We create chemistry **Beaumont Site Procedure**	**Title**: Grounding and Bonding		
	Function: Health and Safety		
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Document Revision Change Table

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Rev 01	Updated to current format	S.Simoneaux	10-26-09
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1. PURPOSE

This procedure establishes the minimum requirements for the use, maintenance, inspection and testing of grounding and bonding systems at the BASF Beaumont Plant.

2. DEFINITIONS

2.1. Grounding

Grounding is attachment of an object that connects a piece of electrical equipment to earth or some conducting body that serves in place of earth. A ground serves to complete the electrical circuit and prevent the hazard of electrical shock.

2.2. Bonding

Bonding is the joining of metallic parts to form an electrically conductive path. This path assures electrical continuity.

2.3. Equipment Grounding Conductor

Equipment grounding conductor is used to connect the non-current carrying metal parts of equipment, raceways, and other enclosures to the overall plant grounding system.

2.4. Structural Grounding System

Structural grounding system bonds the electrical system to an electrode by means of an unbroken wire called a grounding electrode conductor. AC systems operating at 50 volts or more must be grounded. Structural grounding prevents the occurrence of excessive voltages from such sources as lightning, line surges, or accidental contact with higher voltage lines.

2.5. Static Grounding System

Static grounding system bonds metallic parts to an electrically conductive path to prevent static electricity from causing a spark in the presence of flammable or explosive vapors, gases, or dusts or a combustible vapor or gas at a temperature above its flash point.

2.6. Ground Fault Circuit Interrupter (GFCI)

Ground-fault circuit interrupter (GFCI) is a device to de-energize a circuit when a current to ground exceeds a nominal level.

3. SCOPE

This procedure applies to all grounded and bonded systems at the BASF Beaumont Plant.

4. PROCEDURE

4.1. General Requirements

4.1.1. All grounding and bonding systems will be designed and installed in accordance with the latest BASF Corporate Engineering Technical Systems..

4.1.2. Only nonconductive containers with a capacity of five (5) gallons or less are allowed for handling flammable liquids at the BASF Beaumont Plant. Where nonconductive containers are used in the handling of flammable liquids, detailed work practices and procedures to control static electricity will be developed.

4.1.3. Grounding and bonding cables must be durable of low resistance.

- Connections of bonding contacts to process equipment must be direct and positive.
- Clamp contact to the conductive surface must not be inhibited due to paint, rust, or surface contaminants.
- Copper or stainless steel, aviation type, flexible cable and single point clamps will be used for portable equipment.

4.1.4. Dip pipes, bottom entry, low velocity transfer and other techniques shall be used where practical when handling flammable or explosive materials to minimize the buildup of static electricity.

4.1.5. Grounds and bonds will:

- Be permanent wherever possible.
- Have ample capacity to conduct any possible current flow. (*Note*: a ground should not be designed to be a part of the normal current-carrying circuit.)
- Be continuous, and wherever possible, made directly to the basic structure rather than through other bonded parts.
- Be secured so that vibration, expansion, contraction, or other movement will not break the connection or loosen it so that the resistance varies.
- Have connections located in protected areas and where accessible for inspection or replacement.
- Not impede movement of movable components.
- Not be compression-fastened through nonmetallic materials.
- Not have dissimilar metals in contact or be selected to minimize corrosion.

4.2. Equipment grounds

4.2.1. Equipment grounds may be used on the metal parts of a wiring system, such as the conduit, armor, switch boxes, and connected apparatus other than the wire, cable, or other circuit components. They may also be provided for equipment such as metal tables and cabinets that may come in contact with an energized circuit or source of electrical charges. Equipment on which undesirable charges may be induced or generated should also be grounded.

4.2.2. Control equipment:

- Ground the switchboard's framework and the metal parts of guards in accordance with NEC requirements.
- Insulate the floor area within the range of any live parts. Where equipment exposure is 600 volts or less, use special insulating mats or dry wood floors with no metal parts. The insulating mats will be moisture-resistant, nonconductive, and able to withstand mechanical abuses.

