National Fire Protection Association
1 Batterymarch Park, Quincy, MA 02169-7471
Phone: 617-770-3000 • Fax: 617-770-0700 • www.nfpa.org

TECHNICAL COMMITTEE ON STATIC ELECTRICITY

MEMORANDUM

TO: Technical Committee on Static Electricity

FROM: R. P. Benedetti

DATE: October 8, 2012

SUBJECT: Agenda for October 24 - 25, 2012 Meeting

Gentlemen:

Attached is the Agenda for the next meeting of the Technical Committee on Static Electricity, to be held October 24 and 25, 2012 at the Charleston Marriott Hotel, Charleston SC.

If you have anything to add to the agenda, please let me know as soon as possible.

rpb/

cc STA Meeting File
STA/NM

National Fire Protection Association
1 Batterymarch Park, Quincy, MA 02169-7471
Phone: 617-770-3000 • Fax: 617-770-0700 • www.nfpa.org

TECHNICAL COMMITTEE ON STATIC ELECTRICITY

AGENDA

Technical Committee on Static Electricity
Charleston Marriott Hotel
Charleston SC
Wednesday, October 24, 2012, 9:00 AM to 5:00 PM
Thursday, October 25, 2012, 9:00 AM to Noon

1. Call to Order.
2. Introduction of Attendees. Update of Committee Roster. [Attachment № A1]
3. Approval of Minutes of Last Meeting. [Attachment № A2]
4. Report of Committee Chair.
5. Report of Staff Liaison.
    - Technical Committee Membership. [Attachment № A3]
    - Annual 2013 Document Revision Schedule. [Attachment № A4]
6. Review and Action on Public Comments to *Report on Proposals* (ROP) for NFPA 77-2014. [NONE]
7. Review of Missing Section 5.3 of NFPA 77. [Attachment № A5 – C. Noll]
8. Review of Chapter 7 of NFPA 77. [Attachment № A6 – T. Wash]
9. Review of Replacement Material for Section 8.5 [Attachment № A7 – L. Britton & R. Gravell]
10. Chapter Reviews of NFPA 77.
11. Recent Correspondence. [NONE]
12. Other Old Business. [NONE]
13. New Business. [NONE]
14. Schedule Next Meeting(s).
15. Adjournment.

Address List No Phone

Static Electricity

Charles G. Noll **SE** 4/1/1996
Chair **STA-AAA**
XiPro Technologies LLC
370 North Main Street
Sellersville, PA 18960

Peter R. Apostoluk **M** 1/10/2002
Principal **STA-AAA**
Greif Inc.
366 Greif Parkway
Delaware, OH 43015

Laurence G. Britton **SE** 1/1/1983
Principal **STA-AAA**
Process Safety Consultant
848 Sherwood Road
Charleston, WV 25314

Vahid Ebadat **SE** 1/1/1992
Principal **STA-AAA**
Chilworth Technology Inc.
113 Campus Drive
Princeton, NJ 08540
Alternate: C. James Dahn

Stephen L. Fowler **SE** 3/4/2009
Principal **STA-AAA**
Fowler Associates, Inc.
3551 Moore-Duncan Highway
Moore, SC 29369

Robert L. Gravell **U** 7/29/2005
Principal **STA-AAA**
E. I. duPont de Nemours & Company, Inc.
Chambers Works Site
Explosion Hazards Laboratory
Mail Spot WWTP 'O'
Deepwater, NJ 08023

Steven J. Gunsel **SE** 1/1/1992
Principal **STA-AAA**
SGTechnologies, LLC
944 Southport Drive
Medina, OH 44256-3018

Raymond G. Hinske **U** 3/1/2011
Principal **STA-AAA**
ExxonMobil Research & Engineering Co.
3225 Gallows Road
Fairfax, VA 22037
American Petroleum Institute

Brian Minnich **M** 10/20/2010
Principal **STA-AAA**
Schuetz Container Systems
200 Aspen Hill Road
North Branch, NJ 08876

Robert Mitchell **RT** 3/2/2010
Principal **STA-AAA**
Intertek Testing Services
70 Codman Hill Road
Boxborough, MA 01719

Jeffrey S. Patton II **I** 8/9/2011
Principal **STA-AAA**
The Hanover Insurance Group
Verlan Fire Insurance
8403 Colesville Road, Suite 300
Silver Spring, MD 20910

Bernard T. Price **U** 3/2/2010
Principal **STA-AAA**
Alliant Techsystems (ATK)
8400 West 5400 South
Magna, UT 84044

James R. Reppermund **SE** 10/27/2009
Principal **STA-AAA**
15 Livingston Drive
Howell, NJ 07731

Douglas A. Rivord **M** 4/15/2004
Principal **STA-AAA**
Graco, Inc.
PO Box 1441
Minneapolis, MN 55440
Alternate: Michael T. Sherman

Lon D. Santis U 1/15/1999
Principal STA-AAA
Institute of Makers of Explosives
1120 19th Street NW, Suite 310
Washington, DC 20036
Alternate: John E. Capers

