MEMORANDUM

TO: NFPA Technical Committee on Static Electricity
FROM: R. P. Benedetti
DATE: March 15, 2012
SUBJECT: NFPA 77 ROP TC Letter Ballot (A2013)

The ROP letter ballot for NFPA 77 is attached. The ballot is for formally voting on whether or not you concur with the committee’s actions on the proposals. Reasons must accompany all negative and abstention ballots.

Please do not vote negatively because of editorial errors. However, please bring such errors to my attention for action.

Please complete and return your ballot as soon as possible but no later than Friday, April 6, 2012. As noted on the ballot form, please return the ballot to Diane Matthews either via e-mail to dmatthews@nfpa.org or via fax to 617-984-7110. You may also mail your ballot to the attention of Diane Matthews at NFPA, 1 Batterymarch Park, Quincy, MA 02169.

The return of ballots is required by the Regulations Governing Committee Projects.

Attachments: Proposals
Submitter: Technical Committee on Static Electricity,
Recommendation: Review entire document to: 1) Update any extracted material by preparing separate proposals to do so, and 2) review and update references to other organizations documents, by preparing proposal(s) as required.
Substantiation: To conform to the NFPA Regulations Governing Committee Projects.
Committee Meeting Action: Accept
Technical Committee on Static Electricity,

Recommendation: Reorganize NFPA 77 in accordance with the following outline:

Chapter 1 Administration
  1.1 Scope
  1.2 Purpose
  1.3 Application (Reserved)
  1.4 Equivalency

Chapter 2 Referenced Publications
  2.1 General
  2.2 NFPA Publications
  2.3 Other Publications

Chapter 3 Definitions
  3.1 General
  3.2 NFPA Official Definitions
  3.3 General Definitions

Chapter 4 Units and Symbols of Measure
  4.1 Units (Reserved)
  4.2 Symbols

Chapter 5 Fundamentals of Static Electricity
  5.1 General (5.1.1 thru 5.1.8)
  5.2 Separation of Charge by Contact of Materials (5.1.9 thru 5.1.14)
  5.3 Accumulation and Dissipation of Charge (5.2)
  5.4 Discharge of Static Electricity and Ignition Mechanisms (5.3)
    {NOTE: Subsection 5.3.8 moves to new Section 15.6.}

Chapter 6 Evaluating Static Electricity Hazards
  6.1 General
  6.2 Measuring a Static Electric Charge
  6.3 Measuring the Charge on a Conductor
  6.4 Measuring the Charge on a Nonconductor
  6.5 General Practices
  6.6 Measuring the Accumulation and Relaxation of Charge
  6.7 Measuring the Resistivity of Materials
  6.8 Assessment of Bonding & Grounding Conduction Paths
  6.9 Measuring Spark Energies
    6.10 Measuring Ignition Energies

Chapter 7 Control of Static Electricity and Its Hazards by Process Modification and Grounding
  7.1 General
  7.2 Control of Ignitible Mixtures in Equipment
  7.3 Control of Static Electric Charge Generation
  7.4 Charge Dissipation

Chapter 8 Control of Static Electricity & Its Hazards by Static Eliminators & Personnel Factors
  8.1 Charge Neutralization by Ionization of Air (7.5)
  8.2 Control of Static Electric Charge on Personnel (7.6)
  8.3 Maintenance and Testing (7.7)
  8.4 Discomfort and Injury (7.8)

Chapter 9 Flammable and Combustible Liquids and Their Vapors (Chapter 8)
  9.1 General (8.1)
  9.2 Combustion Characteristics of Liquids, Vapors, and Mists (8.2)
  9.3 Generation and Dissipation of Static Electric Charge in Liquids (8.3)

Chapter 10 Fluid Flow in Piping, Hose, Tubing, and Filters (8.4)
  10.1 Metal Piping Systems (8.4.1)
  10.2 Nonconductive Pipe and Lined Pipe (8.4.2)
10.3 Flexible Hose and Tubing (8.4.3)
10.4 Fill Pipes (8.4.4)
10.5 Filtration (8.4.5)
10.6 Suspended Material (8.4.6)
10.7 Miscellaneous Line Restrictions (8.4.7)

Chapter 11 Electrostatic Hazards of Liquids in Containers and Intermediate Bulk Containers
11.1 Portable Tanks, Intermediate Bulk Containers & Non-bulk Containers (8.13)
  11.1.1 Metal Portable Tanks and Metal IBCs (8.13.1)
  11.1.2 Nonconductive Portable Tanks and Nonconductive IBCs (8.13.2)
  11.1.3 Metal Non-Bulk Containers (8.13.3)
  11.1.4 Plastic-Lined Metal Non-bulk Containers (8.13.4)
  11.1.5 Plastic Non-Bulk Containers (8.13.5)
  11.1.6 Hand-held Containers Up To 20L Capacity (8.13.6)
  11.1.7 Nonconductive Containers (8.13.7)
  11.1.8 Containers for Sampling (8.13.8)
  11.2 Cleaning of Containers (8.13.9)
  11.3 Plastic Sheets and Wraps (8.16)

Chapter 12 Electrostatic Hazards of Liquids in Bulk Storage Tanks & Tank Vehicles
12.1 Storage Tanks (8.5)
12.2 Loading of Tank Vehicles (8.6)
12.3 Vacuum Trucks (8.7)
12.4 Railroad Tank Cars (8.8)
12.5 Marine Vessel and Barge Cargo Tanks (8.9)

Chapter 13 Electrostatic Hazards in Process Vessels
13.1 General Process Vessels (8.10)
13.2 Means of Static Electric Charge Accumulation (8.10.1)
13.3 Procedures for Transfer to Tanks (8.10.2)
13.4 Agitation (8.10.3)
13.5 Vessels with Nonconductive Linings (8.10.4)
13.6 Adding Solids (8.10.5)
13.7 Mixing Solids (8.10.6)
13.8 Nonconductive Process Vessels (8.10.7)

Chapter 14 Electrostatic Hazards of Operations in Tanks and Process Vessels
14.1 Gauging and Sampling (8.11)
14.2 Tank Cleaning (8.12)
14.3 Vacuum Cleaning (8.14)
14.4 Clean Gas Flows (8.15)
14.5 Ancillary Operations

Chapter 15 Powders and Dusts (Chapter 9)
15.1 General (9.1)
15.2 Combustibility of Dust Clouds (9.2)
15.3 Mechanisms of Static Electric Charging (9.3)
15.4 Retention of Static Electric Charge (9.4)
15.5 Discharges in Powder Operations (9.5)
15.6 Static Electric Discharges During Filling Operations (5.3.8)
15.7 Pneumatic Transport Systems (9.6)
15.8 Flexible Hose (9.7)
15.9 Flexible Boots and Socks (9.8)
15.10 Bag Houses Fabric Filters (9.9)
15.11 Hybrid Mixtures (9.10)
15.12 Manual Addition of Powders to Flammable Liquids (9.11)
15.13 Bulk Storage (9.2)

Chapter 16 Intermediate Bulk Containers (IBCs) for Powders (10.1)
16.1 General (10.1.1)
16.2 Types of Discharge (10.1.2)
16.3 Granular Material (10.1.3)
16.4 Conductive Intermediate Bulk Containers (10.1.4)
16.5 Nonconductive Intermediate Bulk Containers (10.1.5)
16.6 Flexible Intermediate Bulk Containers (FIBCs) (10.1.6)

{NOTE: New Subsection 16.6.3 replaces 10.1.6.3, 10.1.6.4, 10.1.6.5, and 10.1.7.}

Chapter 17 Web and Sheet Processes
17.1 General (10.2.1)
17.2 Substrates (10.2.2)
17.3 Inks and Coatings (10.2.3)
17.4 Processes (10.2.4)
17.5 Control of Static Electricity in Web Processes (10.2.5)

Chapter 18 Specific Miscellaneous Applications
18.1 Spray Application Processes (10.3)
18.2 Belts and Conveyors (10.4)
18.3 Explosives (10.5)
18.4 Cathode Ray Tube Video Display Terminals (10.6)

Annex A Explanatory Material
Annex B Physical Characteristics of Materials
  B.1 Combustibility Parameters of Gases and Vapors
  B.2 Static Electric Characteristics of Liquids
Annex C Additional Information on Flash Point
Annex D Additional Information on Vapor Pressure
Annex E Additional Information on Charge Relaxation
Annex F Additional Information on Conductivity
Annex G Recommended Means for Providing Bonding and Grounding
Annex H Glossary of Terms
Annex I Bibliography
Annex J Informational References (Annex I)

**Substantiation:** The Technical Committee has determined that the present organization is unwieldy and that breaking up some of the chapters will benefit the user.

**Committee Meeting Action:** Accept

<table>
<thead>
<tr>
<th>77-3</th>
<th>Log #CP7</th>
<th>Final Action: Accept</th>
</tr>
</thead>
</table>

**Submitter:** Technical Committee on Static Electricity,

**Recommendation:**
1. Revise 1.1.3 to read:

"1.1.3 This recommended practice does not apply to the prevention and control of static electricity in hospital operating rooms or in areas where flammable anesthetics are administered or handled. (Reserved)"

2. Delete A.1.1.3 entirely

3. Delete from Section 2.2 and Subsection I.1.1 the citations for NFPA 99.

**Substantiation:** NFPA 99, Standard for Health Care Facilities, no longer addresses the use of flammable anesthetics and Annex E, which addressed the issue of static electricity hazards in surgical suites, has been removed from the document.

**Committee Meeting Action:** Accept
Technical Committee on Static Electricity,

**Recommendation:** Add a new Section 1.5 to read:

"1.5 Symbols, Units, and Formulas. The units of measure and symbols used in this recommended practice are as described in Chapter 4."

**Substantiation:** This complies with the Manual of Style for NFPA Technical Committee Documents.

**Committee Meeting Action:** Accept
Submitter: Technical Committee on Static Electricity,
Recommendation: Revise Chapter 2 to read as follows:

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

2.3 Other Publications.
2.3.1 AIChE Publications. American Institute of Chemical Engineers, 3 Park Avenue, New York, NY 10016-5901.

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

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

2.3.4 CENELEC Publications. CENELEC, Rue de Stassartstraat, 35, B - 1050 Brussels, Belgium.

2.3.5 IME Publications. Institute of Makers of Explosives, 1120 Nineteenth Street, NW, Suite 310, Washington, DC 20036-3605.

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

Standard 6055.9, Ammunition and Explosive Safety Standards.

2.3.8 Additional Publications.

2.4 References for Extracts in Recommendations Sections.
Report on Proposals – June 2013

Substantiation: This proposal updates all referenced publications in Chapter 2 to their most current edition, in accordance with the Manual of Style for NFPA Technical Committee Documents.

Committee Meeting Action: Accept

77-6 Log #CP39
(3.3 General Definitions)
Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: Add the following to the heading for Section 3.3, General Definitions:
"The following terms and their definitions apply only within the scope of this Recommended Practice."
Substantiation: This statement is necessary to caution the reader that the terms and their definitions are being used within the context of static electric behavior.
Committee Meeting Action: Accept

77-7 Log #CP40
(3.3.1 Antistatic)
Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: Revise the definition of "antistatic" to read:
"Capable of dissipating a static electric charge at an acceptable rate for the intended purpose.
Substantiation: The intent of the limiting phrase is to ensure that the "antistatic" is not used to define broad behavior, but only to properties that can be measured.
Committee Meeting Action: Accept

77-8 Log #CP9
(3.3.1.1 Antistatic Additive (New), H.2.3)
Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: Delete the definition of "antistatic additive" in H.2.3.
Add a new definition of the same term to new 3.3.1.1 to read as follows:
"3.3.1.1 Antistatic Additive. An additive used to increase the surface or volume conductivity of a liquid or solid material.
A.3.3.1.1 Antistatic Additive. Extrinsic and intrinsic antistatic additives can be distinguished according to the method of addition. Based on the permanence of their effect, antistatic treatments can be short-term or long-term."
Substantiation: The term "antistatic additive" is used in several places in the body of the text of NFPA 77 and should, therefore, be listed in Chapter 3. Annex H is a glossary of terms that are directly related to the study of static electricity, but are not used in the body of the text of NFPA 77. Also, the definition has been amended to make it more specific for the intended purpose.
Committee Meeting Action: Accept
77-9 Log #13 Final Action: Reject
(3.3.2 Bonding)

Submitter: Glossary of Terms Technical Advisory Committee,
Recommendation: Delete the definition of “bonding” and adopt the preferred definition of “Bonded (Bonding)” from NFPA 70. Move the current definition of “bonding” to become an annex note.
Bonding: For the purpose of controlling static electric hazards, the process of connecting two or more conductive objects together by means of a conductor so that they are at the same electrical potential, but not necessarily at the same potential as the earth:
Bonded (Bonding)*. Connected to establish electrical continuity and conductivity.
A* For the purpose of controlling static electric hazards, the process of connecting two or more conductive objects together by means of a conductor so that they are the same electrical potential, but not necessarily at the same potential as the earth.
Substantiation: This definition, from NFPA 70, is the preferred definition from the Glossary of Terms. The meaning of the term is very similar. Definitions should be in a single sentence. Changing to this definition complies with the Glossary of Terms Project.
Your technical committee has the following options:
a) Adopt the preferred definition
b) Modify the term to make it unique
c) Request that the Standards Council reassign responsibility for the term
d) Request that the standards council authorize a second preferred definition
Committee Meeting Action: Reject
Committee Statement: The current definition serves the purposes of the Recommended Practice. The definition from NFPA 70, National Electrical Code, is specific to their usage.

77-10 Log #CP36 Final Action: Accept
(3.3.3 Breakdown Strength)

Submitter: Technical Committee on Static Electricity,
Recommendation: Revise 3.3.3 to read:
“3.3.3 Breakdown Strength. The minimum electric field voltage, measured in volts per meter of thickness, necessary to cause a spark through a solid material that is held between electrodes that produce a uniform electric field under specified test conditions.”
Substantiation: First, use of the word “voltage” is not technically correct in this definition. What is measured (volts per meter) is the field strength. Second, the “volts per meter” being measured is not a measure of thickness, but of separation. Third, the material being subjected to the electric field can be solid, liquid, or gaseous.
Committee Meeting Action: Accept

77-11 Log #CP37 Final Action: Accept
(3.3.4 Breakdown Voltage)

Submitter: Technical Committee on Static Electricity,
Recommendation: Revise 3.3.4 to read:
“3.3.4 Breakdown Voltage. The minimum voltage, measured in volts, necessary to cause a spark through a material gas mixture between electrodes that produce a uniform electric field under a given set of specified test conditions.”
Substantiation: First “measured in volts” is superfluous. Second, the material being subjected to the voltage is not limited to the gaseous state. Third, the breakdown voltage might or might not be measured in accordance with a standardized test.
Committee Meeting Action: Accept
Submitter: Technical Committee on Static Electricity,

Recommendation: Add the following new definitions to new 3.3.6 to read:

"3.3.6 Charge. A collection or imbalance of electrons or of positive or negative ions that can accumulate on both conductors and insulators and that has both magnitude and polarity. Movement of charge constitutes an electric current. Excess or deficiency of electrons is expressed in coulombs. An electron carries a charge of \(-1.6 \times 10^{-19}\) coulomb.

