-85274-589-3]

Guest, P. G., *Static Electricity in Nature and Industry*, U.S. Department of Commerce — Bureau of Mines, U.S. Government Printing Office, Washington, DC, USA, 1939

Moore, A. D., Ed., *Electrostatics and Its Application*, 2nd Ed., John Wiley & Sons — Wiley Interscience, New York, NY, USA, 1973 [ISBN 0-471-61450-5]

Moore, A. D., *Electrostatics — Exploring, Controlling, and Using Static Electricity*, 2nd Ed., Laplacian Press, Morgan Hill, CA, USA, 1997 [ISBN 1-885540-04-3]

Pratt, T. H., *Electrostatic Ignitions of Fires and Explosions*, Center for Chemical Process Safety, 1997, John Wiley & Sons, New York, NY

Pratt, T. H., *Possible Electrostatic Hazards in Material Handling Systems*, 1992 Process Plant Safety Symposium, South Texas Section, American Institute of Chemical Engineers, 1992, pp. 1114-1123

Uman, M. A., *Lightning*, Dover Publications, New York, NY, USA, 1989

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Submission Date: Wed Nov 16 11:05:16 EST 2016

Committee Statement

Committee Statement: These references have been moved to the appropriate section in Annex J per the Manual of Style.

Response Message:



First Revision No. 3-NFPA 77-2016 [Chapter J]

Annex I Informational References

I.1 Referenced Publications.

The following documents or portions thereof are referenced within this recommended practice for informational purposes only and are thus not part of the recommendations of this document unless also listed in Chapter 2.

I.1.1 NFPA Publications.

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

~~NFPA 30, *Flammable and Combustible Liquids Code*, 2012 edition.~~

NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, 2012 2018 edition.

NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*, 2011 2018 edition.

NFPA 53, *Recommended Practice on Materials, Equipment, and Systems Used in Oxygen-Enriched Atmospheres*, 2011 2016 edition.

NFPA 69, *Standard on Explosion Prevention Systems*, 2008 2014 edition.

NFPA 70[®], National Electrical Code[®], 2014 2017 edition.

NFPA 99, *Health Care Facilities Code*, 2012 2018 edition.

NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft*, 2010 2015 edition.

NFPA 318, *Standard for the Protection of Semiconductor Fabrication Facilities*, 2012 2018 edition.

NFPA 326, *Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair*, 2010 2015 edition.

NFPA 407, *Standard for Aircraft Fuel Servicing*, 2012 2017 edition.

NFPA 780, *Standard for the Installation of Lightning Protection Systems*, 2014 2017 edition.

I.1.2 Other Publications.

I.1.2.1 NPCA ACA Publications.

~~National Paint and American~~ Coatings Association, 1500 Rhode Island Avenue, NW, Washington, DC 20005-5597.

Generation and Control of Static Electricity in Coatings Operations, 2010.

1.1.2.2 AIChE Publications.

American Institute of Chemical Engineers, 3 Park Avenue, New York, NY 10016-5901.

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

Britton, L. G., "Using Material Data in Static Hazard Assessment," *Plant/Operations Progress*, Vol. 11, April 1992, pp. 56–70. Heats of Oxidation to Evaluate Flammability Hazards," *Process Safety Progress*, Vol. 21, No. 1, March 2002.

Britton, L. G., "Using Material Data in Static Hazard Assessment," *Plant/Operations Progress*, Vol. 11, April 1992, pp. 56–70.

Britton, L. G. and Walmsley, H. L., "Static Electricity — New Guidance for Storage Tank Loading Rates," *Process Safety Progress*, Vol. 31, No. 3, September 2012, pp 219-229.

1.1.2.3 API Publications.

American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005.

Bustin, W. M., et al., *New Theory for Static Relaxation from High Resistivity Fuel*, API Refining Division Proceedings, Vol. 44, No. 3, 1964.

API RP 2003, *Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents*, 7th edition, September, 2008.

API 2219, *Safe Operation of Vacuum Trucks in the Petroleum Service*, 3rd edition, 2005. 4th edition, 2016.

Bustin, W. M., et al., *New Theory for Static Relaxation from High Resistivity Fuel*, API Refining Division Proceedings, Vol. 44, No. 3, 1964.

1.1.2.4 ASTM Publications.

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

ASTM D 257 D257, *Standard Test Methods for DC Resistance or Conductance of Insulating Materials*, 2007 2014.

ASTM D 991 D991, *Standard Test Method for Rubber Property - Volume Resistivity of Electrically Conductive and Antistatic Products*, 2010 1989, reapproved 2014.

ASTM E 502 E502, *Standard Test Method for Selection and Use of ASTM Standards for the Determination of Flash Point of Chemicals by Closed Cup Methods*, 2007 reapproved 2013.

ASTM F 2413 F2413, *Standard Specification for Performance Requirements for Foot Protection*, 2005 2011.

1.1.2.5 CENELEC BSI Publications.

BSI Group, 12950 Worldgate Drive, Suite 800, Herdon, VA 20170

European Committee for Electrotechnical Standardization (CENELEC), Rue de Stassart, 35, B-1050 Brussels, Belgium.

CENELEC Technical Report CLC/TR 50404, *Electrostatics - Code of Practice for the Avoidance of Hazards Due to Static Electricity*, June 2003.

CLC/TC 44X, *Safety of Machinery: Electrotechnical Aspects*.

BS PD CLC/TR 60079-32-1, *Explosive Atmospheres Part 32-1: Electrostatic Hazards, Guidance*, 2013, Corrigendum, 2015.

I.1.2.6 Other Publications.

Britton, L. G., and Smith, J. A., "Static Hazards of the VAST," *Journal of Loss Prevention in the Process Industries*, Vol. 25, 2012, pp. 309-328, Elsevier.

Process Safety Progress, Vol. 21, No. 1, March 2003.

I.2 Informational References.-(Reserved)

The following documents or portions thereof are listed here as informational resources only. They are not a part of the recommendations of this document.

Cross, J. A., *Electrostatics: Principles, Problems and Applications* , Adam Hilger, Bristol, England, UK, 1987 [ISBN 0-85274-589-3].

Guest, P. G., *Static Electricity in Nature and Industry* , U.S. Department of Commerce — Bureau of Mines, U.S. Government Printing Office, Washington, DC, USA, 1939.

Moore, A. D., Ed., *Electrostatics and Its Application* , 2nd Ed., John Wiley & Sons — Wiley Interscience, New York, NY, USA, 1973 [ISBN 0-471-61450-5].

Moore, A. D., *Electrostatics — Exploring, Controlling, and Using Static Electricity* , 2nd Ed., Laplacian Press, Morgan Hill, CA, USA, 1997 [ISBN 1-885540-04-3].

Pratt, T. H., *Electrostatic Ignitions of Fires and Explosions* , Center for Chemical Process Safety, 1997, John Wiley & Sons, New York, NY.

Pratt, T. H., *Possible Electrostatic Hazards in Material Handling Systems* , 1992 Process Plant Safety Symposium, South Texas Section, American Institute of Chemical Engineers, 1992, pp. 1114-1123.

Uman, M. A., *Lightning* , Dover Publications, New York, NY, USA, 1989.

I.3 References for Extracts in Informational Sections. (Reserved)

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Submittal Date: Wed Oct 19 13:34:41 EDT 2016

Committee Statement

Committee Statement: Update references to current titles and editions.

Response Message:

Public Input No. 6-NFPA 77-2015 [Chapter J]