Michael L. Savage, Sr. E 10/27/2009
Principal STA-AAA
Middle Department Inspection Agency, Inc.
12136 Holly Road
Ridgely, MD 21660

Don Scarbrough SE 1/1/1983
Principal STA-AAA
550 Randall Road
Elyria, OH 44035

Thomas J. Wash M 8/9/2011
Principal STA-AAA
3M Company
3M Center, Building 224-6W-28
St. Paul, MN 55109-1000

Gene H. Wolfe U 10/1/1996
Principal STA-AAA
R. R. Donnelley & Sons
2971 173rd Place
Lansing, IL 60438

G. Thomas Work II U 3/1/2011
Principal STA-AAA
Dow Corning Corporation
2171 Bellview Lane
Rising Sun, IN 47040
NFPA Industrial Fire Protection Section

John E. Capers U 03/05/2012
Alternate STA-AAA
Austin Powder Company
62534 US Highway 50
McArthur, OH 45651
Institute of Makers of Explosives
Principal: Lon D. Santis

C. James Dahn SE 1/1/1992
Alternate STA-AAA
Safety Consulting Engineers Inc.
2131 Hammond Drive
Schaumburg, IL 60173
Principal: Vahid Ebadat

Michael T. Sherman M 08/09/2012
Alternate STA-AAA
Graco, Inc.
PO Box 1441
Minneapolis, MN 55410-1441
Principal: Douglas A. Rivord

Thomas H. Pratt SE 1/1/1992
Member Emeritus STA-AAA
Burgoyne Inc.
1020 Finsbury Drive
Roswell, GA 30075-1243

Robert P. Benedetti
Staff Liaison STA-AAA
National Fire Protection Association
1 Batterymarch Park
Quincy, MA 02169-7471

National Fire Protection Association
1 Batterymarch Park, Quincy, MA 02169-7471
Phone: 617-770-3000 • Fax: 617-770-0700 • www.nfpa.org

TECHNICAL COMMITTEE ON STATIC ELECTRICITY

MINUTES of MEETING

Technical Committee on Static Electricity
Fowler Associates
Moore SC
February 15, 2012

I. Attendance

P. R. Apostoluk, Greif Incorporated
L. G. Britton, Charleston, WV*
S. L. Fowler, Fowler Associates, Inc.
R. G. Hinske, ExxonMobil Research & Engineering Company (Rep. American Petroleum Institute)
C. G. Noll, XiPro Technologies LLC, CHAIR
J. S. Patton, The Hanover Insurance Group
T. H. Pratt, Burgoyne Inc., MEMBER EMERITUS
L. D. Santis, Institute of Makers of Explosives*
M. L. Savage, Middle Department Inspection Agency, Inc.*
D. Scarbrough, Elyria, OH*
M. T. Sherman, Graco, Incorporated
T. J. Wash, 3M Company
G. H. Wolfe, R. R. Donnelley & Sons*
G. T. Work, Dow Corning Corporation

*Attended via web conference service

R. P. Benedetti, National Fire Protection Association, STAFF LIAISON

GUESTS: J. King, Blitz USA
J. Privette, Barnet Polymers
R. Stemple, Barnet Polymers

I. Minutes

1. The meeting was called to order at 9:00 AM by Technical Committee Chair Chuck Noll.

2. Attendees introduced themselves. The Technical Committee roster was updated as necessary. An updated roster will be posted to the Technical Committee's web page.

3. The Minutes of the last meeting (August 2011, Fowler Assoc., Moore SC) were approved as submitted, with the correction that Mike Savage be added to the attendance list.

4. Technical Committee Chair Chuck Noll reviewed progress to date and tasks to be done.

5. The Staff Liaison reported on the following issues:
   - Technical Committee Membership Status.
   - The Annual 2013 Document Revision Schedule.

6. The Technical Committee reviewed and took action on all remaining public proposals to amend the 2007 edition of NFPA 77.

   The Technical Committee directed the Staff Liaison to circulate the letter ballot for the *Report on Proposals* (ROP) for the 2014 edition of NFPA 77.

7. The Technical Committee reviewed and approved the editorial preprint of the final draft of the proposed 2014 edition of NFPA 77.

8. There was no recent correspondence requiring the Technical Committee's attention.

9. The Technical Committee reviewed all items of old business. There were no items that required the Technical Committee's attention.

10. There were no items of new business requiring the Technical Committee's attention.

11. The Technical Committee scheduled its next meeting for October 24 & 25, 2012, in Charleston SC.

13. The meeting adjourned at 4:15 PM on February 15th.

National Fire Protection Association
1 Batterymarch Park, Quincy, MA 02169-7471
Phone: 617-770-3000 • Fax: 617-770-0700 • www.nfpa.org

TECHNICAL COMMITTEE ON STATIC ELECTRICITY

SCOPE STATEMENT

This Committee shall have primary responsibility for documents on safeguarding against the fire and explosion hazards associated with static electricity, including the prevention and control of these hazards. This Committee shall also have primary responsibility for conductive and static-dissipative floors, except as this subject is addressed by the Committee on Health Care Facilities.