3.3.6.1 Charge Decay Time. The time for static electric charge to be reduced to a specified percentage of the charge's original magnitude.

3.3.6.2 Charge Density. The charge per unit area on a surface or the charge per unit volume in space. Surface charge density is measured in coulombs per square meter. Volume charge density, also called space charge density or charge relaxation. The process by which separated charges recombine or by which excess charge is lost from a system."

In Annex H, delete the entries for "charge" (H.2.7), "charge decay time" (H.2.8), "charge density" (H.2.9), and "charge relaxation" (H.2.10).

Substantiation: These terms are used in several places in the body of the text of NFPA 77 and should, therefore, be listed in Chapter 3. Annex H is a glossary of terms that are directly related to the study of static electricity, but are not used in the body of the text of NFPA 77.

Committee Meeting Action: Accept

Submitter: Glossary of Terms Technical Advisory Committee,

Recommendation: Revise text to read as follows:

3.3.6 Combustible. Capable of undergoing combustion. Capable of reacting with oxygen and burning if ignited.

Also, add a definition for the term combustion, as follows:

Combustion. A chemical process of oxidation that occurs at a rate fast enough to produce heat and usually light in the form of either a glow or flame.

Substantiation: It is important to have consistent definitions of terms within NFPA. The term combustible at present has 6 definitions, as follows:

A substance that will burn. (430)

A material or structure that will release heat energy on burning. (901)

Capable of burning, generally in air under normal conditions of ambient temperature and pressure, unless otherwise specified; combustion can occur in cases where an oxidizer other than the oxygen in air is present (e.g., chlorine, fluorine, or chemicals containing oxygen in their structure). (921)

Any material that, in the form in which it is used and under the conditions anticipated, will ignite and burn or will add appreciable heat to an ambient fire. (1144)

Capable of undergoing combustion. (69, 82, 99, 120, 122, 214, 502, 804, 805, 820, 851, 853, 1126)

Capable of reacting with oxygen and burning if ignited. (77, 220, 1141)

It is therefore recommended, in order to improve consistency within NFPA documents that a simple definition which is widely used be employed in all documents. The document responsible for this definition is NFPA 220 and the same recommendation will be made to that document. This definition is also used by ASTM E 176 for committee ASTM E05 on Fire Standards.

There are 5 definitions of combustion in NFPA and the one chosen is the most widely used, including NFPA 1. This definition is also used by ASTM E 176 for committee ASTM E05 on Fire Standards.

This is not original material; its reference/source is as follows:
The text is used in other NFPA standards.

Committee Meeting Action: Accept

Committee Statement: The Technical Committee notes that Subsection 3.3.6 is designated 3.3.11 in the NFPA 77 ROP Preprint.
Technical Committee on Static Electricity,

Move the definitions of "induction charging" and "triboelectric charging" from H.2.11 to new 3.3.7 and revise to read:

"3.3.7 Charging.

3.3.7.1 Induction Charging. The act of charging an object by bringing it near another charged object, then touching the first object to ground; also known as induction. Charge polarization is induced on a grounded object in the vicinity of a charged surface due to the electric field existing between the object and the surface. If the ground connection is removed from the object during this period, the induced charge remains on the object. Induction charging occurs where a person walks from a conductive floor covering onto an insulating floor in the presence of an electric field.

3.37I.2* Triboelectric Charging. Static electric charging that results from contact or friction between two dissimilar materials; also known as frictional charging and contact-separation charging.

A.3.37I.2 Triboelectric charging is the most familiar, yet least understood, charge generation mechanism. Triboelectric charging results from contact or friction between two unlike materials. The amount of charge generated in this way is dependent primarily on the nature of contact, the intrinsic electrical and static electric properties of the materials involved, and the prevailing conditions of humidity and temperature. An indication of the tendency of materials to accept static electric charge in this way is given by the triboelectric series. Recent studies indicate that the amount of charge transferred depends not only on the composition of the materials but also on the capacitance of the junction. The following situations are examples of triboelectric charging:

(1) Pneumatic transport of powders along pipes
(2) High-speed webs of synthetic materials moving over rollers
(3) Charging of the human body as a person walks across a carpet
(4) Extrusion of plastics or the ejection of plastic parts from a mold

Table A.3.3.7.2 illustrates typical electrostatic voltages observed as a result of triboelectric charging at two levels of relative humidity (RH).

In Annex H, renumber H.2.11.1, Field Charging, to H.2.4.

Substantiation: These terms are used in several places in the body of the text of NFPA 77 and should, therefore, be listed in Chapter 3. Annex H is a glossary of terms that are directly related to the study of static electricity, but are not used in the body of the text of NFPA 77.

Committee Meeting Action: Accept
<table>
<thead>
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<th>Situation</th>
<th>Electrostatic Voltages (kV)</th>
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<tr>
<td></td>
<td>RH 10%–20%</td>
<td>RH 65%–90%</td>
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<tr>
<td>Walking across a carpet</td>
<td>35</td>
<td>1.5</td>
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<tr>
<td>Walking across a vinyl floor</td>
<td>12</td>
<td>0.25</td>
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<tr>
<td>Working at a bench</td>
<td>6</td>
<td>0.1</td>
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<tr>
<td>Vinyl envelopes for work instructions</td>
<td>7</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>Poly bag picked up from bench</td>
<td>20</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>Work chair padded with polyurethane foam</td>
<td>18</td>
<td>1.5</td>
<td></td>
</tr>
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</table>
Technical Committee on Static Electricity,

**Recommendation:** Relocate existing definition of "Conductive" to 3.3.11 and add two new subordinate definitions to read:

"3.3.11.1 Conductive Flooring. Flooring that has an average resistance between $2.5 \times 10^3$ ohms and $1 \times 10^6$ ohms, measured using specified electrodes placed a specified distance apart.

3.3.11.2 Conductive Hose. Hose that has an electrical resistance of less than $10^3$ ohms per meter, measured between the end connectors."

**Substantiation:** These terms are used in several places in the body of the text of NFPA 77 and their definitions should, therefore, be listed in Chapter 3.

**Committee Meeting Action:** Accept

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**Submitter:** Technical Committee on Static Electricity,

**Recommendation:** Add a new definition of "conductivity" to new 3.3.12 to read:

"3.3.12* Conductivity (kappa).* The reciprocal of resistivity, i.e., 1/resistivity. An intrinsic property of a solid or liquid that governs the way electrical charges move across its surface or through its bulk.

A.3.3.12 This property can be dramatically affected by the temperature and especially by the presence of moisture or antistatic additives. Conductors such as metals and aqueous solutions have a high conductivity (low resistivity) and lose charge quickly where grounded. Insulators have a high resistivity and lose charge very slowly, even where grounded. Conductors isolated from ground can store charge and can rise to fairly high potentials in many industrial situations, resulting in hazardous spark discharges.

The unit of conductivity is ohms per meter, which is the same as siemens per meter (S/m). (Note basis as reciprocal of resistivity, with units of ohm-meters.) Some authors express volume resistivity data in terms of ohm-meters (100 Ω-cm = 1 Ω-m).

Conductivity is not generally assigned to a gas. In gases, free electrons or ions can be formed or injected by external means. In the presence of an electric field, the ions migrate to electrodes or charged surfaces and constitute a current. Conductivity is rarely an intrinsic property of gas.

Another way to characterize conductivity is as the ratio of the electric current density to the electric field in a material."

**Substantiation:** This term is used in several places in the body of the text of NFPA 77 and it needs to be defined in Chapter 3.

**Committee Meeting Action:** Accept
<table>
<thead>
<tr>
<th>Log #10</th>
<th>Final Action: Accept in Principle</th>
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<tbody>
<tr>
<td><strong>3.3.13 Nonconductive</strong></td>
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<tr>
<td><strong>Submitter:</strong> Steven J. Gunsel, SGTechnologies, LLC</td>
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</tbody>
</table>
| **Recommendation:** Revise text to read as follows:

- **3.3.13 Nonconductive:** Possessing the ability to resist the flow of an electric charge. Material with a conductivity less than $10^{2}$ pS/m or a resistivity greater than $10^{10}$ ohm-m ($10^{12}$ ohm-cm).

- **Substantiation:** The current definition is meaningless. All materials possess the ability to resist the flow of electric charge. Conductive and semiconductive are defined (Sections 3.3.8 and 3.3.15) in terms of conductivity and resistivity. Note that $10^{2}$ pS/m and $10^{10}$ ohm-m, and $10^{12}$ ohm-cm are equivalent.

- **Committee Meeting Action:** Accept in Principle

- **Committee Statement:** The current definition of nonconductive is more related to a flowing electric current. The definition proposed by the Technical Committee is more specific to static electric phenomena.

<table>
<thead>
<tr>
<th>Log #CP13</th>
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<tbody>
<tr>
<td><strong>3.3.14 Current (New), H.2.19</strong></td>
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<td><strong>Submitter:</strong> Technical Committee on Static Electricity,</td>
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</table>
| **Recommendation:** Add the following new definitions to new 3.14 as follows:

- **3.3.14 Current (I).** A measure of the rate of transport of electric charge past a specified point or across a specified surface. The symbol I is generally used for constant currents, and the symbol i is used for time-variable currents. The unit of current is the ampere. One ampere equals 1 Coulomb/sec ($6.24 \times 10^{18}$ electrons/sec).

- **3.3.14.1 Charging Current (Ic).** The rate of flow of charge into a given system per unit of time, expressed in amperes."

- **Substantiation:** These terms are used in several places in the body of the text of NFPA 77 and should, therefore, be listed in Chapter 3. Annex H is a glossary of terms that are directly related to the study of static electricity, but are not used in the body of the text of NFPA 77.

- **Committee Meeting Action:** Accept

<table>
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<th>Log #9</th>
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<tbody>
<tr>
<td><strong>3.3.14 Nonconductor</strong></td>
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<tr>
<td><strong>Submitter:</strong> Steven J. Gunsel, SGTechnologies, LLC</td>
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</tr>
</tbody>
</table>
| **Recommendation:** Delete text as follows:

- **3.3.14 Nonconductor:** A material or object that resists the flow of an electric charge.

- **Substantiation:** Definition is meaningless. All materials possess the ability to resist the flow of electric charge.

- **Committee Meeting Action:** Accept

<table>
<thead>
<tr>
<th>Log #CP53</th>
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<tbody>
<tr>
<td><strong>3.3.14.2 Streaming Current (New))</strong></td>
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<tr>
<td><strong>Submitter:</strong> Technical Committee on Static Electricity,</td>
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</tbody>
</table>
| **Recommendation:** Add the following new definition to 3.3.14:

- **3.3.14.2 Streaming Current (Is).** The charging current produced by the flow of a liquid.

- **Substantiation:** This term is used throughout the document and should be defined.

- **Committee Meeting Action:** Accept
Technical Committee on Static Electricity,

Add the following new definition to new 3.3.15 as follows:

"3.3.15* Dielectric Constant. The ratio of the permittivity of a material to the permittivity of a vacuum that indicates a material's ability, relative to a vacuum, to store electrical energy or charge, where the material is placed in an electric field.

A.3.3.15 Typical dielectric constants and dielectric strengths are shown in Table A.3.3.E. A dielectric is not necessarily an insulator. For example, water, which has a high dielectric constant, is not a very good insulator. The measure of a good dielectric is its polarizability rather than its conductivity."

*****Insert Table A.3.3.E from file:*****

NFPA 77 A2013 ROP - Log CP14 -Table A.3.3.15.doc

Delete the entry for "dielectric constant" in H.2.21.

Substantiation: These terms are used in several places in the body of the text of NFPA 77 and should, therefore, be listed in Chapter 3. Annex H is a glossary of terms that are directly related to the study of static electricity, but are not used in the body of the text of NFPA 77.

Committee Meeting Action: Accept

Relocate H.2.22, "Dielectric Strength" to new 3.3.16 and change "rupture" to "electric breakdown".

Substantiation: These terms are used in several places in the body of the text of NFPA 77 and should, therefore, be listed in Chapter 3. Annex H is a glossary of terms that are directly related to the study of static electricity, but are not used in the body of the text of NFPA 77. Replacement of the word "rupture" is for accuracy.

Committee Meeting Action: Accept
Table A.3.3.15  Dielectric Properties of Selected Materials

<table>
<thead>
<tr>
<th>Material</th>
<th>Dielectric Constant</th>
<th>Dielectric Strength (V/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bakelite</td>
<td>4.9</td>
<td>$2.4 \times 10^7$</td>
</tr>
<tr>
<td>Cellulose acetate</td>
<td>3.8</td>
<td>$1.0 \times 10^7$</td>
</tr>
<tr>
<td>Mica</td>
<td>5.4</td>
<td>$1.0 \times 10^8$</td>
</tr>
<tr>
<td>Plexiglas, Lucite</td>
<td>3.4</td>
<td>$4.0 \times 10^7$</td>
</tr>
<tr>
<td>Polystyrene</td>
<td>2.5</td>
<td>$2.4 \times 10^7$</td>
</tr>
<tr>
<td>Porcelain</td>
<td>7</td>
<td>$6.0 \times 10^6$</td>
</tr>
<tr>
<td>Titanium dioxide</td>
<td>90</td>
<td>$6.0 \times 10^6$</td>
</tr>
<tr>
<td>Barium titanate</td>
<td>1200</td>
<td>$5.0 \times 10^6$</td>
</tr>
</tbody>
</table>
Technical Committee on Static Electricity,

**Recommendation:** Add the following new definitions to new 3.3.17 to read as follows:

**3.3.17 Discharge.**

3.3.17.1 Brush Discharge. A higher energy form of corona discharge characterized by low-frequency bursts or by streamers. Brush discharges can form between charged nonconductive surfaces and grounded conductors acting as electrodes. For positive electrodes, pre-onset or breakdown streamers are observed, and the maximum effective energy is a few millijoules. For negative electrodes, the maximum effective energy is a few tenths of a millijoule. Brush discharges can ignite flammable gas and hybrid mixtures but not dust in air. Also called cone discharge.

3.3.17.2 Bulking Brush Discharge. A partial surface discharge created during bulking of powder in containers, appearing as a luminous, branched channel flashing radially from the wall toward the center of the container. Its maximum effective energy is 10 mJ to 25 mJ. It can ignite flammable gas, hybrid mixtures, and some fine dusts in air.

3.3.17.3 Corona Discharge. An electrical discharge in the microampere range that results from a localized electrical breakdown of gases by charges on surfaces such as sharp edges, needle points, and wires. The charges can arise on conductors at high voltage or on grounded conductors that are situated near a charged surface. Corona is accompanied by a faint luminosity.