4.2.3. Motors:

- If current carrying parts of motors must be exposed and grounding is not possible, elevate them at least eight (8) feet above the work area or provide enclosures, barriers, or guards to prevent personnel from contacting them.
- Be aware of moisture's deteriorating affects upon motors. Not all electrical insulation acts as a barrier to moisture. Electrical resistance can drop to a point where current leaks through the insulation to ground. This can result in fire or electrical shock. If motor cannot be relocated, consult with manufacturer about drip-proof, splash proof, or enclosed design.

4.3. System grounding

4.3.1. System grounding at the BASF Beaumont Plant will be in accordance with National Electric Code using the grounding electrode specified in the NEC.

4.3.2. Once the grounded circuit conductor is taken beyond the service equipment, it must not be grounded at any point. The white, grounded circuit conductor must not be connected to the silver terminals and the green equipment-grounding terminals of a parallel U-blade receptacle. This does not double the grounding. It sets up a dangerous condition: If the neutral circuit is interrupted anywhere between the receptacle and its point of attachment to ground, any equipment enclosures that have been grounded by means of this receptacle will be energized at full-line voltage.

4.4. Equipment grounding

4.4.1. The equipment-grounding conductor:

- may be grounded continuously along its length.
- The conductor may be a bare conductor, the metal raceway surrounding the circuit conductors, or an insulated conductor.
- If insulated, it must have a continuous green cover or a green cover with a yellow stripe in it.
- Is always attached to the green hexagonal-headed screw on receptacles, plugs, and cord connectors.

4.4.2. Where an approved metal conduit system is used as an equipment-grounding conductor, bond the receptacle to the box by means of a separate jumper. If this is not done, the receptacle must be listed by Underwriters Laboratories as being constructed to provide self-grounding.

4.4.3. Equipment requiring grounding are:

- Within eight (8) feet vertically or five (5) feet horizontally of ground.
- Located in a damp or wet location and not isolated.
- In electrical contact with metal.
- In a hazardous location.
- Supplied by a metal-clad, metal-sheathed, or metal-raceway wiring method.
- Operated with any terminal in excess
- of 150 volts to ground.
- The exposed, noncurrent-carrying metal parts, regardless of voltage, of certain motor frames, controller cases for motors, electric equipment in garages, accessible electric signs, and switchboard frames and structures.
- Frames and tracks of electrically operated cranes.
- Hand-operated metal shifting ropes or cables of electric elevators.
- Metal enclosures around equipment carrying voltages in excess of 750 volts between conducts.

4.4.4. To ground portable equipment, use a separate green, insulated equipment-grounding conductor within the portable cord. Using a separate, external-grounding conductor is much less reliable. The NEC permits this form of equipment grounding only if it is protected against physical damage and if it is part of the equipment.

- All hand-held portable tools and equipment connect to a power source by a flexible cord shall have the cord and equipment connected to a ground fault circuit interrupter (GFCI) or outlet.

4.4.5. Attachment plugs:

- Use noninterchangeable attachment plugs for equipment-grounding

circuits. These plugs each have a specific size and shape.

- General duty plugs may be used where they are not subjected to rough service or moisture. Select the most rugged and watertight equipment if this kind of exposure is present.
- The high-impact, transparent plugs allow easy inspection of the terminals without having to disassemble it.

4.4.6. Connections to equipment-grounding conductors

- Make connections to the equipment-grounding conductor and to the grounded circuit conductor so that removing receptacles, switches, lighting fixtures, and other devices will not interrupt either of the two conductors.
- Use proper jumpers and pressure connectors to maintain flexibility and integrity when performance maintenance.
- *Note:* Solder is *not* permitted in the equipment-grounding circuit nor are switches, fuses, or any other interrupting device.
- Ground the equipment-grounding conductor in the same enclosure with the conductors of the circuit that it protects.

4.4.7. Size of equipment-grounding conductor

- The NEC states the proper size for equipment-grounding conductors used on various sizes of circuits.
- Increase the conductor's size if long runs are expected and the drop of voltage exceeds an overall value of 5%.