Responsible for NFPA 77, *Recommended Practice on Static Electricity*.

COMMITTEE MEMBERSHIP BALANCE SUMMARY

Members:	21	M:	5 (24%)*	U:	6 (29%)**
Voting Alternates:	0	I/M:	0	L/C:	0
Alternates:	2	R/T:	1 (5%)	E:	1 (5%)
Non-Voting:	0	I:	1 (5%)	SE:	7 (33%)
Emeritus:	1				
Task Group:	0				
Hold List:	2	Balance:	OK		

*(containers: 2 control equipment: 2 spray application equipment: 1)

ATTACHMENT № A4

2013 ANNUAL REVISION CYCLE

	PROCESS STAGE	PROCESS STEP	DATES FOR TC	DATES FOR TCC	COMPLETION DATE	VERIFY MATERIAL IN FILE
1	PRELIMINARY	1.0 Notification of intent to enter cycle	7/8/11	7/8/11		
2	REPORT ON PROPOSALS (ROP)	2.1 Proposal closing date	11/25/11*	11/25/11*		
		2.2 Final date for ROP meeting	2/24/12	2/3/12		
		2.3 Final date for mailing TC ballots	3/16/12	2/17/12		
		2.4 Receipt of (TC) ballots by staff liaison	4/20/12	3/9/12		
		2.5 Receipt of TC recirculation ballots	5/4/12	3/16/12		
		2.6 Final date for TCC meeting		4/13/12		
		2.7 Final date for mailing TCC ballots		4/20/12		
		2.8 Receipt of TCC ballots		5/11/12		
		2.9 Receipt of TCC recirculation ballots		5/18/12		
		2.10 Final copy (w/ ballot statements) to Secretary, Standards Council	5/11/12	5/25/12		
		2.11 Completion of Reports	5/18/12	6/1/12		
		2.12 ROP Published and Posted	6/22/12	6/22/12		
3	REPORT ON COMMENTS (ROC)	3.1 Comment closing date	8/31/12	8/31/12		
		3.2 Final date for ROC meeting	11/2/12	10/5/12		
		3.3 Final date for mailing TC ballots	11/16/12	10/19/12		
		3.4 Receipt of (TC) ballots by staff liaison	11/30/12	11/9/12		
		3.5 Receipt of TC recirculation ballots	12/7/12	11/16/12		
		3.6 Final date for TCC meeting		12/14/12		
		3.7 Final date for mailing TCC ballots		12/21/12		
		3.8 Receipt of TCC ballots		1/11/13		
		3.9 Receipt of TCC recirculation ballots		1/18/13		
		3.10 Final copy (w/ ballot statements) to Secretary, Standards Council	12/21/12	1/25/13		
		3.11 Completion of Reports	1/11/13	2/1/13		
		3.12 ROC Published and Posted	2/22/13	2/22/13		
4	TECH SESSION PREPARATION & ISSUANCE OF CONSENT DOCUMENTS	4.1 Notice of Intent to Make a Motion (NITMAM) Closing Date	4/5/13	4/5/13		
		4.2 Posting of Filed NITMAM	5/3/13	5/3/13		
		4.3 Appeal Closing Date for Consent Documents	5/18/13	5/18/13		
		4.4 Council Issuance Date for Consent Documents	5/28/13	5/28/13		
5	TECHNICAL SESSION	5.0 Association Meeting for Documents with Certified Amending Motions	6/9-13/13	6/9-13/13		
6	APPEALS & ISSUANCE OF DOCUMENTS W/CAMS	6.1 Appeal closing date for Documents with Certified Amending Motions	7/3/13	7/3/13		
		6.2 Council issuance for Documents with Certified Amending Motions	8/1/13	8/1/13		

* Proposal Closing Dates may vary according to documents and schedules for Revision Cycles may change. Please check the NFPA website (www.nfpa.org) for the most up-to-date information on proposal closing dates and schedules.

5.3 {5.2} Accumulation and Dissipation of Charge.

5.3.1 {5.2.1} A static electric charge will accumulate where the rate at which charges separate exceeds the rate at which charges recombine. Work must be done to separate charges, and there is a tendency for the charges to return to a neutral state. The potential difference, that is, the voltage, between any two points is the work per unit charge that would have to be done to move the charges from one point to the other. This work depends on the physical characteristics (that is, shape, size, and nature of materials and location of objects) of the particular system and can be expressed by the following equation:

$$C = Q/V$$

where:

C = capacitance (farads)
Q = charge that has been separated (coulombs)
V = potential difference (volts)

5.3.2 {5.2.2} Typical examples of accumulation are illustrated in Figure 5.3.2. (See also Table A.3.3.5.)