3.3.17.4 Propagating Brush Discharge. An energetic discharge caused by electrical breakdown of the dielectric layer in a capacitor. The capacitor is typically formed by charged plastic coating on a metal substrate, although plastic pipe and tote bins can also form the required charged double layer. The effective energy can exceed 1000 mJ, causing both shock to personnel and ignition hazards for a wide variety of materials, including dusts in air.

In Annex H, delete the following entries: H.2.4, H.2.6, H.2.16, H.2.17, and H.2.23 and all its subordinate entries. These terms are used in several places in the body of the text of NFPA 77 and should, therefore, be listed in Chapter 3. Annex H is a glossary of terms that are directly related to the study of static electricity, but are not used in the body of the text of NFPA 77.

Committee Meeting Action: Accept

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Technical Committee on Static Electricity,

**Recommendation:** Add the following new definition to new 3.3.18 to read:

**3.3.18 Dissipative.** A material or a construction that will reduce static charge to acceptable levels. Typically, this is a material having a surface resistivity between 10^5 ohms per square and 10^12 ohms per square or a volume resistivity between 10^5 to 10^9 ohm-meters.

A.3.3.18 Dissipative. Some applications might require different resistivities, while the intent is to dissipate charge.

Delete H.2.24.

Substantiation: This term is used in several places in the body of the text of NFPA 77 and should, therefore, be listed in Chapter 3. Annex H is a glossary of terms that are directly related to the study of static electricity, but are not used in the body of the text of NFPA 77.

Committee Meeting Action: Accept
3.3.19 Double Layer (New, H.2.25)

Submitter: Technical Committee on Static Electricity,
Recommendation: Move the definition of "double layer" from H.2.25 to new 3.3.19 to read:
"3.3.19 Double Layer. A phenomenon usually associated with a solid–liquid interface where ions of one charge type
are fixed to the surface of the solid, and an equal number of mobile ions of opposite charge are distributed through the
neighboring region of the liquid.
A.3.3.19 Double Layer. In such a system, the movement of liquid causes a displacement of the mobile ions with
respect to the fixed charges on the solid surface."
Substantiation: This term is used in several places in the body of the text of NFPA 77 and should, therefore, be listed
in Chapter 3. Annex H is a glossary of terms that are directly related to the study of static electricity, but are not used in
the body of the text of NFPA 77.
Committee Meeting Action: Accept

3.3.20 Electrometer (New, H.2.27)

Submitter: Technical Committee on Static Electricity,
Recommendation: Relocate the definition of "electrometer" from H.2.27 to new 3.3.20.
Substantiation: This term is used in several places in the body of the text of NFPA 77 and should, therefore, be listed
in Chapter 3. Annex H is a glossary of terms that are directly related to the study of static electricity, but are not used in
the body of the text of NFPA 77.
Committee Meeting Action: Accept

3.3.21 Flammable Limit (New, H.2.33)

Submitter: Technical Committee on Static Electricity,
Recommendation: Relocate the definitions of "lower" and "upper flammable limits" from H.2.33 to new 3.3.21.
Substantiation: These terms are used in several places in the body of the text of NFPA 77 and should, therefore, be listed in Chapter 3. Annex H is a glossary of terms that are directly related to the study of static electricity, but are not used in the body of the text of NFPA 77.
Committee Meeting Action: Accept

3.3.24 Ignition Energy (New, H.2.34)

Submitter: Technical Committee on Static Electricity,
Recommendation: Relocate the definition of "ignition energy" from H.2.34 to new 3.3.24.
Substantiation: These terms are used in several places in the body of the text of NFPA 77 and should, therefore, be listed in Chapter 3. Annex H is a glossary of terms that are directly related to the study of static electricity, but are not used in the body of the text of NFPA 77.
Committee Meeting Action: Accept
<table>
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<tr>
<th>Log #</th>
<th>Description</th>
<th>Final Action: Accept</th>
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<tr>
<td>77-29</td>
<td><strong>Log #CP21</strong> (3.3.25 Incendive (New), H.2.35)</td>
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<td><strong>Submitter:</strong> Technical Committee on Static Electricity, <strong>Recommendation:</strong> Relocate the definition of &quot;incendive&quot; from H.2.35 to new 3.3.25. <strong>Substantiation:</strong> This term is used in several places in the body of the text of NFPA 77 and should, therefore, be listed in Chapter 3. Annex H is a glossary of terms that are directly related to the study of static electricity, but are not used in the body of the text of NFPA 77. <strong>Committee Meeting Action:</strong> Accept</td>
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<tr>
<td>77-30</td>
<td><strong>Log #CP22</strong> (3.3.26 Induction (New), H.2.36)</td>
<td></td>
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<td><strong>Submitter:</strong> Technical Committee on Static Electricity, <strong>Recommendation:</strong> Relocate the definition of &quot;induction&quot; from H.2.36 to new 3.3.26. <strong>Substantiation:</strong> This term is used in several places in the body of the text of NFPA 77 and should, therefore, be listed in Chapter 3. Annex H is a glossary of terms that are directly related to the study of static electricity, but are not used in the body of the text of NFPA 77. <strong>Committee Meeting Action:</strong> Accept</td>
<td></td>
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<tr>
<td>77-31</td>
<td><strong>Log #CP23</strong> (3.3.27 Induction Bar (New), H.2.37)</td>
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<td></td>
<td><strong>Submitter:</strong> Technical Committee on Static Electricity, <strong>Recommendation:</strong> Relocate the definition of &quot;induction bar&quot; from H.2.37 to new 3.3.27. Delete the word &quot;highly&quot; in the first sentence. Relocate the second sentence to Annex A. <strong>Substantiation:</strong> This term is used in several places in the body of the text of NFPA 77 and should, therefore, be listed in Chapter 3. Annex H is a glossary of terms that are directly related to the study of static electricity, but are not used in the body of the text of NFPA 77. <strong>Committee Meeting Action:</strong> Accept</td>
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<td>77-32</td>
<td><strong>Log #CP24</strong> (3.3.29 Ionization (New), H.2.39)</td>
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<td><strong>Submitter:</strong> Technical Committee on Static Electricity, <strong>Recommendation:</strong> Relocate the definition of &quot;ionization&quot; from H.2.39 to new 3.3.29. <strong>Substantiation:</strong> This term is used in several places in the body of the text of NFPA 77 and should, therefore, be listed in Chapter 3. Annex H is a glossary of terms that are directly related to the study of static electricity, but are not used in the body of the text of NFPA 77. <strong>Committee Meeting Action:</strong> Accept</td>
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<td>Log #</td>
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<td>77-33</td>
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<td>(3.3.30 Megohmmeter (New), H.2.43)</td>
<td>Final Action: Accept</td>
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<td><strong>Submitter:</strong> Technical Committee on Static Electricity, <strong>Recommendation:</strong> Relocate the definition of &quot;megohmmeter&quot; from H.2.43 to new 3.3.30. <strong>Substantiation:</strong> This term is used in several places in the body of the text of NFPA 77 and should, therefore, be listed in Chapter 3. Annex H is a glossary of terms that are directly related to the study of static electricity, but are not used in the body of the text of NFPA 77. <strong>Committee Meeting Action:</strong> Accept</td>
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<td>77-34</td>
<td>Log #CP26</td>
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<td>(3.3.31 Minimum Explosible Concentration (New), H.2.44)</td>
<td>Final Action: Accept</td>
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<td><strong>Submitter:</strong> Technical Committee on Static Electricity, <strong>Recommendation:</strong> Relocate the definition of &quot;minimum explosible concentration&quot; from H.2.44 to new 3.3.31. <strong>Substantiation:</strong> This term is used in several places in the body of the text of NFPA 77 and should, therefore, be listed in Chapter 3. Annex H is a glossary of terms that are directly related to the study of static electricity, but are not used in the body of the text of NFPA 77. <strong>Committee Meeting Action:</strong> Accept</td>
<td></td>
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<tr>
<td>77-35</td>
<td>Log #CP27</td>
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<tr>
<td>(3.3.33 Ohms per Square (New), H.2.47)</td>
<td>Final Action: Accept</td>
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<tr>
<td><strong>Submitter:</strong> Technical Committee on Static Electricity, <strong>Recommendation:</strong> Add a new definition for &quot;Ohms per Square&quot; in new 3.3.33 to read: &quot;<strong>3.3.33 Ohms per Square</strong>: A unit of measure used to describe surface resistivity that reflects the resistance value between two electrodes that form two sides of a square and is independent of the size of the square and by which the resulting value indicates how easily electrons can flow across a surface. A 3.3.33 Ohms per square is normally used to characterize the resistivity of a thin conductive layer of one material over a relatively insulative base material.&quot; Delete H.2.47. <strong>Substantiation:</strong> This term is used in several places in the body of the text of NFPA 77 and should, therefore, be listed in Chapter 3. Annex H is a glossary of terms that are directly related to the study of static electricity, but are not used in the body of the text of NFPA 77. The definition has been amended for technical accuracy. <strong>Committee Meeting Action:</strong> Accept</td>
<td></td>
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<tr>
<td>77-36</td>
<td>Log #CP28</td>
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<td>(3.3.34 Relaxation Time Constant (New), H.2.49)</td>
<td>Final Action: Accept</td>
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<td><strong>Submitter:</strong> Technical Committee on Static Electricity, <strong>Recommendation:</strong> Relocate the definition of &quot;relaxation time constant&quot; from H.2.49 to new 3.3.34. <strong>Substantiation:</strong> This term is used in several places in the body of the text of NFPA 77 and should, therefore, be listed in Chapter 3. Annex H is a glossary of terms that are directly related to the study of static electricity, but are not used in the body of the text of NFPA 77. <strong>Committee Meeting Action:</strong> Accept</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
77-37 Log #CP29
(3.3.36 Resistivity (New), H.2.51)

Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: Relocate the definition of "resistivity" and "surface resistivity" from H.2.51 to new 3.3.36.
Add new definition of "volume resistivity" to new 3.3.37.2 per Proposal 77-__ (Log #12).

Substantiation: These terms are used in several places in the body of the text of NFPA 77 and should, therefore, be listed in Chapter 3. Annex H is a glossary of terms that are directly related to the study of static electricity, but are not used in the body of the text of NFPA 77.
Committee Meeting Action: Accept

77-38 Log #CP30
(3.3.38 Spark (New), H2.52)

Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: Relocate the definition of "spark" from H.2.52 to new 3.3.38.

Substantiation: This term is used in several places in the body of the text of NFPA 77 and should, therefore, be listed in Chapter 3. Annex H is a glossary of terms that are directly related to the study of static electricity, but are not used in the body of the text of NFPA 77.
Committee Meeting Action: Accept

77-39 Log #CP31
(3.3.41 Surface Streamer (New), H.2.56)

Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: Relocate the first sentence of the definition of surface streamer" from H.2.56 to new 3.3.41.
Relocate the second sentence of the definition to new A.3.3.41.

Substantiation: This term is used in several places in the body of the text of NFPA 77 and should, therefore, be listed in Chapter 3. Annex H is a glossary of terms that are directly related to the study of static electricity, but are not used in the body of the text of NFPA 77.
Committee Meeting Action: Accept

77-40 Log #CP32
(3.3.42 Triboelectric Series (New), H.2.59)

Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: Relocate the first sentence of the definition of "triboelectric series" from H.2.59 to new 3.3.42.
Relocate the remainder of the definition to new A.3.3.42.

Substantiation: This term is used in several places in the body of the text of NFPA 77 and should, therefore, be listed in Chapter 3. Annex H is a glossary of terms that are directly related to the study of static electricity, but are not used in the body of the text of NFPA 77.
Committee Meeting Action: Accept
<table>
<thead>
<tr>
<th>77-41</th>
<th>Log #CP45</th>
<th>Final Action: Accept</th>
</tr>
</thead>
</table>

**Submitter:** Technical Committee on Static Electricity,

**Recommendation:** In 4.2, make the following changes:
- delete the entries for "A" and "P"
- change the symbol for "liquid conductivity" from Kappa to lower-case sigma
- epsilon should read "permittivity of a material, farads/m"
- epsilon\_0 should read "permittivity of vacuum, farads/m"
- epsilon/epsilon\_0 should read "dielectric constant, kappa".

**Substantiation:** "A" and "P" are not used, so need not be defined. All other changes reflect current usage in the SI system of units.

**Committee Meeting Action:** Accept
Replace current Section 5.2 (new 5.3) with the following:

"5.3 Charging by Induction

5.3.1 Induction is the process of drawing opposite-polarity charge nearer and pushing same polarity charge further away from an electrically charged object. When an electrically neutral conductor is brought near a charged object, induction separates charge so that the opposite polarity charge is concentrated closer and the same polarity charge is concentrated further from the charged object.

5.3.2 As an example, if a person walks about, there is a redistribution of charge on his/her body as he/she approaches and leaves places where there is charge. By the term person, one includes the body, clothing, tools, flashlights, pens, and other articles carried along. The “person” includes all the mentioned items and the nature of their electrical connection. The total charge on the person does not change as he/she walks around, unless there is passage of charge from the person to his/her environment, e.g., the charged object, the floor, the air, or anything else in the surroundings that becomes a path for charge redistribution.

5.3.3 Induction charging of the person can occur in a variety of ways:

5.3.3.1 The person touches the charged object. In this case charge flows between the object and person, and the person’s conductivity gives charge the possibility of being distributed further from the object.

5.3.3.2 If the object is a conductor, charge from its entirety will be reduced by the amount transferred to the person, so that both will end up with the same voltage (potential).

5.3.3.3 If the object is an insulator, local discharge will occur and that charge will be distributed to the person. A moving web would be one case where the local discharges to the person would add up on the person to produce net charging that is similar to that from a conductor. The person would end up with the average voltage (potential) of the web.

5.3.3.4 An electrical discharge occurs between the person and the charged object. The result will be very similar to what happens with direct contact, and in fact, a discharge probably will occur as the person approaches and touches the charged object. The electrical discharge generally occurs from where there is a high concentration of charge – nearby regions on the person or object that are pointed or sharp (points, corners, or edges). There will be sparks or some form of corona discharge – See Section 5.5 and its subsections for descriptions of electrical discharges.

5.3.3.5 Current is conducted through shoes to the floor. If there is conduction through the shoes, charge will distribute beyond the person, and an equal amount of charge will be conducted to the person to be drawn closer to the charged object. If the shoes or floor are not good conductors, it will take time for the net charge on the person to grow and be lost as the person walks from the area.

5.3.3.6 The person touches others, structural steel, tool boxes in the area, etc., or provides other paths for charge to redistribute. Each of these actions give larger area for charge redistribution, and when those paths are broken leave net charge on the person. If shoes and floor are nonconductive, the charge will remain on the person, when he or she leaves the charged object.

5.3.3.7 There is an electrical discharge between the person and something – typically grounded – in the environment. The discharge can come from the hair, rings, finger nails, conductive clothing, etc. In the case of corona, the discharge can be into the air without a nearby grounded surface.