4.4.8. Workmanship

- Ensure that connection of conductors to terminal parts provides a complete and acceptable connection without damaging the conductors. Where this is not done, a point of low-thermal capacity will occur, which can result in overheating, arcing, and fires.

4.5. Periodic Inspection and Testing

4.5.1. Structural grounding system devices, such as grounding electrodes, ground grids and ground mats will be tested by the "fall of potential" procedure at the time of installation and thereafter, at a frequency not to exceed three (3) years. The frequency may vary depending upon soil conditions, environmental conditions, and other factors that may contribute to the deterioration, corrosion, or erosion of the earth ground.

4.5.2. Accessible electrical cable interconnecting equipment and the earth ground will be made at the time of installation and thereafter at a frequency not to exceed (3)

years. The frequency may vary depending upon the conditions, hazards, and environment of the location. The inspection shall be both visual and electrical.

4.5.3. Perform visual inspection to identify corrosion or mechanical damage. Such damage will be repaired.

4.5.4. Perform electrical inspection by resistance measurement to ensure that the resistance is not greater than two (2) ohms. If resistance is greater than two (2) ohms, appropriate repairs will be made.

4.5.5. Static grounding system cables and connections for stationary equipment will be inspected at the time of installation and thereafter at a frequency of one (1) year. These systems will also be tested electrically at the time of installation and thereafter, at a frequency not to exceed five (5) years. The test will be done by resistance measurement to ensure that the resistance is not greater than five (5) ohms. Whenever corrosive or mechanical damage or high resistance is found, appropriate repairs will be made.

4.6. Portable equipment or containers

4.6.1. The grounding of portable equipment will be inspected before use to ensure complete connection and good condition. Maintain a log of tests, repairs, and replacements signed by the testing employee.

4.6.2. When handling flammable or explosive materials in portable equipment, inspect the bonding cables to verify that they are intact.

4.6.3. Use an insulation-resistance tester that provides for the application of 500 volts DC between the motor windings and the metal enclosure. The tester should also check into continuity of the equipment-grounding conducting as well.

4.7. Documentation of inspections and testing

4.7.1. Inspections and testing of all grounding and bonding systems will be documented and maintained at the BASF Beaumont Plant by the department or contractor performing the inspections and tests.

4.7.2. A list of the most often violated OSHA/NEC/NFPA electrical standards relating to grounding and bonding will be found at Appendix 3. Inspection and testing documentation will reflect compliance status with these rules. Any defective equipment, conductors, or connectors will be taken out of service until repaired or replaced.

4.7.3. The documentation of the inspections and tests will also reflect compliance status with OSHA 29 CFR 1910.305, appendix 1.

4.7.4. The status of corrective actions and repairs will be documented and tracked to completion. The completion date will be entered and signed off by the responsible department, supervisor, or contractor.

4.7.5. The rules listed below will be followed when inspecting and testing grounding and bonding:

- Ensure that the green, insulated, equipment-grounding conductor is attached to the green-hexagonal binding screw.
- Ensure that the white-grounded circuit conductor is attached only to the silver-colored binding screw.
- Ensure that an electrically continuous equipment-grounding path runs from the metal enclosure of portable equipment through the line cord, plug, receptacle, and grounding system.
- Take any equipment out of service that has the equipment grounding pin cut off until it can be replaced.
- Use a receptacle circuit tester to check the receptacle for proper connection of ground wire, correct polarity, and faults in any of the three wires.
- Use a ground loop impedance tester to check the electrical circuit.
- Use a receptacle tension tester to be sure receptacle contact tension is 8 oz. or more.

4.8. Grounding and Bonding Devices

4.8.1. Three-wire adapters.

- The NEC requires that all adapters have a wide neutral blade.
- The NEC also requires that the equipment ground be made by means of a rigid tab under the cover screw on the bottom of the adapter rather than by a flexible pigtail.