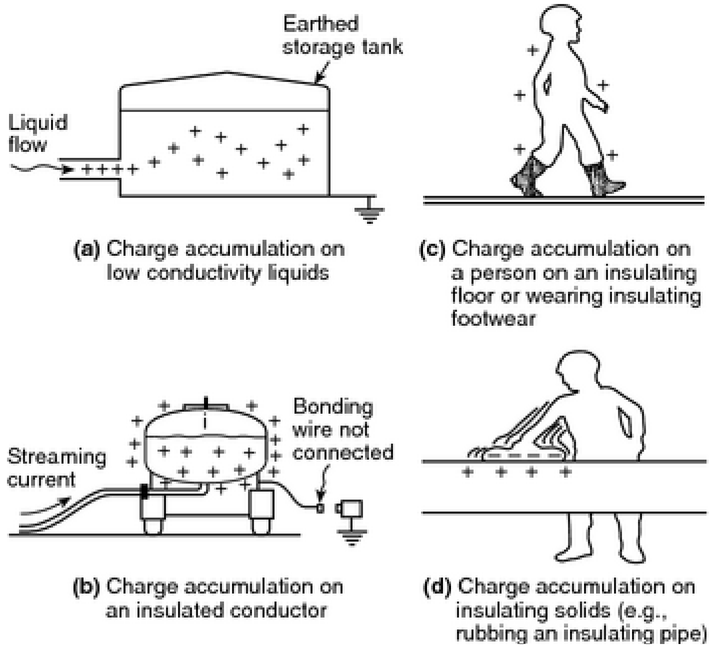

FIGURE 5.3.2 {Figure 5.2.2} Examples of Charge Accumulation.
(Source: H. L. Walmsley, Avoidance of Electrostatic Hazards in the Petroleum Industry, p. 37.)

5.3.3 {5.2.3} Separation of electric charge might not in itself be a potential fire or explosion hazard. There must be a discharge or sudden recombination of the separated charges to pose an ignition hazard. One of the best protections from static electric discharge is a conductive or semiconductive path that allows the controlled recombination of the charges.

5.3.4 {5.2.4} In static electric phenomena, charge is generally separated by a resistive barrier, such as an air gap or insulation between the conductors, or by the insulating property of the materials being handledor processed. In many applications, particularly those in which the materials being processed are chargedinsulators (nonconductors), it is not easy to measure the charges or their potential differences.

5.3.5 {5.2.5} Where recombining 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*, τ.

This relaxation process is typically exponential and is expressed by the following equation:

$$Q_t = Q_0 e^{-t/\tau}$$

where:

Q_t = charge remaining at elapsed time t (coulombs)
Q_0 = charge originally separated (coulombs)
e = base of natural logarithms = 2.718
t = elapsed time (seconds)
τ = charge relaxation time constant (seconds)

5.3.6 {5.2.6} The rate of charge recombination depends on the capacitance of the material and its resistance and is expressed as follows:

$$\tau = RC$$

where:

τ = charge relaxation time constant (seconds)
R = resistance (ohms)
C = capacitance (farads)

5.3.7 {5.2.7} For bulk materials, the relaxation time is often expressed in terms of the volume resistivity of the material and its electrical permittivity as follows:

$$\cancel{\tau = \rho\varepsilon\varepsilon_0} \qquad \underline{\tau = \rho\varepsilon}$$

where:

τ = charge relaxation time constant (seconds)
ρ = volume resistivity of the material (ohm-meters)
$\cancel{\varepsilon\varepsilon_0}$ $\underline{\varepsilon}$ = electrical permittivity of material (farads per meter)

5.3.8 {5.2.8} The exponential decay model described in 5.3.5 {5.2.5} is helpful in explaining the recombination process but is not necessarily applicable to all situations. In particular, nonexponential decay is observed where the materials supporting the charge are certain low-conductivity liquids or powders composed of combinations of insulating, semiconductive, and conductive materials. The decay in such cases is faster than the exponential model predicts.

5.3.9 {5.2.9} Dissipation of static electric charges can be achieved ~~effected~~ by modifying the volume or surface resistivity of insulating materials with antistatic additives, by grounding isolated conductors, or by ionizing the air near insulating materials or isolated conductors. Air ionization involves introducing mobile electric charges (positive, negative, or both) into the air around the charged objects. The ions are attracted to the charged objects until the charges on the objects are neutralized. The ion current in the air serves as the mechanism that brings the neutralizing charge to the otherwise bound or isolated charge.

Formatted: Space After: 0 pt

ground vary from application to application. Chapters 7 through 10 provide examples of acceptable grounding practices.

6.8.6 The resistance to ground is measured with an ohmmeter or a megohmmeter. Care should always be taken to avoid ignition hazards by using ~~use~~ appropriate instruments or procedures, ~~to avoid ignition hazards~~ based on the classification of the area.

6.9 Measuring Spark Discharge Energies.

6.9.1 The spark discharge energy for conductors is determined from the voltage on the conductor and its capacitance and is expressed by the following equations (which were also given in 5.4.3.1 ~~5.3.3.3~~):

$$W = \frac{1}{2}CV^2$$

$$W = \frac{1}{2}\left(\frac{Q^2}{C}\right)$$

where:

W = energy (joules)
C = capacitance (farads)
V = potential difference (volts)
Q = charge (coulombs)

6.9.2 A capacitance meter often can be used to measure electrostatic charge storage capacity where the charge is stored on a conductive element.