5.3.4 The actual redistribution of charge is complex and dynamic, and the net charge on the person changes with time. One must be careful in handling tools and actions performed while working with charged operations in industry. Gravure printing, coating, and finishing with solvent based materials are particularly hazardous as a result of induction charging. Without good static elimination, pointing a finger at process lines, and working with conductive tools can be hazardous. There are numerous opportunities for spark discharges, brought on by proximity of workers and charged objects.

5.3.5 Pneumatic conveying of bulk solids in nonconductive hoses poses special problems, because charging/discharging along the lines induces complex charges and currents in the work area. The induced charges and currents can be hazardous to workers and electronic equipment.

5.3.6 One area often overlooked is the pickup of charge by induction at one workstation, possibly in a nonhazardous area, that is carried to a hazardous location. Appropriate footwear flooring is thus advised in the hazardous area. Spark discharges from charged objects, however, are typically greater when footwear and flooring are conductive.

5.3.7 Charge Injection into Fluids. (5.1.14) Charge can also be injected into a stream of nonconductive fluid by submerging within the stream a pointed electrode on which a high voltage has been impressed."

Substantiation: This provide a more practical example of induction charging.
Report on Proposals – June 2013
Committee Meeting Action: Accept

77-43 Log #CP48
(5.2.2 (New 5.3.2))
Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: Revise 5.2.2 (New 5.3.2) to read: "Typical examples of accumulation are illustrated in Figure 5.3.2. (See also Table A.3.3.5."
Substantiation: A reference to comparative values of capacitance is helpful here.
Committee Meeting Action: Accept

77-44 Log #CP38
(5.2.5 (New 5.3.5))
Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: Revise the first sentence of 5.2.5 (new 5.3.5) to read:
"Where recombinining of charges occurs through a path that has electrical resistance, the process proceeds at a finite rate, 1/tau, and is described by the charge relaxation time or charge decay time, tau."
Substantiation: This amendment is a more technically accurate description of the physical process of charge decay.
Committee Meeting Action: Accept

77-45 Log #CP46
(5.2.7 (New 5.3.7))
Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: In 5.2.7, revise the equation to read tau = rho X epsilon and revise the third line of the description of terms to read: epsilon = permittivity of material (farads per meter).
Substantiation: This change must be made to correlate with the action taken in Proposal 77-___ (Log CP45).
Committee Meeting Action: Accept

77-46 Log #CP49
(5.3.2 (New 5.4.2))
Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: Revise the first sentence of 5.3.2 (New 5.4.2) to read: "Corona discharge is an electrical discharge in the microampere range that results from a localized needle-shaped electrical breakdown of gases by charges on surfaces such as sharp edges, points, and wires.
Substantiation: The words "needle shaped" serve no purpose.
Committee Meeting Action: Accept

77-47 Log #CP6
(Figure 5.3.3.3)
Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: Correct Figure 5.3.3.3 to accurately represent source document.
Substantiation: The Figure was incorrectly reproduced from source document.
Committee Meeting Action: Accept
Technical Committee on Static Electricity,

Revise 5.3.3.5 (New 5.4.3.5) to read:
"Most gases and vapors of saturated hydrocarbons require about 0.25 mJ of energy for spark discharge ignition, assuming optimum mixtures with air. There are some that require less energy for ignition. Unsaturated hydrocarbons can have lower MIEs. Discussion of the minimum ignition energy for specific materials can be found in 9.2.3, 9.2.4, and 15.11.1 6.2.3, 9.2.4, and 9.10.1. (See Table B.1.)"  

Substantiation: The references to saturated and unsaturated hydrocarbons are deleted because the distinction is not relevant here. The new sentence is a precautionary statement. The reference to Table B.1 is helpful here.

Committee Meeting Action: Accept

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Technical Committee on Static Electricity,

Revise 5.3.5.2 (New 5.4.5.2) to read:
"A person insulated from ground can accumulate a significant charge by walking on an insulating surface, by touching a charged object, by brushing surfaces while wearing nonconductive clothing, or by momentarily touching a grounded object in the presence of charges in the environment. During normal activity, the potential of the human body can reach 10 kV to 15 kV. At a capacitance of 200 pF (see Table A.3.3.5), and the accumulated energy available for a possible spark can reach 10 \( \text{to} \) 22.5 \( \text{mJ} \). A comparison of these values to the MIEs of gases or vapors makes the hazard readily apparent."

The range of capacitance for the human body is 100 to 300 picoFarads. Using an average value of 200 picoFarads, the energy of a spark from the human body is more correctly given as 10 to 22.5 milliJoule.

Committee Meeting Action: Accept

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Technical Committee on Static Electricity,

In Figure 6.1.2, add the following:
- in Note 1, add a new bullet to read: "deliberate or intentional generation of electrostatic charge, e.g., an electrostatic coating process"
- in Note 2, add a new bullet to read: "isolated conductive liquids, e.g., a conductive liquid in an electrostatic system where the entire system is isolated from ground"

These two items are valid examples of the concepts depicted.

Committee Meeting Action: Accept

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Technical Committee on Static Electricity,

In Figure 6.7 (b), change the legend on the horizontal axis from "ohm-m" to "ohm per square".

This is a correction of an error.

Committee Meeting Action: Accept
A permanent/fixed grounding system that is acceptable for power circuits or for lightning protection is more than adequate for a static electricity grounding system.

In field based situations such as "HAZMAT" hazardous response operations or flammable/combustible materials spill control and transfer, it may be necessary to establish a temporary or emergency grounding system in a remote location in order to dissipate static charges. In these situations, various types of conductive grounding electrodes may be used, such as rods, plates and wires which are sometimes used in combination to increase surface area contact with the earth. If the purpose of the temporary grounding system is to dissipate static electricity, a total resistance of up to 1 k ohm (1,000 Ohms) in the ground path to earth is considered adequate. This may be measured using standard ground resistance testing instruments, and is realistically and quickly achievable in most types of terrain and weather conditions.

The need for effective and safe grounding and bonding techniques and equipment for mobile/field use is absolutely vital for Hazardous Materials/Emergency Response Teams and Vacuum Truck - Environmental/Clean-up operations involving flammable or combustible materials. NFPA and other safety codes all point to ensuring proper bonding and grounding as the prime way to avoid static sparks in hazardous areas. While attending an incident involving flammable or combustible liquids, gases or bulk powders, it is necessary to ensure all potentially isolated transfer equipment, vehicles, tanks, containers and other items are bonded and grounded to prevent accumulation of dangerous levels of static charge. However, the technical standards and guidelines for rendering an operation safe can be confusing, difficult to achieve and verify extremely time consuming to set up in a situation where time is of the essence.

One very real and specific problem area is setting up and testing a satisfactory "ground" point in a remote location where a permanent grounding system is not available. In different types of terrain and climatic conditions it can be impossible to verify a proper ground according to the most commonly referenced standard (NEC Article 250) which is written to meet the requirements of electrical fault current grounding and lightning protection, both of which require a much lower "ground resistance" (<25 Ohms).

NFPA 77 (7.4.1.3.1) states that in order to dissipate static charges a "resistance of 1 Meg Ohm (10^6 Ohms) or less generally is considered adequate", however with standard instruments typically used to verify a satisfactory ground, like Clamp-on Ground Resistance Meters, an elevated resistance at this level is impossible to measure – more specialized and costly equipment is required.

The proposed maximum of 1,000 Ohms (i.e. 1,000 times less than the maximum previously stated) is therefore seen as a realistic level which 1) can be achieved in most soil and weather conditions and 2) can quickly and easily tested and verified. Our own research in various types of terrain confirms that this level of ground resistance can be rapidly achieved and confirmed using commercially available test instruments, leaving the HazMat responders or Environmental Contractors to get on with the urgent matters in hand.

We believe this addition to NFPA 77 will provide people in these positions to carry out their urgent tasks in a timely manner, while still continuing to work within extremely safe parameters with a wide margin of safety.

Committee Meeting Action: Accept in Part

Accept the amendment to 7.4.1.3.1 and the proposed new paragraph, to be designated 7.4.1.3.1.1. Do not accept the proposed amendment to 7.4.1.3.2.

Committee Statement: The Technical Committee agrees with the proposed amended and new text. The addition to 7.4.1.3.2 is not accepted because the diagram referenced was not submitted.
Technical Committee on Static Electricity,

Recommendation: Revise 7.6.2 (New 8.2.2) to read as follows:

8.2.2 (7.6.2) Conductive Flooring and Footwear.

8.2.2.1 (7.6.2.1) Conductive or static dissipating antistatic flooring can provide effective dissipation of static electricity from personnel, who are adequately bonded to the floor by means of contact. Materials can be solid or they can be coatings that are selected on the basis of wear characteristics, chemical resistance, and the floor area that needs to be covered. Small areas can be handled with a grounded metal plate. Typical resistance to ground for flooring systems should be less than $10^8$ ohms. Clean, uncoated concrete floors typically have a resistance to ground of $10^6$ to $10^8$ ohms. Accumulation of debris, wax, and other high-resistivity materials will compromise the conductivity of the floor. Floors should be routinely tested to confirm that they are adequately continuous with ground.

8.2.2.2* (7.6.2.2) Electrostatic dissipative (SD) (ESD) footwear used in conjunction with conductive or static dissipating flooring provides a means to control and dissipate static electric charges from the human body. Resistance to earth through SD ESD footwear and conductive or static dissipating flooring should be between $10^6$ ohms and $10^9$ ohms. For materials with very low ignition energies, the resistance to earth through footwear and flooring should be less than $10^6$ ohms. Resistance can be measured with commercially available footwear conductivity testers.

A.8.2.2.2 (A.7.6.2.2) See ANSI Z41, Standard for Personal Protection — Protective Footwear.

8.2.2.3 (7.6.2.3) Resistance of footwear can increase with accumulation of debris such as wax or silica powder on the sole of the footwear or on the flooring itself, use of orthopedic foot beds or orthotic devices, and reduced floor contact area. Conductivity of footwear can be tested on a periodic basis to confirm functionality.

Substantiation: The text changes are intended to improve the technical accuracy of the discussion.

Committee Meeting Action: Accept

Technical Committee on Static Electricity,

Recommendation: Revise 8.1(3) (New 9.1(3)) to read:

*loading and unloading of tank vehicles

Substantiation: Chapter 9 logically covers both loading and unloading.

Committee Meeting Action: Accept
Flash point is determined using a variety of test procedures and apparatus, the selection of which sometimes depends on other physical characteristics of the liquid. For reasons discussed in A.8.2.1.2, ignition might occur at temperatures lower than the reported flash point.

A.9.2.1.1 [A.8.2.1.1] [No Changes]

9.2.1.2 (8.2.1.2) If the flash point of a liquid is at or below typical ambient temperatures, it is likely to evolve an ignitible vapor. The lower the flash point, the higher the vapor pressure and the more likely that an ignitible vapor concentration will be present to ignite. Because of the inherent errors variability in standard flash point measurements test methods, the published flash point of a particular liquid only approximates the lowest temperature at which ignition is possible for that liquid. Thus, an allowance of at least 5°C to 11°C, 4°C to 9°C below the published flash point should be made in the evaluation of an ignition hazard. A minimum safety factor of 5°C is appropriate for single component liquids having a well-defined flash point. The higher minimum safety factor of 11°C is appropriate for mixed liquids of less certain composition such as fuels.

A.8.2.1.2 The standard “closed cup” flash point is generally higher than true flash point known as the “lower temperature limit of flammability” or LTLF. This is the temperature at which the vapor at thermal equilibrium with the liquid achieves a concentration equal to the lower flammable limit (LFL). For single component liquids, it is found that the standard flash point can be 4°C to 6°C higher than the true flash point (LTLF). For complex fuel mixtures such as Jet Fuel A the difference can be 10°C to 15°C.

9.2.1.3 Operations at high elevations, such as mining operations, require an additional safety factor depending on the elevation. The recommended additional safety factor for each 1000 meters above sea level is 2.6°C for complex fuels, such as diesel fuels, and 1.9°C, for pure liquids such as toluene and ethanol. Elevations below 1000 meters can be neglected, because the additional correction factor is no greater than the typical error of a flash point measurement of a given sample.

9.2.1.4 (8.2.1.3) In addition to the conditions described in 9.2.1.2 8.2.1.2, the following effects also can generate an ignitible vapor:

1. Off-gassing of flammable vapors from solids or low-volatility liquids
2. Switch Loading
3. Flow through common vapor headers
4. Processing at pressures below atmospheric pressure
5. Nonhomogeneity of the vapors above the liquid
6. Mist, droplets, or foam on the surface of a liquid

9.2.1.4.1 The term switch loading describes a situation that warrants special consideration. When a tank is emptied of a cargo of Class I liquid, a mixture of vapor and air is left, which can be, and often is, within the flammable range. When such a tank is refilled with a Class I liquid, any charge that reaches the tank shell will be bled off by the required bond wire. Also, there will be no flammable mixture at the surface of the rising oil level because the Class I liquid produces at its surface a mixture too rich to be ignitible. This is the situation commonly existing in tank vehicles in gasoline service. If, as occasionally happens, a static charge does accumulate on the surface sufficient to produce a spark, it occurs in a too-rich, nonignitible atmosphere and thus causes no harm.

A very different situation arises if the liquid is “switch loaded,” that is, when a Class II or Class III liquid is loaded into a tank vehicle that previously contained a Class I liquid. Class II or Class III liquids are not necessarily more potent static generators than the Class I liquid previously loaded, but the atmosphere in contact with the rising oil surface is not enriched to bring it out of the flammable range. If circumstances are such that a spark should occur either across the oil surface or from the oil surface to some other object, the spark occurs in a mixture that can be within the flammable range, and an explosion can result.

It is emphasized that bonding the tank to the fill stem is not sufficient; a majority of the 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 the
change of such internal static ignition 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 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.

For additional information, see Annex C.

This revision of the section on flash point provides additional information of interest to the user, especially the information on switch loading, which has been extracted from NFPA 30, Flammable and Combustible Liquids Code.

Annex C.2.2 has been deleted because it duplicates the information in 8.2.1.

Committee Meeting Action: Accept
77-58 Log #CP4 Final Action: Accept
(Figure 8.4.1.4(a))

Submitter: Technical Committee on Static Electricity,
Recommendation: 1. Correct Figure 8.4.1.4(a) to accurately represent source document.
2. Replace the "S" in the left-most column and in the note below the figure with lower-case Greek letter sigma.
Substantiation: The Figure was incorrectly reproduced from source document. Also, the "S" for volumetric charge density should be designated by lower-case Greek letter sigma. These are corrections of errors.
Committee Meeting Action: Accept

77-59 Log #CP5 Final Action: Accept
(Figure 8.4.1.4(b))

Submitter: Technical Committee on Static Electricity,
Recommendation: Correct Figure 8.4.1.4(b) to accurately represent source document.
Substantiation: The Figure was incorrectly reproduced from source document.
Committee Meeting Action: Accept

77-60 Log #CP35 Final Action: Accept
(8.4.3.4 (New 10.3.4))

Submitter: Technical Committee on Static Electricity,
Recommendation: Add a new 10.3.4.1 to read:
"10.3.4.1 Hose with more than one internal spiral should not be used because it is not possible to determine if one of the spirals has lost its continuity."
Substantiation: This addition correlates with (old) 9.7.2 (new 15.8.2).
Committee Meeting Action: Accept

77-61 Log #CP68 Final Action: Accept
(8.5.2.1 (New 12.1.2.1))

Submitter: Technical Committee on Static Electricity,
Recommendation: In item (4), replace "50 m³" with "200 m³ (50,000 gal)"
Substantiation: This is the correct criterion, according to IEC 60079.
Committee Meeting Action: Accept
Report on Proposals – June 2013

77-62     Log #CP69
(8.5.2.1 (New 12.1.2.1))

Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: Add new Items (5) and (6), to read as follows:

"(5) The following applies to vertical axis storage tanks greater than 75 m$^3$ (20,000 gal) and less than 200 m$^3$ (50,000 gal) containing liquids that are either nonconductive or for which conductivity is unknown:

(a) The product of inlet flow velocity and pipe inside diameter can be increased to 0.50 m$^2$/sec after the fill pipe is submerged.