4.8.2. Ground-fault circuit interrupters (GFCI)

- The GFCI protects against the most common form of electrical shock, “ground fault.” This ground fault condition occurs when cords, cord connectors, receptacles, or cord-connected equipment are improperly used or maintained, or become damaged.

Note: The GFCI does not protect the employee from line-to-line contact hazards, such as touching two exposed bare wires of a frayed electrical cord.

4.8.3. Equipment requirements and repairs:

- GFCI’s shall be housed in a sturdy, durable, non-metallic enclosure that is water-resistant.
- GFCI’s shall be the in-line cord type or a multi-receptacle box.
- GFCI’s shall not be altered from the original factor design or specifications, and shall only be repaired by a qualified electrician.
- Locate the GFCI as close as possible to the electrical equipment it protects. Excessive length of temporary electrical wiring or long extension cords can

cause ground-fault current leaks to flow by capacitive and inductive coupling. The combined leaks can cause the GFCI to trip.

4.8.4. Safe use requirements:

- GFCI's shall *not* be used with low voltage lighting systems that are used for confined space entry.
- GFCI's shall be tested before every use to ensure proper operation. Any GFCI that does not pass the "before use" test will be taken out of service until repaired or replaced.

GFCI "Before Use" Test:

Each GFCI is equipped with 'test" and "reset" buttons. With the device plugged into a power source, press the "test button. This should cause the "reset" button to pop out and break the circuit going to the receptacle or in-line device. Turn equipment on to ensure that the GFCI is operating properly. (Equipment should not start.) Push the "reset" button to return the device to its ready-to-use status.

4.8.5. Should nuisance tripping occur, re-inspect the tools or equipment and the GFCI for damage. If none is noted, try again. If tripping continues to occur, replace the tool or equipment, the cord, and GFCI. Take the defective equipment out of service and tag all the equipment with a "**DO NOT OPERATE OR USE"** tag.

4.8.6. Tripping may be caused by:

- wet electrical cord-to-cord connections of extension cords
- wet power tools
- outdoor GFCIs not protected from rail or water sprays
- defective electrical equipment with case-to-hot conductor fault
- too many power tools on one GFCI branch
- resistive heaters
- coiled extension cords (long lengths)
- poorly installed GFCIs
- defective or damaged GFCIs
- electromagnetic-induced current near high voltage lines
- portable GFCI plugged into a GFCI-protected branch circuit
- defective power tools

4.8.7. Fuses **and circuit breakers**

- The most common types of fuses used are link, plug, and cartridge. Use them only in the type of circuit for which they were designed. Using the wrong type or the wrong size fuse may cause injury to personnel and damage to equipment. Only BASF Beaumont Plant designated maintenance personnel will replace fuses within the Plant facilities.
- Only BASF Beaumont Plant designated maintenance personnel will service

circuit breakers

4.8.8. Contractors

4.8.8.1. Contractors on BASF Beaumont Plant premises will ensure that their employees are trained in, understand, and follow the rules and practices contained in this procedure.

5. RESPONSIBILITIES

5.1. Beaumont Site Leadership Team

Has primary responsibility for implementation of this procedure.

5.2. Environmental, Health and Safety Manager

Has primary responsibility for the initiation, re-issuance, administration, and/or interpretation of this procedure.

5.3. Beaumont Site Employees

Have primary responsibility for adherence to procedure including identifying deficiencies in the procedure, and identifying, reporting and correcting activities not in compliance with the procedure.

6. RELATED DOCUMENTS

BMEHS-002.005 Control of Hazardous Energy - LT&T
BMEHS-002.007 Electrical Safety
BMEHS-002.033 Energized Electrical Work
BMEHS-002.034 Electrical Room Access & Work Permitting
OSHA 29 CFR 1910 SUBPART S - 303 - General Requirements
OSHA 29 CFR 1910 SUBPART S - 304 - Wiring Design and Protection
OSHA 29 CFR 1910 SUBPART S - 305 - Wiring Methods, Components, and Equipment For General Use