6.10 Measuring Ignition Energies.

6.10.1 Any combustible solid (e.g., dust), liquid, vapor ~~(vapor)~~, or gas should be evaluated for its potential as an ignitible atmosphere in the presence of discharges of static electricity. This evaluation requires determining the MIE of the material. Some data on MIE can be found in Table B.1.

6.10.2 Standardized test equipment and procedures have been developed for measuring the MIEs of particulate and gaseous materials. The equipment is highly specialized and requires trained technicians for its operation. Typically, the equipment is operated and maintained by specialized testing firms.

Chapter 7 Control of Static Electricity and Its Hazards by Process Modification and Grounding

7.1 General.

7.1.1 The objective of controlling a static electricity hazard is to provide a means whereby charges, separated by whatever cause, can recombine harmlessly before discharges can occur.

7.1.2 Ignition hazards from static electricity can be controlled by the following methods:

(1) Removing the ignitible mixture from the area where static electricity could cause an ignition-capable discharge

(2) Reducing charge generation, charge accumulation, or both by means of process or material ~~product~~ modifications

(3) Neutralizing the charges, the primary methods of which are grounding isolated conductors and air ionization

Formatted: Highlight

Comment [GTW1]: Should there be a comment or explanation somewhere in the document that defines Product Modification? I'm guessing we are talking about things like adding a conductive polymer or other conductive ingredient. Maybe refer them to 7.4.3. .

7.2 Control of Ignitible Mixtures in Equipment.

7.2.1 General. Despite efforts to prevent accumulation of static electric charges through good design, many operations that involve the handling of nonconductive materials or nonconductive equipment do not lend themselves to engineered solutions. It then becomes desirable or essential, depending on the nature of the materials involved, to provide other measures, such as one of the following:

(1) Inerting of the equipment

(2) Ventilation of the equipment or the area in which it is located

(3) Relocation of the equipment to a safer area

Formatted: Space After: 0 pt

7.2.2 Inerting.

7.2.2.1 Where an ignitible mixture is contained, such as in a processing vessel, the atmosphere can be made oxygen deficient by introducing enough inert gas (e.g., nitrogen or combustion flue gas) to make the mixture nonignitible. This technique is known as *inerting*.

7.2.2.2 Where operations are normally conducted in an atmosphere containing a mixture above the upper flammable limit (UFL), it might be practical to introduce the inert gas only during those periods when the mixture passes through its flammable range. NFPA 69, *Standard on Explosion Prevention Systems*, contains requirements for inerting systems.

7.2.3 Ventilation. Mechanical ventilation can be used to dilute the concentration of a combustible material to a point well below its lower flammable limit (LFL), in the case of a gas or vapor, or below its minimum explosible concentration (MEC), in the case of a dust. Usually, such a reduction means dilution to a concentration at or below 25 percent of the lower limit. Also, by properly directing the air movement, it might be practical to prevent the material from approaching an area of operation where an otherwise uncontrollable static electricity hazard exists.

7.2.4 Relocation. Where equipment that can accumulate a static electric charge is unnecessarily located in a hazardous area, it might be possible to relocate it to a safe location rather than to rely on other means of hazard control.

7.3 Control of Static Electric Charge Generation. Electric charges separate where materials are placed in contact and then pulled apart. Reducing process speeds and flow rates reduces the rate of charge generation. Such charge separation is found where plastic parts and structures, insulating films and webs, liquids, and particulate material are handled. If the material flows at a slow enough rate, a hazardous level of excess charge does not normally accumulate. This means of static electricity control might not be practical due to processing requirements. *(See Chapters 8 through 18 ~~10~~ for recommended practices in specific applications.)*

7.4 Charge Dissipation.

7.4.1 Bonding and Grounding. Bonding is used to minimize the potential difference between conductive objects, even where the resulting system is not grounded. Grounding (i.e., earthing), on the other hand, equalizes the potential difference between the objects and the earth. Examples of bonding and grounding are illustrated in Figure 7.4.1.

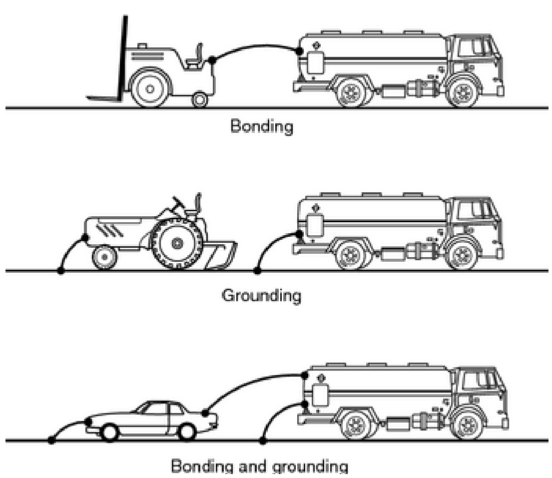

FIGURE 7.4.1 Bonding and Grounding.

7.4.1.1 A conductive object can be grounded by a direct conductive path to earth or by bonding it to another conductive object that is already connected to the ground. Some objects are inherently bonded or inherently grounded because of their contact with the ground. Examples of inherently grounded objects are underground metal piping and large metal storage tanks resting on the ground.