(6) The following applies to vertical axis storage tanks greater than 1 m$^3$ (250 gal) and less than 75 m$^3$ (20,000 gal) containing liquids that are either nonconductive or for which conductivity is unknown:

(a) The product of inlet flow velocity and pipe inside diameter can be increased to 0.38 m$^2$/sec after the fill pipe is submerged.

(b) If the liquid is nonconductive and contains a dispersed phase, such as entrained water droplets, the flow velocity should be restricted to 1 m/sec throughout the filling operation."

Renumber existing items (5) through (8) accordingly.

Substantiation: This information is based on internationally accepted practice, as set forth in IEC 60079.

Committee Meeting Action: Accept

77-63     Log #CP44
(8.5.2.1(8) (New 12.1.2.1(8)))

Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: Revise 8.5.1.2(8) [new 12.1.2.1(8)] to read:

"(8) Lines should not be blown out with air or other gases if the liquid is a Class I liquid or is handled at or above its flash point, because introducing substantial amounts of air or other gas into a tank through such a liquid can create a hazard due to charge generation, misting of the liquid, and formation of an ignitible atmosphere, unless it is certain that the operation will not overpressure the lines or the equipment into which they terminate. The smallest source pressure that will successfully clear the line should be used to minimize the volume of entrained gas delivered to the receiving vessel. Introducing substantial amounts of air or other gas into the liquid in the line can create a hazard due to misting of the liquid, subsequent charge generation, and formation of an ignitible atmosphere."

Substantiation: The last sentence of the proposed new text provides the technical justification for this revision.

Committee Meeting Action: Accept
Technical Committee on Static Electricity,

Revise 8.5.4 to read as follows:

12.1.4 (8.5.4) Coated and Lined Tanks. Metal tanks with nonconductive coatings or linings can be treated as conductive tanks. The presence of internal coatings or linings in grounded metal tanks can generally be neglected, provided that either one of the following criteria applies:

1. The nonconductive coating or lining has a volume resistivity equal to or lower than \(10^{10}\ \text{ohm-m}\), such as fiberglass-reinforced linings for corrosion prevention, and
2. Thickness of a painted coating is no thicker than 50 \(\mu\text{m}\) (2 mils) of \(\text{mm}\).
3. The nonconductive lining has a volume resistivity greater than \(10^{10}\ \text{ohm-m}\), such as polyethylene or rubber linings, but has a breakdown potential less than 4 kV.
4. The liquid is conductive and is always in contact with ground, for example, a grounded dip tube or grounded metal valve.

Also, delete the third and fourth sentences in 8.5.4.1 and delete 8.5.4.2 entirely.

Substantiation:

1. The revisions made to the lead-in sentence for purposes of clarity.
2. The change to the volume resistivity criterion is made to correlate with international standards, thus preventing conflicts.
3. The change to the thickness criterion corrects a transcription error.
4. Deletion of former item (2) recognizes that the \(10^{10}\ \text{ohm-m}\) and 4 kV criteria are no longer recognized as valid.
5. Deletion of text in 8.5.4.1 and all of 8.5.4.2 is to remove information that is now considered to be erroneous and which could lead to a hazardous situation.

Committee Meeting Action: Accept

Table 8.6 (New Table 12.2)

Submitter: Technical Committee on Static Electricity,

Recommendation: In Table 8.6 (New Table 12.2), make the following changes:

1. In the first column, under "Maximum Loading Rate" add the following new text:

   "The maximum loading rate for ultra low-sulfur diesel and gas oils (< 50 ppm S) with conductivity less than 10 pS/m or unknown conductivity should not exceed (0.25/d) m/s. The loading rate can be increased to (0.38/d) m/s if S > 50 ppm or if the conductivity exceeds 10 pS/m. If S > 50 ppm and the conductivity exceeds 10 pS/m the loading rate can be increased to (0.5/d) m/s. If the conductivity exceeds 50 pS/m the loading rate can be increased to (0.5/d) m/s in both cases."

2. In Footnote e, add "(See 9.2.1 for applicable safety factors.)"
3. In Footnote f, change "maximum fill rate" to "maximum flow velocity".

Substantiation:

1. This correlates with CENELEC 50404-2003.
2. This is a cross reference to additional information on flash point of use to the reader.
3. This is a correction of a transcription error.

Committee Meeting Action: Accept
Report on Proposals – June 2013

77-66 Log #CP71 (8.6.5 (New) (New 12.2.5))

Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: Add a new 12.2.5 to read:
"Unloading of Tank Vehicles. For bulk transfer of liquids from tank vehicles to storage tanks, see Section 12.1."

Substantiation: Relevant information for unloading of tank vehicles is missing and can be provided by means of this cross reference.
Committee Meeting Action: Accept

77-67 Log #CP72 (8.8.1 (New 12.4.1))

Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: Revise 8.8.1 (New 12.4.1) to read:
"In general, the precautions for railroad tank cars are similar to those for tank vehicles specified in Section 12.2.6. The major exception is the larger volume typical of railroad tank cars (e.g., greater than 87 m3) compared with that of tank vehicles (e.g., about 50 m3). The greater volume allows greater maximum flow velocities to be used for filling rates to be used, up to a maximum of \(0.8/\phi\) m/sec, where \(\phi\) is the inside diameter of the inlet in meters."

Substantiation: The measurement given, \(0.8/\phi\), is not a volume fill rate, it is a flow velocity through the piping.
Committee Meeting Action: Accept

77-68 Log #CP54 (8.10.5.4 (New 13.5.4))

Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: Revise 8.10.5.4 (New 13.5.4) to read:
"Fiber drums or packages should not have a loose plastic liner that can leave the package and behave like a plastic bag. All metal chimes should be grounded."

Delete the text in 8.10.5.5 (New 13.5.5) and mark the paragraph "(Reserved)."

Substantiation: The provision of 8.10.5.5 really should be a second sentence to 8.10.5.4, because it relates to fiber drums. Grounding the chime of a fiber drum is required because otherwise the chime will serve as an ungrounded conductor with the capability of releasing an ignition-capable spark, if it accumulates a charge.
Committee Meeting Action: Accept
Technical Committee on Static Electricity,

Revise 8.10.7.2(2) (New 13.7.2(2)) to read:

“(2) Where the tank is used to store nonconductive liquids, the following criteria should be met:
(a) An enclosing, grounded conductive shield should be provided to prevent external discharges. This
(b) The shield should be a grounded wire mesh buried in the tank wall and should enclose all external surfaces.
(b) A metal plate should be installed to provide a path through which charge can flow from the liquid contents to
ground. The metal plate should have a surface area not less than 500 cm²/m³ of tank volume and should be located at
the bottom of the tank and bonded to ground.”

Delete item (3) and renumber remaining items accordingly.

Substantiation: As written the reader could erroneously interpret the current text as offering items 92) and (3) as
alternatives. This is not correct; they both apply and should be written as such.

Committee Meeting Action: Accept
Technical Committee on Static Electricity,

Revise 8.13.4 (New 11.1.4) to read:

"11.1.4 Plastic-Lined Metal Non–Bulk Containers.

11.1.4.1 The effects of static electricity from thin, internal coatings, such as phenolic or epoxy paints, can be ignored, provided that the thickness of the coating does not exceed 50 m (2 mils) 2 mm. A container with a thin lining up to 2 mm in thickness can be treated as a metal container. The hazards of special coatings such as fluoropolymers have not been fully evaluated and it is advised that at a minimum, liquid is not directly sprayed at such coatings above the liquid level, such as via a hand-held wand.

11.1.4.2 Where the drum has a lining of nonconductive plastic thicker than 50 m (2 mils) 2 mm, it should be treated as a nonconductive container, unless it can be shown that the surface resistivity is not greater than 10^10 ohms per square. The lining is either conductive (volume resistivity < 10^5 ohm-m) or static dissipative (volume resistivity < 10^9 ohm-m). Conductive and static dissipative linings are adequately conductive to safely dissipate charge provided the lining is not isolated from ground by a nonconductive coating beneath it (see 8.13.4.2.1). Owing to the common use of “surface resistivity” to describe linings, it is recommended that “conductive” types be used where the volume resistivity is in doubt. To avoid spark hazards due to batch defects of “conductive” linings, a simple performance test can be used. For example, megger or tera-ohmmeter measurements can be made between the top and bottom of several lining samples to confirm the resistance is within the range provided by the lining supplier.

8.13.4.2.1* Removable Conductive and Static Dissipative Linings. Drums and pails usually have internal nonconductive phenolic or epoxy internal painted coatings less than 2 mil (50 microns) thick. These coatings can isolate the removable lining plus any liquid contents from ground. No special measures are needed for grounded, lined pails during ordinary liquid transfer and stirring operations, although open pails should be grounded using a clamp at the upper rim that also grounds the removable lining. The following measures should be considered for drums.

(a) Open head drums should be grounded using a clamp connected across the upper chime, so that both the drum and removable lining are bonded and grounded.

(b) Closed head drums can in many cases be filled via a grounded dip pipe that is fully inserted before the drum is filled. Where these measures are impractical, a helpful measure is to select drums that have coating thicknesses in the range 0.5-1 mil (12-25 microns), so that the breakdown voltage between the lining and the drum is minimized. A pragmatic solution is simply to remove part of the drum coating at the chime so that the lining contacts bare metal.

A.8.13.4.2.1 Removal of linings that are wet with flammable material pose ignition hazards during handling and storage. Conductive and static dissipative linings should be handled by a grounded person and stored outside the operating area in a well-ventilated location. Nonconductive linings pose special hazards if they are stacked and then unstacked, creating static via rubbing. A hazard review should be considered to determine the safest way to handle and store removable linings."

Substantiation: The added information is much more comprehensive than the previous text, in that it provides more detailed guidance in handling of lined containers and container liners.

Committee Meeting Action: Accept
Technical Committee on Static Electricity,
Revise 8.13.5 (New 11.1.5) to read:
"The use of plastic containers for Class I liquids is limited by Table 9.4.3 and Paragraph 9.4.3.1 of NFPA 30, Flammable and Combustible Liquids Code. Where such containers are used for Class II and Class III liquids, the precautions for filling depend on the size of the container, the container design, and the conductivity of the liquid."

Substantiation: This provides a reference to the exact intended location in NFPA 30.
Committee Meeting Action: Accept

Technical Committee on Static Electricity,
Revise 8.13.6.1 (New 11.1.6.1) to read:
"Listed safety cans should be used, especially those types equipped with a flexible metal dispensing nozzle so they can be used without a funnel."

Substantiation: The word nozzle is the more accepted term.
Committee Meeting Action: Accept

Steven J. Gunsel, SGTechnologies, LLC
Revise text to read as follows:
*Collecting liquids and solids in an ignitable atmosphere using a vacuum cleaner can create a significant hazard due to ignition from static electric discharge. If it is necessary to use such equipment in a process area, the hazards and the procedures for safe use should be carefully reviewed and clearly communicated to the potential users. If electrically powered, the vacuum cleaner should be listed for use in the applicable hazardous atmosphere.

Recommendation: Revise 8.14 to read:
"Collecting liquids and solids in an ignitable atmosphere using a vacuum cleaner can create a significant hazard due to ignition from static electric discharge. If it is necessary to use such equipment in a process area, the hazards and the procedures for safe use should be carefully reviewed and clearly communicated to the potential users. If electrically powered, the vacuum cleaner should be listed for use in the applicable hazardous (classified) location, as defined in Article 500 of NFPA 70, National Electrical Code. Air-operated vacuum cleaners are available for this application. Special consideration should be given to grounding the vacuum hose and the nozzle per manufacturers recommendations, regardless of the type of vacuum used."

Committee Statement: The proposed text is acceptable, but needs to be limited to electrically operated units and additional text added to cover air-operated vacuums. The Technical Committee notes that Section 8.14 is designated 14.3 in the Preprint.
<table>
<thead>
<tr>
<th>Log #</th>
<th>Final Action</th>
<th>(Chapter Number)</th>
<th>Submitter: Technical Committee on Static Electricity,</th>
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<tbody>
<tr>
<td>77-75 Log #CP83</td>
<td>Accept</td>
<td>9 (New Chapter 15))</td>
<td><strong>Recommendation:</strong> Change the value of &quot;10^8 ohm-m&quot; to &quot;10^6 ohm-m&quot; throughout the chapter.</td>
</tr>
<tr>
<td><strong>Substantiation:</strong></td>
<td>Consensus of an upper limit of 10^6 ohm-m for the volume resistivity of conductive powders has been agreed to internationally. This value should be harmonized in NFPA-77.</td>
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<td>77-76 Log #CP76</td>
<td>Accept</td>
<td>9.1 (New 15.1))</td>
<td><strong>Recommendation:</strong> Revise the first sentence of Section 9.1 (New 16.1) to read: &quot;Powders include pellets, granules, and dust particles and other particulate solids.&quot;</td>
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<tr>
<td><strong>Substantiation:</strong></td>
<td>This makes the applicability of the chapter more general.</td>
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<tr>
<td>77-77 Log #CP64</td>
<td>Accept</td>
<td>9.1.1 (New )</td>
<td><strong>Recommendation:</strong> Add a new 9.1.1 (new numbering system) to read: &quot;9.1.1. Static control measures need to be taken whenever ignitable mixtures may be present. Conversely, if ignitable mixtures can be ruled out, these measures are not required. However, it requires careful evaluation to rule out the possibility of ignitable mixtures under all conditions (see 8.2). Also, some operations may pose a risk of shocks to people (see 7.8) and, in such cases, bonding and grounding will usually correct the problem.&quot;</td>
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<td><strong>Substantiation:</strong></td>
<td>This is an appropriate introductory discussion of the focus of Chapter 9.</td>
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<td>77-78 Log #CP77</td>
<td>Accept</td>
<td>9.2.1 (New 15.2.1))</td>
<td><strong>Recommendation:</strong> Revise 9.2.1 (New 15.2.1) to read: &quot;A combustible dust is defined as 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. Any finely divided solid material 429 µm or smaller in diameter (i.e., material that will pass through a U.S. No. 40 standard sieve) that can present a fire or deflagration hazard.&quot;</td>
</tr>
<tr>
<td><strong>Substantiation:</strong></td>
<td>This definition is consistent with that used in NFPA 654, Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids.</td>
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<tr>
<td><strong>Committee Meeting Action:</strong></td>
<td>Accept</td>
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</tbody>
</table>
Submitters: Technical Committee on Static Electricity,

Recommendation: Replace the second sentence of 9.2.4 (New 15.2.4) with the following:

“For discharges typical of sparks which may be produced by charged, ungrounded conductors, ignition of a dust cloud is possible if the energy in the discharge exceeds the minimum ignition energy (MIE) of the dust. The MIE is a measure of the minimum amount of capacitive spark energy necessary to ignite a dust cloud of optimal concentration.”

