PETROGUARDIAN™ LLC

BEST PRACTICES

LIGHTNING & STATIC PROTECTION FOR OILFIELD ASSETS

PETROGUARDIAN LLC

Lightning and Static Protection Guidlines

by Petro Guardian LLC

This engineering recommendation outlines site protection for both static discharge and lightning strikes and is based on industry standards and practices. This guideline, when applied, does not guarantee a production location will not be susceptible to lightning strikes or static discharge events. By using these guidelines and industry practices, the likelihood of lightning or static related damage will be decreased but not eliminated.

Best practices against ignitions arising from lightning and static events

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1 Introduction

Lightning is an atmospheric discharge of electricity that typically occurs during thunderstorms. A bolt of lightning can travel at a speed of 136,000 miles per hour (220,000 kilometer per hour) and can reach temperatures approaching 54,000 degrees Fahrenheit (°F) [30,000 degrees Celsius (°C)], hot enough to fuse soil or sand into glass.

In some U.S. geographical locations, lightning storms occur as many as 100 times per year. Some of the most powerful and dangerous thunderstorms occur over the United States, particularly in the Midwest and the southern states. These storms can also produce large hail and powerful tornadoes.

A single lightning flash (event) will typically consist of from one to twenty or more individual current strokes with the average being between four and seven.

Each year, thousands of industrial, commercial, residential, and other properties are damaged or destroyed by lightning. Electrical current produced by a voltage gradient resulting from a lightning flash to a facility can initiate physical damage, fires, equipment damage or injury to personnel damage.

Surface flash over or arcing of generated electrical current between conductive surfaces not in equilibrium can initiate damage directly by the heat, sparks, and molten metal generated by the arc. Lightning could initiate a fire involving combustible materials inside the facility.

Lightning can affect support systems such as communication, CATV, fire protection, HVAC, and security systems. Lightning can reach a structure not only by direct strike, but also indirectly by coupling to conductors or conductive utility services that penetrate the structure.

2 Industry Issues

Lightning and static issues have resulted in the loss of oil production sites. Modern upstream oil production locations include technologies that are growing a rapid rate. The industry standards in place to help operators protect these sites have not been able to keep pace with the increased advance in technology. As a result, issues continue to plague the industry. This document addresses some of the known issues and provides guidance for protection. The guidelines discussed in this document are not only an aggregation of current standards, but in most cases provide protection in excess of these standards. In itself, this document can be considered an industry standard.

Explosions and fire resulting from lightning and static issues are very detrimental to a production location.

Direct losses as a result of these events include:

- Loss of life
- Cleanup costs
- Reconstruction costs
- EPA fines
- Data loss
- Higher insurance costs
- Deferred production
- Corporate image

Important elements of the protection system include considerations for ESD from lightning & static related events, and electrical transients. When assessing electrostatic hazards, consideration should be given to the flammable atmospheres present in and around production sites. Earth grounding is the basis for an entire protection system. Typical hydrocarbon processing facilities utilize a below grade grid system for common earth grounding. These systems usually take an abundance of time to install along with a large budget. Oil field production facilities are not unlike their larger oil refinery cousins in the sense that they are processing hydrocarbon products utilizing automation. A below grade grounding grid is necessary to bond all elements in the production site to a common ground-reference. Due to time/budget constraints a buried grounding grid is not a feasible option for an oil production site.

Because lightning and static protection systems act as a total unit, the integrity of the system cannot be compromised else the system cannot thoroughly perform a task of total protection. One of the common issues of a subterranean grounding system include decaying metals over time which results in future grounding issues. By bringing this grounding grid above grade and designing the system on the facility itself, both financial budgets and time budgets can be met. Also, all lightning protection components shall be visible so that future continuity testing of the components is kept to a minimum. Concealed components require periodic continuity testing to ensure they do not degrade over time. Visible components can eliminate this testing requirement.

This document addresses all aspects of the protection system including lightning protection, bonding, grounding, static mitigation and protection of electrical components.

3 Scope

This engineering recommendation outlines site protection for both static discharge and lightning strikes and is based on industry standards and practices. This design in no way 100% guarantees a production location will not be subject to a lightning strike or static discharge event. By using these designs and industry practices the likelihood should be decreased but not eliminated.

All new existing but not yet grounded or rebuilt tank installations should be grounded in accordance with this design. All existing batteries that have grounding systems currently in place will be checked for integrity and repaired so the system is in working condition or if the system has corroded beyond repair, this design will be implemented. The primary purpose of a grounding system is to dissipate lightning and static energy to ground if it strikes the production tanks and to prevent arcing across the thief hatch where flammable vapors are located. API 2008 sec. 4.1.5, B & C discusses preventative measures to avoid static discharge with the use of bonding and grounding procedures. The applicable preventative measures suggested have been incorporated into this design. Additional operational procedures are also recommended which are outside of the scope of this design.

Compliance with this design reduces the likelihood and consequences of lighting and static discharge.

Clarification drawings accompany this design.

This specification shall govern procedures for installation of grounding, bonding and lightning protection systems for the purposes of:

Controlling Static Electricity on production equipment or structures where a spark could cause an ignition and result in a fire or cause damage to sensitive electronic components.