Formatted: Space After: 0 pt

7.4.1.2 The total resistance between a grounded object and the soil is the sum of the individual resistances of the ground wire, its connectors, other conductive materials along the intended grounding path, and the resistance of the ground electrode (i.e., ground rod) to the soil. Most of the resistance in a ground connection exists between the ground electrode and the soil. This ground resistance is quite variable because it depends on the area of contact, the resistivity of the soil, and the amount of moisture present in the soil.

7.4.1.3 To prevent the accumulation of static electricity in conductive equipment, the total resistance of the ground path to earth should be sufficient to dissipate charges that are otherwise likely to be present. A resistance of 1 megohm (10^6 ohms) or less generally is considered adequate.

7.4.1.3.1 Where the bonding/grounding system is all metal, resistance in continuous ground paths typically is less than 10 ohms. Such systems include those having multiple components. Greater resistance usually indicates that the metal path is not continuous, usually because of loose connections or corrosion. A permanent or fixed grounding system that is acceptable for power circuits or for lightning protection is more than adequate for a static electricity grounding system.
[Proposal 77-52, Log #3]

7.4.1.3.1.1 In field-based situations such as "HAZMAT" hazardous response operations or control of spills of flammable or combustible materials, 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 can be used, such as rods, plates, and wires, which are sometimes used in combination to increase the surface area of 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. [Proposal 77-52, Log #3]

7.4.1.3.2 Annex G contains diagrams of various grounding devices, connections, and equipment.

7.4.1.4 Where wire conductors are used, the minimum size of the bonding or grounding wire is dictated by mechanical strength, not by its current-carrying capacity. Stranded or braided wires should be used for bonding wires that will be connected and disconnected frequently. *(See Annex G for additional information.)*

7.4.1.5 Although grounding ~~Grounding~~ conductors can be insulated (e.g., a jacketed or plastic-coated cable) or uninsulated (i.e., bare conductors), ~~.~~ uninsulated ~~Uninsulated~~ conductors should be used because defects are easier to detect visually.

7.4.1.6 Permanent bonding or grounding connections can be made by brazing or welding. Temporary connections can be made using bolts, pressure-type ground clamps, or other special clamps. Pressure-type clamps should have sufficient pressure to penetrate any protective coating, rust, or spilled material to ensure contact with the base metal.

Comment [GTW2]: Add work "visually" for clarity?

Comment [GTW3]: Bolted connectors are frequently used in what would be considered a permanent installation. If PM and inspections are conducted wouldn't it be okay to consider these as permanent as well?

7.4.1.7 Workers should be grounded only through a resistance that limits the current to ground to less than 3 mA for the range of voltages experienced in the area. This method, referred to as *soft grounding,* is used to prevent injury from an electric shock from line voltages or stray currents.

7.4.2 Humidification.

7.4.2.1 The surface resistivity of many materials can be controlled by the humidity of the surroundings. At humidities of 65 percent and higher, the surface of most materials adsorbs enough moisture to ensure a surface conductivity that is sufficient to prevent accumulation of static electricity. When the humidity falls below about 30 percent, these same materials could become good insulators, in which case accumulation of charge occurs ~~increases~~.

7.4.2.2 While humidification does increase the surface conductivity of the material, the charge will dissipate only if there is a conductive path to ground.

7.4.2.3 Humidification is a not a cure-all for static electricity problems. Some insulators do not adsorb moisture from the air; high humidity, therefore, will not noticeably decrease their surface resistivity. Examples of such insulators are uncontaminated surfaces of some polymeric materials, such as plastic piping, containers, and films, and the surface of petroleum liquids. These surfaces are capable of accumulating a static electric charge even when the atmosphere has a humidity of 100 percent.

7.4.3 Charge Relaxation and Antistatic Treatments.

7.4.3.1 Based on their properties, liquid and solid materials carrying a static electric charge need time to dissipate, or "relax," the charge. In some cases, the materials can be allowed sufficient time for the charges to relax before being introduced into a hazardous area or process.

Formatted: Space After: 0 pt

7.4.3.2 Charge relaxation can occur only if a path to ground for conduction of the charge is available. Increasing the conductivity of the material will not eliminate hazards if the material remains isolated from ground.

7.4.3.3 A nonconductive material often can be made sufficiently conductive to dissipate static electric charge, either by adding conductive ingredients to its composition or by applying hygroscopic agents to its surface to attract atmospheric moisture.

7.4.3.4 Carbon black can be added to some plastics or rubbers to increase conductivity. Carbon-filled plastics and rubber articles are sometimes sufficiently conductive to be grounded like metal objects. Antistatic additives can also be mixed with liquid and particulate streams to foster charge relaxation.

7.4.3.5 In some cases, particularly with plastic films or sheeting, a material is added to attract atmospheric moisture to the surface, thus increasing surface conductivity. Care should be taken where antistatic plastic film or sheeting is used in low-humidity conditions. In environments with less than 30 percent humidity, film or sheeting can become nonconductive and accumulate static electric charge.