Substantiation: The second sentence is somewhat confusing and should be reworded for clarity.

Committee Meeting Action: Accept

Submitters: Technical Committee on Static Electricity,

Recommendation: In 9.3.1 (New 15.3.1), replace the word "friction" with "contact and separation."

Substantiation: The term ‘frictional charging’ is somewhat incorrect; tribocharging is more of a contact/separation phenomenon and may involve very little friction between particles.

Committee Meeting Action: Accept

Submitters: Technical Committee on Static Electricity,

Recommendation: In 9.3.3 (new 15.3.3), change “10µC/m²” to “27 µC/m²”.

Substantiation: Analysis of a body in free-space shows a maximum surface charge of 27 µC/m² is possible.

Committee Meeting Action: Accept

Submitters: Technical Committee on Static Electricity,

Recommendation: Add a new 9.3.4 (new number to be 15.3.4) to read:

“Electrostatic charge accumulation in particulate solids can be minimized by decreasing the powder’s bulk resistivity by increasing the moisture content of the powder, by reducing conveying speed or throughput, or by substituting processes which result in less particle contact per unit time (e.g., gravity transfer vs. pneumatic conveying). The use of ionization to reduce accumulated charge may also be effective for some applications.”

Substantiation: Guidelines on how to prevent or minimize static charge generation would be useful as an additional section and are not really presented in the current edition of NFPA 77.

Committee Meeting Action: Accept

Submitters: Technical Committee on Static Electricity,

Recommendation: Revise the equation and its list of terms to read identically with the revised equation in 5.2.7 (New 5.3.7), as shown in Proposal 77-41 (Log CP46).

Substantiation: This change must be made to correlate with the action taken in Proposal 77-41 (Log CP45).

Committee Meeting Action: Accept
77-84 Log #CP82
(9.4.2 (New 15.4.2))

Submitter: Technical Committee on Static Electricity,
Recommendation: Delete the second sentence of 9.4.2 (New 15.4.2).
Substantiation: A discussion of liquid conductivity is not relevant in a section on powders and dusts.
Committee Meeting Action: Accept

77-85 Log #CP84
(9.4.3.1 (New 15.4.3.1))

Submitter: Technical Committee on Static Electricity,
Recommendation: In 9.4.3.1 (New 15.4.3.1), add the phrase "from the charged mass of solid material" to the end of the third sentence.
Substantiation: It is not completely clear where the spark originates from.
Committee Meeting Action: Accept

77-86 Log #CP85
(9.4.3.3 (New 15.4.3.3))

Submitter: Technical Committee on Static Electricity,
Recommendation: Revise the second sentence of 9.4.3.3 (New 15.4.3.3) to read:
"High-resistivity powders lose charge at a slow rate, determined by their volume resistivity, even in properly grounded containers.
Substantiation: Bulk resistivity also determines the rate of charge decay from high-resistivity powders.
Committee Meeting Action: Accept

77-87 Log #CP86
(9.5.1.2 (New 15.5.1.2))

Submitter: Technical Committee on Static Electricity,
Recommendation: Revise 9.5.1.2 (New 15.5.1.2) to read as follows:
"15.5.1.2 (9.5.1.2) It should be noted that equations 15.5.1.1a through 15.5.1.1d 9.5.1.1(a) through 9.5.1.1(d) apply only to capacitive discharges from conductors and cannot be applied to discharges from insulators. Discharge energies so estimated can be compared with the MIE of the dust to provide an insight into the probability of ignition by capacitive spark discharge (see 5.4.3 5.3.5). Layers of combustible dusts can be ignited by capacitive spark discharge, which can lead to secondary dust explosions. For a dust layer, there is no correlation with the MIE for dust cloud ignition. Capacitive spark discharges must be avoided by grounding all conductive containers, equipment, and products and personnel. Personnel that are exposed to clouds of combustible dust that have a minimum ignition energy less than 30 mJ should also be grounded."
Substantiation: Personnel only need to be grounded if the dust cloud MIE is less than the maximum reasonable discharge energy possible from a person. This is estimated to be ~30 mJ.
Committee Meeting Action: Accept
<table>
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<td>77-91</td>
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**Submitter:** Technical Committee on Static Electricity,

**Recommendation:** Revise the last sentence of 9.5.2 (New 15.5.2) to read:
"Likewise, there is no evidence suggesting that brush discharges are capable of igniting a dust cloud is available that a brush discharge can ignite dusts with MIEs greater than 3 mJ, provided that no flammable gas or vapor is present in the dust cloud."

**Substantiation:** The state of knowledge based on recent test work indicates that brush discharges are not capable of igniting even ignition-sensitive dust clouds having minimum ignition energies of less than 1 mJ.

**Committee Meeting Action:** Accept

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**Submitter:** Technical Committee on Static Electricity,

**Recommendation:** Revise the title of 9.5.4 (New 15.5.4) to read:
"Bulking Brush Discharge (Cone Discharge)."

**Substantiation:** The two terms are used synonymously.

**Committee Meeting Action:** Accept

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**Submitter:** Technical Committee on Static Electricity,

**Recommendation:** In 9.5.4.1 (new 15.5.4.1), replace "10 mJ" with "20 mJ".

**Substantiation:** An upper limit of 10 mJ for cone discharges is too low based on studies cited by Britton. A more appropriate limit is 20 mJ.

**Committee Meeting Action:** Accept

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**Submitter:** Technical Committee on Static Electricity,

**Recommendation:** Replace the current text of 9.7.1 (New 15.8.1) with the following:
"Significant static charge can be generated where non-conductive hoses are used for solids transport. This in turn can result in various types of electrostatic discharge. Such hoses should only be used in areas that are not hazardous (classified) locations per Article 500 of NFPA 70 and where solids are not capable of producing ignitable dust or vapor. Additionally, a severe shock hazard to personnel might exist."

**Substantiation:** Hoses made from non-conductive material can acquire significant charge during pneumatic flow of solids, leading to various types of discharges; they should not be recommended for handling combustible dusts.

**Committee Meeting Action:** Accept
77-92 Log #CP92
(9.7.2 (New 15.8.2))

Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: Revise 9.7.2 (new 15.8.2) to read:
"Where non-conductive hose containing a spiral reinforcing wire is used the wire should make good contact with metal end couplings. Hose with more than one internal spiral wire should not be used, because it is not possible to determine if one of the spirals has lost its continuity."
Substantiation: This revision correlates with the revisions to 9.7.1 (new 15.8.1).
Committee Meeting Action: Accept

77-93 Log #CP94
(9.8.2 (New 15.9.2))

Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: Revise 9.8.2 (New 15.9.2) to read:
"For combustible dusts are handled, the end-to-end resistance of boots and socks should be less than 10^8 ohms, preferably less than 10^6 ohms, measured with a megohmmeter."
Substantiation: Editorial clarity.
Committee Meeting Action: Accept

77-94 Log #CP95
(9.9.4 (New 15.10.4))

Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: Replace the current text of 9.9.4 (New 15.10.4) to read:
"In general, conductive filter media provide no extra protection where non-conductive combustible dusts alone are handled. In fact, such bags could pose an additional sparking hazard if improperly grounded or if they become loose and fall into the bottom of the baghouse. However, the use of such bags should be considered if hybrid combustible dust/flammable vapor mixtures having minimum ignition energies of less than 4 mJ are present or where combustible conductive dusts are handled."
Substantiation: There are cases where the use of conductive filter bags is justified, such as where flammable vapor atmospheres, hybrid flammable vapor/combustible dust mixtures, or low ignition energy combustible conductive dusts are handled.
Committee Meeting Action: Accept

77-95 Log #CP96
(9.10.1 (New 15.11.1))

Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: Add a new second sentence to 9.10.1 (New 15.11.1) to read:
"In general, vapor concentrations greater than 20% of the lower flammable limit of the vapor are necessary for such mixtures to exist."
Substantiation: The definition of 'hybrid mixtures' simply as mixtures where dust/vapor combinations can support combustion is extremely vague—better guidance is needed.
Committee Meeting Action: Accept
Technical Committee on Static Electricity,
Revise 9.10.2 (New 15.11.2) to read:

"15.11.2 (9.10.2) Powders that contain enough solvent (i.e., greater than 0.5 0.2 percent by weight) so that
significant concentrations of solvent vapor can accumulate in the operations in which they are handled are referred to as
solvent-wet powders. In such cases, there will be the potential for developing an ignitable atmosphere in the storage
vessel. Appropriate precautions must be taken to address this hazard. Even at lower concentrations, a hazard might
exist if the solvent-wet powder is held for extended periods of time or at elevated temperature. Consideration should be
given to applying the recommendations of Chapter 8 to solvent-wet powders unless the resistivity of the solvent-wet
product is less than $10^6 - 10^8$ ohm-m."

Substantiation: The criterion of 0.2 percent is too conservative. The 0.5 percent criterion correlates with internationally
accepted practice per EN 60079-32, § 9.4, Note 1.

Committee Meeting Action: Accept

Technical Committee on Static Electricity,
Revise 9.11.1 (New 15.12.1) to read:

"The most frequent cause of static electric ignitions in process vessels is the addition of solids to flammable liquids in
the vessels. Even where the vessel is inerted, large additions of solids introduce air into the vessel while expelling
flammable vapor from the vessel. The sudden addition of a large volume of solids can also result in static discharge
from a floating pile of charged powder. See Section 13.5 for general precautions on addition of powders to vessels
containing flammable liquids."

Substantiation: This cross-reference directs the reader to Section 13.5, which contains recommended safety
procedures for adding solids to vessels of liquids.

Committee Meeting Action: Accept

Technical Committee on Static Electricity,
Revise 9.11.1.3 (New 15.12.1.3) to read:

"The addition of solids from nonconductive plastic bags can be hazardous, even if the solids are noncombustible (e.g.,
silica). Bags should be constructed of: static dissipative plastic or paper; paper and plastic in which the
nonconductive plastic film is covered by paper on both sides, or antistatic plastic. Paper bags containing a
nonconductive coating on the inside surface are acceptable provided the coating is less than 2mm thick. Because
grounding clips can be impractical, such bags can be effectively grounded by contact with a grounded conductive
vessel, loading chute, or through by skin contact with a grounded operator, either by direct contact with the skin or by
means of static dissipative gloves. Where grounding is via the operator, static dissipative shoes should also be used
and it should be ensured that the floor surface resistance is less than $10^8$ ohms."

Substantiation: (1) Gloves are often required in process operations, meaning that direct skin contact may not be
possible; also, loading chutes are often used in solids transfer operations.

(2) The requirement for paper on both sides of a liner is not necessary, provided the internal plastic liner is <2 mm
thick and is securely attached to the paper so that it cannot leave the bag.

Committee Meeting Action: Accept
Technical Committee on Static Electricity,
Revise 9.11.1.4 (New 15.12.1.4) to read:
"Fiber drums or packages should not have a loose plastic liner that can leave the package and behave like a plastic bag. In some cases it may be possible to eliminate the flammable vapor atmosphere by cooling the liquid well below flash point prior to solids addition. However, where combustible powders are handled consideration must be given to the potential for formation of hybrid mixtures.

Substantiation: It is possible to remove the flammable atmosphere by cooling the liquid well below flash point prior to solids addition.
Committee Meeting Action: Accept

Technical Committee on Static Electricity,
Revise text to read as follows:
"Powder should not be emptied from any nonconductive container or plastic bag into a vessel that contains the presence of a flammable atmosphere.
First, powders are commonly emptied into vessels from plastic bags and this should be recognized in this paragraph. Second, the hazard being addressed here is the potential for an ignition of vapors inside the vessel, not, as currently written of a hazardous atmosphere outside the vessel.
Committee Meeting Action: Accept

Technical Committee on Static Electricity,
Add a new 9.12.3 (new 15.13.3) to read:
"In general the use of non-conductive containers for storage of combustible conductive powders should be avoided. Where this is not possible provision for grounding of the powder should be provided, for instance, by inserting a grounded rod into the container prior to filling."

Substantiation: Consideration must be given to earthing of conductive powders when handled in nonconductive containers.
Committee Meeting Action: Accept

Technical Committee on Static Electricity,
Revise 10.1.2.2 (New 16.2.2) to read:
"Brush discharge usually is not a concern in the normal handling of granular materials. However, brush discharge can be a source of ignition where flammable gases or vapors are present, as in the handling of hybrid mixtures or very rapid discharge of a granular material from a container. Such situations should be avoided if possible."

Substantiation: The statement that “brush discharge can be a source of ignition...[where there is] very rapid discharge of granular material from a container” makes no sense here since it does not appear to refer to flammable or hybrid mixtures, but only coarse granular materials.
Committee Meeting Action: Accept
Technical Committee on Static Electricity,

Revise 10.1.2.4 (New 16.2.4) to read:

"Bulking brush discharges are believed to have an upper energy limit of 30 mJ in conductive containers less than 3 m in diameter; higher values may be possible for nonconductive containers. Bulking brush discharges contain energies on the order of 10 mJ. To minimize the risks associated with bulking brush discharge, powders that have minimum ignition energies (MIEs) of 10 mJ or less should be loaded only into containers of 2 m³ or less, unless the vessel is inerted."

Substantiation: Bulking brush discharges have been shown to have energies in excess of 10 mJ, although there is much controversy regarding the effective energy in such discharges. An upper limit of 20-30 mJ is believed possible for conductive containers up to 3 m in diameter; higher values are possible for insulative containers, where the discharge path length can be twice as large.

Committee Meeting Action: Accept

Submitter: Technical Committee on Static Electricity,

Revise 10.1.3.1 (New 16.3.1) to read:

"In general the formation of combustible dust clouds is not possible for spherical particles greater than 420 microns in diameter. However, attrition of coarse particles during processing can result in fine particles which are capable of forming such clouds. The presence of fine particles in 'as received' coarse granular material should also be considered. Particles consisting of fibrids and very thin flakes might be capable of forming combustible dust clouds even if their major dimension is greater than 420 microns. If a granular material contains only particles larger than 420 m, then ignitable dust clouds cannot be formed. However, if a granular material consists of fine particles or contains an appreciable fraction of fine particles, then ignitable dust suspensions can be formed and ignition sources cannot be tolerated.

Substantiation: This statement is confusing and inconsistent with the NFPA 654 definition of combustible dust. It does not allow that processing of granular material may result in particle attrition that can form fine dusts capable of combustion.

Committee Meeting Action: Accept
Report on Proposals – June 2013

Final Action: Accept

77-105  Log #CP108
(10.1.6 and 10.1.7 (New 16.6))

Submitter: Technical Committee on Static Electricity,
Recommendation: Replace the current Sections 10.1.6 and 10.1.7 with new 16.6 to read as follows:

*****Insert Include 77_LCP108 Rec Here*****

Substantiation: This rewrite correlates with internationally accepted recommendations for flexible intermediate bulk containers, as set forth in IEC 61340-4-4.
Committee Meeting Action: Accept

77-106  Log #CP104
(10.2.3.3 (New 17.3.3))

Submitter: Technical Committee on Static Electricity,
Recommendation: Revise 10.2.3.3 (New 17.3.3) to read:
*Measurement of coating solution conductivity can provide additional data to determine static generation and dissipation characteristics. Solvent-based coatings having conductivities less than $10^{-4}$ pS/m should be carefully evaluated for their ability to dissipate charge. Flammable solvent-based inks and coatings should be considered nonconductive and, therefore, incapable of dissipating a charge. Conductivity enhancers in the ink or coating cannot be relied on to assist dissipation of charge at high processing speeds. Measurement of coating solution conductivity can provide additional data to determine static generation and dissipation characteristics.

Substantiation: The statement that “Flammable solvent-based inks and coatings should be considered nonconductive” isn’t necessarily true.
Committee Meeting Action: Accept
16.6 {10.1.6} Flexible Intermediate Bulk Containers (FIBCs).

16.6.1 {10.1.6.1} Description. Flexible intermediate bulk containers (FIBCs) are basically very large fabric bags supported in a frame. They are more convenient than rigid IBCs because they can be fully collapsed after use, taking up little storage space.

16.6.1.1 {10.1.6.1.1} The fabric is usually polypropylene and the fabric is sewn to form a three-dimensional cube or rectangle with lifting straps. An FIBC can be filled with a powder or granular material and moved about with conventional materials-handling equipment.

16.6.1.2 {10.1.6.1.2} An advantage of FIBCs is that they can be unloaded quickly, typically 300 kg to 500 kg in 30 sec or less. Therefore, rates at which static electric charges are generated can often exceed the rates at which the charges can relax under common conditions of use. Accumulation of a static electric charge can be expected.

16.6.2 {10.1.6.2} Charge Generation. Static electric charges can be generated during the filling and emptying of FIBCs and can accumulate on both the contents and the fabric of the FIBC. If the accumulated charge is strong enough and is released in the presence of an ignitible atmosphere, ignition can occur.

16.6.3 {10.1.6.3} Types of FIBCs and Their Inner Liners. International Standard IEC 61340-4-4, Standard Test Methods for Specific Applications - Electrostatic Classification of Flexible Intermediate Bulk Containers, describes four types of FIBCs: Type A, Type B, Type C, and Type D, defined by the construction of the FIBCs, the nature of their intended operation, and associated performance requirements. FIBCs should be tested in accordance with the requirements and test procedures specified in IEC 61340-4-4 and in accordance with their intended use before being used in hazardous environments. See Table 16.6.3 for a summary of FIBC use, as described in 10.1.6.4 through 10.1.6.7. The subject of inner liners is not addressed in this Recommended Practice. Guidance on the safe use of inner liners is given in IEC 61340-4-

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<tr>
<th>Bulk product in FIBC</th>
<th>Surroundings</th>
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<td>Non-flammable atmosphere</td>
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<tr>
<td>MIE of dust(^a)</td>
<td></td>
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<tr>
<td>MIE &gt; 1 000 mJ</td>
<td>A,B,C,D</td>
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<tr>
<td>1 000 mJ ≥ MIE &gt; 3 mJ</td>
<td>B,C,D</td>
</tr>
<tr>
<td>MIE ≤ 3 mJ</td>
<td>C,D</td>
</tr>
</tbody>
</table>

\(^a\) MIE = Minimum Ignition Energy

\(^b\) \(\text{Type } D\)
NOTE 1  Additional precautions are usually necessary when a flammable gas or vapour atmosphere is present inside the FIBC, e.g. in the case of solvent wet powders.

NOTE 2  Non-flammable atmosphere includes dusts having a MIE > 1 000 mJ.

a Measured in accordance with IEC 61241-2-3, capacitive discharge circuit (no added inductance).
b Use of Type D shall be limited to Gas Groups C & D with MIE > 0.14 mJ.

16.6.4 {10.1.6.4}  Type A FIBCs.

16.6.4.1 {10.1.6.4.1}  Type A FIBCs are constructed of nonconductive materials (e.g., polypropylene fabric with polyester stitching) and have no special features incorporated in their design to control static electric discharge hazards. Type A FIBCs can be used for materials that do not form ignitable atmospheres in normal handling operations.

16.6.4.2 {10.1.6.4.2}  Experience has shown that propagating brush discharges can occur in Type A FIBCs. The energy released in propagating brush discharges can reach 1000 mJ. The following criteria apply:

(1) Type A FIBCs should not be used for powder or granular materials that have an MIE of less than 1000 mJ.

(2) Type A FIBCs should never be used in areas where a flammable gas or vapor is present.

(3) Type A FIBCs should not be used for conductive powders ($\rho_v < 1$ megohm-m).

16.6.5 {10.1.6.5}  Type B FIBCs.

16.6.5.1 {10.1.6.5.1}  Type B FIBCs, like Type A FIBCs, are constructed of nonconductive materials (e.g., polypropylene fabric with polyester stitching). However, the material of construction of Type B FIBCs is designed to have a breakdown voltage less than 6KV and hence control static electric discharge hazards.

16.6.5.2 {10.1.6.5.2}  Type B FIBCs are designed to avoid the occurrence of propagating brush discharges. Propagating brush discharges can only occur in FIBCs if the materials from which FIBCs are constructed have sufficient electrical strength to sustain high surface charge densities. Research has shown that propagating brush discharges cannot occur if the breakdown voltage of the materials used to construct FIBCs is less than 6 kV.

16.6.5.3 {10.1.6.5.3}  Filling charged, high resistivity powder into FIBCs may generate a region of very high space charge density within the heap of bulked powder. This leads to high electrical fields at the top of the heap. Under these circumstances, cone discharges running along the surface have been observed. Although cone discharge can occur in all forms of containers, including grounded conductive containers, cone discharges may have a much higher energy in Type B FIBCs than in grounded conductive containers, where the walls of the containers will be at close to zero potential. Energy calculations predict that, in Type B FIBCs, cone discharges might be incendiary to powders with MIE of up to 3 mJ.
16.6.5.4  Since Type B FIBCs have no mechanism for dissipating electrostatic charge, brush discharges might occur that can ignite flammable gases and vapors. The following criteria apply:

(1) Type B FIBCs should be made from materials with breakdown voltage less than 6 kV.
(2) Type B FIBCs should not be used for powder or granular materials that have an MIE of 3 mJ or less.
(3) Type B FIBCs should never be used in areas where a flammable gas or vapor is present.
(4) Type B FIBCs should not be used for conductive powders ($\rho_v < 1$ meghom-m).

16.6.6  Type C FIBCs.

16.6.6.1  Type C FIBCs are constructed entirely from conductive material or insulating material that contain fully interconnected conductive threads or tapes with specific spacing and can be treated the same as conductive IBCs, as specified in 16.4. It is essential that Type C FIBCs be grounded during filling and emptying operations.

16.6.6.2  FIBCs constructed of nonconductive fabric and containing woven, grounded, conductive filaments can be considered to be conductive. One type of FIBC has conductive filaments spaced less than 20 mm apart, each of which is connected at least once to its neighbor, preferably at both ends. They are intended to be grounded. Another type has conductive filaments or threads that form an interconnecting grid of not more than 50 mm mesh size. They also are intended to be grounded.

16.6.6.3  The recommendations for conductive IBCs given in 10.1.4 also apply to conductive FIBCs. A grounding tab that is electrically connected to the conductive material or threads is provided and is intended to be connected to a ground point when the FIBC is filled or emptied. The resistance between the conductive elements in the FIBC and the grounding tabs should be less than $1.0 \times 10^7$ Ω.

16.6.6.4  For FIBCs constructed of multi-layer materials, the resistance between the inside or outside surface of the FIBC and the grounding tabs should be less than $1.0 \times 10^7$ Ω. If the inside layer does not have a resistance to grounding tabs of less than $1.0 \times 10^7$ Ω, then the material should have a breakdown voltage of less than 6 kV. All layers of multi-layer materials should remain in firm contact during filling and emptying operations.

16.6.6.5  Materials used to construct inner baffles, other than mesh or net baffles, should meet the requirements stated in 16.6.6.3 and 16.6.6.4.

16.6.7  Type D FIBCs.

16.6.7.1  Type D FIBCs are constructed from fabrics and/or threads with special electrostatic properties to control discharge incendivity and are intended for use without grounding in the presence of flammable vapors or gases with MIE of 0.14 mJ or greater and with combustible powders, including those with ignition energies of 3 mJ or less.

16.6.7.2  Before being used in hazardous environments, Type D FIBCs should be qualified as safe, i.e. by demonstrating that no incendiary discharge can occur under normal operating conditions. IEC 61340-4-4 describes test procedures for ignition testing that can be used for this...
purpose.

16.6.7.3 {10.1.6.7.3} If Type D FIBCs are made from materials that have an insulating layer (e.g., coating, film, or lamination) on the inside of the container, the materials should have a breakdown voltage of less than 6 kV. All layers of multi-layer materials should remain in firm contact during filling and emptying operations.

16.6.8 {10.1.7} Liners for Flexible Intermediate Bulk Containers – Reserved
Technical Committee on Static Electricity,

**Recommendation:** Revise 10.2.4.2 (New 17.4.2) to read:

“Coating. Coating of web materials is done using both flammable and nonflammable liquids on a wide variety of equipment. Significant charge may be generated where high forces between rollers and web are present, such as in gravure coating, and where web slippage is present due to tension difference across the coating roller. This may result in a static ignition hazard where flammable coatings are used. High charge can also accumulate on the rubber backup roller and an electrostatic neutralizer may be needed if this poses an ignition hazard. Some coating processes can generate hazardous amounts of static electric charge due to their design, while others cause little effect. The operating conditions that cause high rates of charge generation include high forces between rollers and the web, such as in gravure coating. This high rate of generation is aggravated by maintaining a tension difference across the coating roller, which causes slippage. The result is a sizable charge at the point where a large amount of ignitable vapor and a large liquid surface area are present. The rubber backup roller can accumulate enough electrostatic charge to present an ignition hazard. An electrostatic charge neutralizer might be needed on the roller.

**Substantiation:** Editorial improvement. The comments in this section apply to coating operations in general, although the way in which it is worded seems to imply that it only applies to flammable coating operations.

**Committee Meeting Action:** Accept

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**Submitter:** Technical Committee on Static Electricity,

**Recommendation:** Delete both 10.2.4.5.1 (New 17.4.5.1) and 10.2.4.5.2 (New 17.4.5.2).

**Substantiation:** These two paragraphs address issues which are outside the scope of NFPA 77.

**Committee Meeting Action:** Accept
Technical Committee on Static Electricity,

Replace the current 10.2.5 (New 17.5) with the following:

"17.5. (NEW) Control of Static Electricity in Web Processes.

17.5.1 Charging in Web Handling Operations. Charging of webs may occur during unwinding, travel over rollers, pressing between rolls, or contact with coating rolls. Charging will generally increase with increasing web speed, tension, and roller wrap angle; a finer roll surface finish will enhance charging by increasing the area of roll/web contact. Web slippage over roll surfaces, caused by differential web speed or roll malfunction, may also significantly increase charging.

17.5.2 Potential Hazards of Charged Webs.

17.5.2.1 Static charges on a web may result in brush discharges from the web or spark discharges from ungrounded machine components or personnel which have become inductively charged as a result of their close proximity to the web. Such discharges may present shock hazards to operators or lead to fires in flammable coating operations and gravure printing.

17.5.2.2 For flammable operations, mechanical ventilation can be used in order to dilute vapors to a safe concentration well below the lower flammable limit (LFL). “Pumping” of vapors by the moving web at higher speeds may increase the volume over which such an atmosphere may be present. Vapors will always be within the flammable range close to the point of coating application; this volume should be minimized by capturing vapors as close to their source as possible. Equipment should be interlocked to shut down upon ventilation system failure or if vapor concentration becomes too high.

17.5.3 Static Charge Control

17.5.3.1 Conductive Components. Items which may become potential ignition sources via induction charging include ungrounded conductive machine components, conductive objects on or in the web, and personnel in close proximity to the operation. All conductive parts of the machine should be grounded in order to prevent them from becoming a potential spark source due to inductive charging; resistance to ground from fixed metallic objects should not exceed 10Ω.

17.5.3.1.1 The resistance to ground of rollers should be determined upon initial installation and verified periodically thereafter. Resistance should not exceed 1 megohm. Since lubricant films can significantly increase resistance (as the bearings “float” on the lubricant), measurement should be performed during operation. The grounding of conductive rollers may also be compromised by non-conductive bearing lubricants or excessive bearing clearances, as well as build up of dirt or rust over time. Rolling or sliding contacts, such as conductive brushes, can be used to ground rollers in cases where an acceptably low resistance cannot be obtained.

17.5.3.1.2 Isolated conductive objects on or in the film may become inductively charged by the web and present a sparking hazard. Grounding of such objects, where possible, will prevent this.

17.5.3.2 Non-Conductive Webs. Grounding of non-conductive webs is not possible and other methods are necessary for static control. Existing processes should be audited to determine where significant charge is being generated. Measurements may be made with an electrostatic fieldmeter for web sections well away from grounded objects, such as rollers.

17.5.3.2.1 The first goal of a static-control program should be to minimize charge generation. Possible methods include minimizing web tension (but not to the extent that slippage occurs), ensuring that idler rollers have clean surfaces and are freely-rotating, minimizing web slippage, and increasing roller surface roughness. Non-conductive roller covers can acquire significant charge and should be replaced with static-dissipative covers where possible; otherwise the use of non-conductive covers which will minimize contact charging with the web material.

17.5.3.2.2 Humidification is sometimes used to reduce static charge on non-conductive objects by providing a monolayer of moisture that decreases surface resistivity, enhancing charge dissipation. This is often not possible in web handling operations since the speed of the operation does not allow sufficient time for uptake of atmospheric moisture by the surface of the material. Also, many plastic web materials will not be significantly affected by moisture even with extended exposure time. For these reasons humidification should not be relied upon as the sole method for static control in web handling processes, although in some cases higher humidity levels can be used to reduce static charge.