7.4.3.6 Topical hygroscopic coatings attract atmospheric moisture and make the surface of the coated material conductive. However, such coatings can be easily washed away or rubbed off or can lose effectiveness over time. This type of coating should be considered only as a temporary measure to reduce accumulation of static electric charge.

7.4.3.7 Conductive polymers, laminates with conductive elements, and metallized films have been developed for improved static dissipation.

Chapter 8 Control of Static Electricity and Its Hazards by Static Eliminators and Personnel Factors

8.1 {7.5} Charge Neutralization by Ionization of Air.

8.1.1 {7.5.1} General. Air can be made to contain mobile ions that are attracted to surfaces and will eliminate unbalanced static electric charge from those surfaces. In using air ionizers, certain factors that can influence their effectiveness must be considered, such as environmental conditions (e.g., dust and temperature) and positioning of the device in relation to the material processed, machine parts, and personnel. It is important to note that these control devices do not prevent the generation of static electric charge. They provide ions of opposite polarity to neutralize the generated static electric charge.

8.1.2 {7.5.2} Inductive Neutralizers.

8.1.2.1 {7.5.2.1} Inductive neutralizers include the following:

(1) Needle bars, which are metal bars equipped with a series of needlelike emitters
(2) Metal tubes wrapped with metal tinsel
(3) Conductive string
(4) Brushes made with metal fibers or conductive fibers

8.1.2.2 {7.5.2.2} The design of each type of inductive neutralizer is based on or consists of sharply pointed elements arranged for placement in the static electric field near the charged surfaces.

8.1.2.3 {7.5.2.3} A charge drawn from ground to the needlelike tips of an inductive neutralizer produces a concentrated electric field at the tips. If the tips are sharply pointed, the electrical field will be sufficient (i.e., greater than 3 kV/mm) to produce a localized electrical breakdown of the air. This electrical breakdown, known as corona, injects ions into the air that are free to move to distant charges of opposite polarity. The flow of ions produced in corona constitutes a neutralizing current. *(See Figure 8.1.2.3.)*

8.5 Storage Tanks. The following precautions should be taken where flammable atmospheres could be present in storage tanks.

8.5.1 Conductive and dissipative tanks and containers

Conductive and dissipative tanks are defined as vessels having less than 1 megohm resistance to ground. Measures to prevent hazardous accumulations of static charge when handling non-conductive liquids are based on tank geometry and size in accordance with Table 8.5.1.

Table 8.5.1 Tank Sizes and Definitions

	Vertical axis cylindrical tanks and non-cylindrical rectangular tanks with length to width ratio ≤ 1.5	Horizontal axis cylindrical tanks or non-cylindrical rectangular tanks with length to width ratio >1.5
Large tanks	D > 10 m	capacity >500 m^3 (125,000 gal)
Medium tanks	1.3 m < D ≤ 10 m	2 m^3 (500 gal) < capacity capacity ≤ 500 m^3 (125,000 gal)
Small tanks and containers	D ≤ 1,3 m	capacity ≤ 2 m^3 (500 gal).

D = diameter of cylindrical tank, m; for non-cylindrical rectangular tanks $D = 2(LW/\square)^{1/2}$

L = maximum linear dimension of non-cylindrical rectangular cross-section tank, m

W = minimum linear dimension of non-cylindrical tank rectangular cross-section tank, m

d = inlet fill line diameter, m

v = inlet liquid flow velocity, m/s

N = a factor describing the effect of tank length; N is 1 for tank lengths <2 m, $(L/2)^{1/2}$ for tank lengths of 2-4.6 m, and 1.5 where tank length is greater than 4.6 m

8.5.1.1 Large conductive or dissipative tanks. In all cases the following general precautions should be taken:

1. The tank and all associated structures such as pipes, pumps, and filter housings should be grounded.
2. Personnel entering or working near tank openings should be grounded.
3. Splash filling should be avoided.

8.5.1.2 Large Conductive or Dissipative Fixed roof tanks. For nonconductive liquids, the following general precautions should be taken:

1. Locate high charge generating elements (pumps, filters) a suitable residence time upstream of the tank inlet (see Section XXXXX)

2. For uncontaminated single-phase liquids restrict inlet flow velocity to 1 m/s until the fill pipe has been submerged to twice its diameter; fill rate may then be increased up to 7 m/s
3. Restrict inlet flow velocity to 1 m/s during the entire fill cycle for multi-phase or contaminated liquids and where it cannot be ensured that water bottoms will not be disturbed
4. Use of a centrally located inlet pipe extending close to the bottom of the tank is recommended; a horizontal tee is recommended at the discharge for bottom fill connections
5. Minimize accumulation of water and sediment in the tank
6. For multi-stage liquid loading addition of liquids in increasing order of density
7. In all cases a maximum flow velocity of 7 m/s is recommended

8.5.1.3 Tanks with floating roofs or internal floating covers. For tanks with floating roofs or with internal floating covers, the flow velocity should be restricted to 1 m/s until the roof has floated off its landing legs. At this time, the flammable atmosphere will be shielded from the potentials developed during filling by the floating roof or cover, provided the floating roof or cover is made from conductive material and is properly grounded.

Table XXX: Precautions for filling large conductive tanks with low conductivity liquids

Precautions	**Applicability to tank**	
	With floating roof or internal cover	**With fixed roof, no floating cover**
Keep flow velocities below 1 m/s	Essential until the roof or cover is afloat	Essential during the initial filling period, and when loading a contaminated or two phase liquid or a liquid with a substantially lower density than that already in the tank
Keep flow velocities below 7 m/s	Not essential when the roof or cover is afloat NOTE A flow rate limit will often be needed to avoid damaging the roof by too rapid movement.	Recommended in all cases in which the 1 m/s limit does not apply
Ensure an adequate residence time between strong charge generators (e.g. microfilters) and the tank	Essential until the roof or cover is afloat NOTE The residence time can be calculated using a velocity of 1 m/s in this instance.	Essential
Avoid disturbing water bottoms with incoming product, entrained air or by blowing out lines with gas	Essential until the roof or cover is afloat	Essential
Avoid charging low density liquids into tanks containing substantially higher density liquids (see 7.3.2.1.1)	Unnecessary	Recommended as far as practicable. If unavoidable keep the flow velocity below 1 m/s (see row 1 of this table)

8.5.1.4 Medium-sized conductive and dissipative tanks – Precautions for All Liquids

1. Follow recommendations in 8.5.1.1

2. Flow velocities should be kept within the limits outlined in Section 8.5.1.3

3. Do not clear lines with air or other gas unless it is certain that the operation will not overpressure the equipment.

8.5.1.4.1 Additional precautions for low conductivity liquids

1. Provide adequate residence time for charge relaxation between high charging elements (e.g., filters) and tank inlet
2. The level of water bottoms should be kept at least two pipe diameters below the inlet discharge.
3. The inlet should be designed to minimise the jetting of highly charge product to the surface and to minimise the disturbance of water bottoms or sediment. For example, use dip pipe for overhead filling or horizontal tee for bottom side entry filling
4. Splash Filling should be avoided by bottom filling or use of an inlet pipe extending close to the tank bottom or by bottom. A fill pipe directed towards the inner tank wall can be used where the process requires top filling. In such cases flow velocity should not exceed the lesser of 2 m/s or 50% of the flow velocity determined from the allowable velocity limit (Section 8.5.1.3) and the pipe discharge should be at least 200 mm above the maximum fill level

8.5.1.5 Flow velocity and flow rate limits

8.5.1.5.1 To prevent dangerous accumulation of static charge flow velocity must be limited throughout a relaxation region upstream of the tank. This region consists of the pipework where liquid has a residence time equal to the lesser of 30 seconds or 3 relaxation times. Relaxation time should be based on the liquid having lowest possible conductivity that may be handled. The 30 s criterion should be adopted where this is unknown.

8.5.1.5.2 To ensure that the velocity limits are met throughout the relaxation region it is necessary only to ensure that they are met over the most critical section within the region, which is the one with the smallest pipe diameter in an unbranched system. If the section having the smallest diameter is less than 5 m long and only one nominal pipe size less than the section having the next smallest diameter the latter may be taken as the critical one.

8.5.1.5.3 For branched systems (e.g. a large feeder line splitting into smaller lines such that the upstream pipe segments feed several tanks while downstream sections each feed just one tank), the critical section is the one with the highest value of F_s/d_s^m where F_s is the highest possible flow rate through the segment, d_s is the diameter of the pipe in the segment, and $m=3$.

8.5.1.5.4 Limits for fixed tanks. Allowable flow velocities are dependent on liquid conductivity and tank size and geometry. For medium and low conductivity liquids where there could be water bottoms or sediment present in the tank, the initial flow velocity should not exceed 1 m/s until the fill pipe outlet is submerged to two pipe diameters. If a tank is filled in a series of separate stages, a slow start of 1 m/s is recommended for each individual stage.

After the low initial filling rate or where such a period is not needed a maximum flow can be established

1. <u>Conductive and single-phase medium conductivity liquids</u>: A maximum flow velocity of 7 m/s is recommended
2. <u>Contaminated or two-phase medium or low conductivity liquids</u>: A maximum flow velocity of 1 m/s is recommended
3. <u>Uncontaminated single-phase low conductivity liquids</u>: For vertical-axis cylindrical tanks or rectangular tanks of near-square cross section maximum flow velocity should be the lesser of 7 m/s or $0.7(D/d)^{1/2}$ m/s; for horizontal-axis or rectangular tanks having L/W ☐ 1.5 the maximum velocity should be 0.5N/d for top loading or bottom loading without a central conductor or 0.38N/d for bottom loading without a central conductor. When filling multiple tanks through a branched line the critical section may occur at a location that feeds more than one tank. In this case, the maximum velocity in the critical section may be increased by a factor $N_s^{1/2}$ from the value given above, where N_s is the ratio of the maximum flow rate through the critical segment to the flow rate into the tank