17.5.3.2.3 Ionization involves the use of devices which produce ions that neutralize surface charges and is the primary method used for static control on webs. Ionization devices may be needed at various points in a web handling system where charging occurs (reference existing figure). Such devices should extend across the full width of the web. Passive ionization involves the use of grounded tinsels, strings, needles, or brushes located a short distance (typically 5
to 25 mm) above the web. The electric field above the web is concentrated at the points of the tinsel, string, needle, or brush, resulting in breakdown and ionization of the surrounding air. Air ions having polarity opposite to charges on the web are attracted to the surface of the web, neutralizing the charge. Typically, this method can reduce surface potential to 0.5-3 kV. It is important that passive ionizing elements be positioned properly, grounded, and have points which are kept clean and sharp. Performance should be verified by periodic static charge measurements on the web downstream of the ionizer.

17.5.3.2.4 Active ionization involves the use of electrically-powered devices or radiological sources. AC ionizers are most commonly used and contain an array of high voltage pointed electrodes which emit both positive and negative air ions. Neutralization is achieved by the attraction of air ions having opposite polarity to surface charges on the web. The effectiveness of ionizers decreases greatly with distance from the web; for this reason ionizers are typically located about 25-50 mm from the web; forced air-assisted units (ionizing blowers) may be capable of neutralizing charge at somewhat greater distances. Ionizers should be located in a position so that ion flow will be towards the web rather than to nearby grounded surfaces and in accordance with manufacturers' recommendations. See Figure 17.5.3.2.4.

17.5.3.2.5 Performance of ionizers should be verified upon initial installation and periodically during use. Electrically-powered ionizers used in flammable vapor environments must be listed for the hazardous (classified) location in which they are installed.

17.5.3.2.6 It is particularly important to ensure that web charge is reduced to a safe level as it enters flammable coating stations. Potentially incendive brush discharges may occur if web surface charge density exceeds 10 C/m². To maintain a margin of safety, it is recommended that maximum indicated voltage above the web not exceed 5 kV as measured at a distance of 25 mm (field strength of 200 kV per meter).

17.5.3.2.7 An ionizer should be located as close as possible to where the web enters the coater. Surface charge should be continuously monitored after the ionizer and the process should be automatically shut down if safe electric field values are exceeded. An additional ionizer may also be required at the coater exit if charging can occurs at that point.

17.5.3.2 Personnel Personnel should be grounded, preferably by use of static-dissipative footwear and a static dissipative flooring surface.“

Substantiation: This rewrite of the section on web processes is primarily an editorial revision to clarify the presentation of the material and to cover topics not addressed previously.

Committee Meeting Action: Accept

77-110 Log #CP58 (10.2.5.3.5 (New 17.5.3.5)) Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: Revise the first sentence of 10.2.5.3.5 (New 17.5.3.5) to read: “The location of the initial inductive ionizer should be 100 mm to 150 ±75 mm from the roller tangent (i.e., web exit) point and 6 mm to 25 mm from the web.”
Substantiation: The 175 mm measurement is not correct; it does not match what is depicted in Figure 10.2.5.3.1 (new Figure 17.5.3.1).
Committee Meeting Action: Accept

77-111 Log #CP59 (10.4.2.2.2 (New 18.2.2.2.2)) Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: Relocate 10.4.2.2.2 (New 18.2.2.2.2) to a new location designated 18.2.4.3.
Substantiation: The subject of this text has to do with conveyor belts, not flat power transmission belts.
Committee Meeting Action: Accept

Printed on 3/15/2012 45
77-112 Log #CP52
(10.4.3.2 (New 18.2.3.2))
Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: Add the following to the end of this paragraph:
"(See CENELEC 60079-10, Electrical Apparatus for Explosive Gas Atmospheres - Part 10: Classification of Hazardous Areas.)"
Substantiation: the referenced document provides additional information to the user.
Committee Meeting Action: Accept

77-113 Log #CP90
(15.5.5 (New))
Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: Add a new 15.5.5 to read:
"Lightning-Like Discharges. While collection of individual particle charges to create a lightning-like discharge is seen in nature (thunderstorms, volcanic eruptions), such discharges have not been seen in industrial operations."
Substantiation: Dust cloud ignition is still sometimes erroneously attributed to 'lightning like' discharges; this should be dispelled.
Committee Meeting Action: Accept

77-114 Log #CP93
(15.8.3 (New))
Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: Add a new 15.8.3 to read:
"Conductive or static dissipative hoses should be used for transport of combustible dust and in situations where a flammable external atmosphere may exist. It should be ensured that such hoses are adequately connected to conductive end fittings and are properly grounded.
Substantiation: It should be stated that only conductive or static-dissipative hoses should be used for combustible dusts or where there potentially is a combustible or flammable external atmosphere.
Committee Meeting Action: Accept

77-115 Log #CP60
(A.8.4.1 (New A.10.1))
Final Action: Accept

Submitter: Technical Committee on Static Electricity,
Recommendation: In the third sentence, replace the phrase "charging current" with "streaming current".
Substantiation: Correction of error in terminology.
Committee Meeting Action: Accept
Report on Proposals – June 2013

77-116 Log #CP113 (Table B.1) Final Action: Accept

**Submitter:** Technical Committee on Static Electricity,
**Recommendation:** Correct the entries for LMIE in Table B.1 in accordance with the following:

****Insert 77_LCP113_Tbl Here****

Lowest MIE = lowest minimum ignition energy measured at optimum concentration
(a) = Lowest MIE calculated using heat of oxidation method
(b) = Lowest MIE is too high, measured at stoichiometric concentration, but is not amenable to calculation using heat of oxidation method.
**Substantiation:** This incorporates more recently developed data for the lowest minimum ignition energies of selected gases and vapors.
**Committee Meeting Action:** Accept

77-117 Log #1 (D.1.2) Final Action: Accept

**Submitter:** Cash Mason, Teck Cominco
**Recommendation:** Revise text to read as follows:
"...and toluene generates its lowest-MIE vapor air-mixture at about 26°C (4.1 percent)..."
**Substantiation:** Wrong data – please get your expert to check this out.
**Committee Meeting Action:** Accept

77-118 Log #11 (H.2.15.1.3) Final Action: Accept in Principle

**Submitter:** Steven J. Gunsel, SGTechnologies, LLC
**Recommendation:** Revise text to read as follows:
H.2.15.1.3 The unit of conductivity is ohms per meter (Ω/m). [note basis in reciprocal of resistivity with units of ohm-meters; mhos ohms per meter is the same as siemens per meter (S/m)]. Some authors express volume resistivity data in terms of ohm-m (100 ohm-cm = 1 ohm-m).
**Substantiation:** Conductivity is the reciprocal of resistivity. Resistivity is usually stated in ohm-cm or ohm-m. The reciprocal of ohm-m is NOT ohm/m, but 1/(ohm-m). Mho is the symbol for 1/ohm. Note: 1 mho = 1 siemen = 1/ohm; therefore mho/m = siemens per meter
**Committee Meeting Action:** Accept in Principle
Delete H.2.15.1.3 entirely. See action on Proposal 77-16 (Log #CP12).
**Committee Statement:** The proposed action in Proposal 77-16 (Log #CP12) presents a more accurate and a more editorially clean means of addressing the concerns of the submitter.
**Flammability Data for Gases and Vapors**

*In dry air at 1 atm, 25°C except where indicated*

See footnotes for explanations of symbols

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<thead>
<tr>
<th>Gas/Vapor</th>
<th>LMIE = G (mJ)</th>
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</thead>
<tbody>
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<td>n-hexane</td>
<td>0.23</td>
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# Flammability Data for Gases and Vapors

In dry air at 1 atm, 25°C except where indicated

See footnotes for explanations of symbols

<table>
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<tr>
<th>Gas/Vapor</th>
<th>LMIE = G</th>
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Report on Proposals – June 2013

77-119     Log #8
(H.2.46)

Submitter: Steven J. Gunsel, SGTechnologies, LLC
Recommendation: Revise text to read as follows:

H.2.46 Ohm. The resistance of a circuit through which a current of 1 ampere will flow when a potential difference of 1 volt is applied across the current circuit.

OR

The unit of electrical resistance (R), which measures the resistance between two points of a conductor when a constant difference of potential of one volt between these two points produces in this conductor a current of one ampere.

Substantiation: The electrical potential across the resistance causes current to flow. An electrical potential of one volt causes a current of 1 ampere to flow through a resistance of 1 ohm. The first definition above corrects a mistake in terminology, the second definition is the preferred definition in NFPA Glossary of Terms.

This is not original material; its reference/source is as follows:

NFPA Glossary of Terms.

Committee Meeting Action: Accept in Principle

Delete H.2.46 entirely.

Committee Statement: The concept is adequately explained in the definition of "resistance" in H.2.50. This is a simpler means of meeting the submitter's intent.

77-120     Log #6
(H.2.50)

Submitter: Steven J. Gunsel, SGTechnologies, LLC
Recommendation: Revise text to read as follows:

The opposition that a device or material offers to the flow of direct current. The resistance in ohms is equal to the voltage drop, in volts, across the material element divided by the current, in amperes, through the material element for a purely resistive circuit, also known as electrical resistance.

Substantiation: Resistance applies equally to both alternating and direct currents. The use of Ohm’s law for calculating the value of a resistance in ohms applies to purely resistive loads only. When alternating currents are present, special precautions must be taken to allow for inductive and capacitive circuit elements to assure an accurate measurement.

Committee Meeting Action: Accept in Principle

Delete H.2.50 and add a new definition to new 3.3.35 to read:

"3.3.35 Resistance (R). The opposition that a material offers to the flow of current, expressed in ohms, which is equal to the voltage (V, volts) between two points divided by the current (I, amperes) that flows between those points."

Committee Statement: The proposed new definition is more accurate and meets the submitter’s intent. It has been relocated to Chapter 3, as the term "resistance" is used throughout the text. The Technical Committee notes that this definition is designated 3.3.35 in the Preprint.
Report on Proposals – June 2013

77-121 Log #7 Final Action: Accept in Principle
(H.2.51)

Submitter: Steven J. Gunsel, SG Technologies, LLC
Recommendation: Add new text to read as follows:

**Resistivity.** The intrinsic property of all materials that opposes the flow of electric current. A low resistivity (high conductivity) indicates a material that readily allows the movement of electrical charge. The resistivity on the surface of a material often differs from the resistivity through a volume of the same material. The resistance of a material depends on its resistivity and geometry. Resistivity is the reciprocal of conductivity.

Substantiation: Resistivity is a fundamental property that is critical to defining and understanding resistance. “Resistance” is used repeatedly throughout this document and proper understanding of the term is important to assure correct implementation. The definitions for surface resistivity and volume resistivity should also be improved.

Committee Meeting Action: Accept in Principle

Delete H.2.51 Heading and add a new definition of “resistivity” to 3.3.36 to read:

“3.3.36 **Resistivity.** The intrinsic property of a homogeneous material that opposes the flow of electric current. A low resistivity (high conductivity) indicates a material that readily allows the movement of electrical charge. The resistivity across the surface of a material will differ from the resistivity through a volume of the same material. Also, the resistance of a material depends on its resistivity and its geometry. Resistivity is the reciprocal of conductivity.”

Committee Statement: The Technical Committee’s version is more technically accurate and meets the submitter’s intent.

77-122 Log #5 Final Action: Accept in Principle
(H.2.51.1)

Submitter: Steven J. Gunsel, SG Technologies, LLC
Recommendation: Revise text to read as follows:

**H.2.51.1 Surface Resistivity.** The resistivity resistance of the surface of a material an insulator, in ohms per square, as measured between the opposite sides of a square on the surface reported in units of ohms or in ohms per square and whose value in ohms is independent of the size of the square or the thickness of the surface film. The resistivity of a surface can differ from the volume resistivity of a material due to surface contamination, chemical reactivity, and atmospheric moisture. Common electrode arrangements for measuring surface resistivity of a solid material include: parallel electrodes, coaxial electrodes, a four point probe, and the van der Paaw method.

Alternate: surface resistivity, resistance across opposite sides of a surface of unit length and unit width commonly expressed in ohms (or ohms/square). Measurement of surface resistivity depends upon selection of the appropriate test procedure.

Substantiation: The existing definition of surface resistivity is incomplete and does not include common measurement techniques.

Committee Meeting Action: Accept in Principle

Accept in principle by means of Proposal 77-37 (Log #CP29).

Committee Statement: See Proposal 77-37 (Log #CP29).
Submitter: Steven J. Gunsel, SG Technologies, LLC

Recommendation: Revise text to read as follows:

H.2.51.2 Volume resistivity. The intrinsic property resistance of a sample of material that opposes the flow of electric current through the material, expressed in ohm-meters or ohm-cm, having unit length and unit cross sectional area.

Substantiation: The resistance of an object is a function of its resistivity and geometry.

Committee Meeting Action: Accept in Principle

Delete H.2.51.2 entirely.

Add a new definition of “volume resistivity” to 3.3.36.2 to read as follows:

"3.3.36.2 Volume Resistivity. The intrinsic property of a material that offers resistance to the flow of electric current through the material, expressed in ohm-meters (ohm-m) or ohm-centimeters (ohm-cm).

A.3.3.36.2 The resistance of an object is a function of its resistivity and its geometry. Typical test procedures include ASTM D991, Standard Test Method for Rubber Property-Volume Resistivity of Electrically Conductive and Antistatic Products, and D257, Standard Test Methods for DC Resistance or Conductance of Insulating Materials."

Committee Statement: Since this term is used throughout the text of NFPA 77, it is appropriate that it be defined in Section 3.3 and not in Annex H. The Technical Committee has provided a new definition that is more technically accurate and that includes appropriate test procedures.

——

77-124 Log #CP112 Final Action: Accept

(Annex I, Bibliography (New))

Submitter: Technical Committee on Static Electricity.

Recommendation: Add a new Annex I Bibliography to read:

BIBLIOGRAPHY for NFPA 77 - 2000
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
Redesignate current Annex I as Annex J.

Substantiation: The Technical Committee has determined that a bibliography of books, monographs, etc. on the subject of static electricity will be a benefit to the user.

Committee Meeting Action: Accept
Submitter: Technical Committee on Static Electricity,

Recommendation: Redesignate "Annex I" as "Annex J" and revise to read as follows:

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

J.1.2 Other Publications.

J.1.2.1 AIChE Publications. American Institute of Chemical Engineers, 3 Park Avenue, New York, NY 10016-5901.

J.1.2.2 ANSI Publications. American National Standards Institute, Inc., 11 West 43rd Street, 4th Floor, New York, NY 10036.

J.1.2.3 API Publications. American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005.

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

J.1.2.5 CENELEC Publications. European Committee for Electrotechnical Standardization (CENELEC), Rue de Stassart, 35, B - 1050 Brussels, Belgium.

J.1.2.6 NPCA Publications. National Paint and Coatings Association, 1500 Rhode Island Avenue, NW, Washington, DC 20005-5597.

J.2 Informational References. (Reserved)
J.3 References for Extracts in Informational Sections. (Reserved)

Substantiation: This proposal updates all referenced publications in Annex J (new designation) to their most current edition, in accordance with the Manual of Style for NFPA Technical Committee Documents.

Committee Meeting Action: Accept