Provide lightning and surge protection for structures, high value equipment, sensitive electronic equipment, and volatile or flammable material storage.

The target audience for this document is: all project engineers, facility engineers, construction coordinators, field supervisors, technicians, contract engineering firms and contract construction firms.

4 Codes and Standards

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

- API RP74 – Recommended practice for occupational safety for onshore oil and gas production operation.
- *API RP 2003, Protection against ignition arising out of lightning, static and stray current*
- *NFPA 780, Standard for the protection of Lightning Protection Systems*
- *NFPA 77 – Recommended practices for static electricity*
- *IEEE std, 142, Powering and grounding of commercial and industrial equipment*
- *IEEE std 1100,* Recommended Practice for Powering and Grounding Sensitive Electronic Equipment,
- IEC 61643-12:2002, *Low-voltage surge protective devices – Part 12: Surge protective devices connected to low-voltage power distribution systems – Selection and application principles*
- *IEC 61643-1 Ed. 1.1 (2002-01): Surge protective devices connected to low-voltage power*
- IEC 62305-1, *Protection against lightning – Part 1: General principles*
- IEC 62305-2, *Protection against lightning – Part 2: Risk management*
- *IEC 62305-3, Protection against lightning – Part 3: Physical damage to structures and life hazard*
- IEC 62305-4, *Protection against lightning – Part 4: Electrical and electronic systems within* distribution systems
- OSHA- Occupational Safety Health Act

5 Safety

5.1 Contractor Responsibility

The Contractor is responsible for the maintenance of their equipment in safe order, for the development of safe working practices and the sufficient training of their personnel. As a minimum, Contractor's safe working standards shall comply with OSHA CFR 1910.252 and safety practices as required in the Master Service Agreement. In any event, should the Inspector inform the Contractor of inadequate safety standards, practices, or events on the part of any contractor personnel, such deficiency shall be promptly rectified.

5.2 Contractor Work Performance

It is recommended that installations be designed and installed by qualified, trained, personnel. Training for installers requires a company approved instructor-led course or a private in-house training session. Contractor to perform all work in a safe, workmanlike manner consistent with all industry practices and applicable rules and regulations. In addition, Contractor must follow all appropriate documentation and safety procedures including general and site specific.

5.3 Electrical Safety

Electrical work should only be performed on de-energized equipment and wiring unless de-energizing introduces additional or increased hazards or is infeasible due to equipment design or operating limitations.

6 Conflicts

6.1 General

Where there are conflicts between drawings, data sheets specifications or requisition and the specified code or governmental requirements, such conflicts shall be referred to in writing for resolution.

6.2 Application

If the above referenced standards conflict, the more stringent shall apply. If the above referenced standards conflict with this Specification, the requirements of this Specification shall apply. In all cases, applicable governmental regulations shall be fulfilled.

6.3 Contractor Compliance

The Contractor shall comply with changes and/or additions incorporated in the most recent issue or edition of codes, regulations and other references issued up to the time of award of contract.

6.4 Code Revisions

Where there are revisions to codes, regulations or other references listed in the contents of this Specification, the current revisions shall apply to new construction.

6.5 Deviations

Contractor shall obtain the company's written approval for all deviations, exceptions and substitutions to this Specification including those which are permitted subject to the approval of the company.

7 General Work Requirements

7.1 Work Performance

All work performed by Contractor shall be neat, compact and performed by qualified craftsmen with attention to general appearance, accessibility for maintenance and protection of the equipment during installation, construction, transportation and operation.

7.2 Permits and Inspections

The Contractor is responsible for procuring and delivering to the Company all permits and final certificates of inspection and approval required by the governing jurisdictions. No final payment will be issued until delivery of any certificates of inspection and approval is complete.

7.3 System Installation

Contractor shall install, terminate, and test all grounding conductors, grounding electrodes (i.e. rods, plates, etc.), connections and accessories in accordance with the scope of work, specifications and/or drawings. Accessories shall include all necessary brackets, bracing and fastening. Contractor shall furnish all additional parts and materials as required for a complete and functional installation not listed in Company supplied materials.

7.4 Testing and Commissioning

Contractor shall test and commission all grounding, bonding and lightning protection systems unless otherwise noted. A signature of compliance is required for all installations.

7.5 Materials

7.5.1 Hazardous Classification

Where applicable, all equipment and fittings shall be rated for the areas indicated on the hazardous area classification drawings. **(ATTACH DRAWING)**

7.5.2 UL Compliance

All lightning protection wires, connections, and clamps must be UL96 rated products.

7.5.3 Approved Products for Load Outs

All truck load out wires, connections, and clamps must be approved products.

7.5.4 Static Mitigation

Static mitigation equipment must be approved prior to installation.

7.5.5 Exceptions

If a contractor has a need to use a non-UL 96 rated product in a specific application, written approval must be obtained for use and substitution.

8 Approved Vendors and Material List

(see Appendix 1-C - Approved Materials)

9 Grounding Requirements

The point on which the lightning stroke terminates is frequently a point of some elevation. This termination may be on a metallic structure, which is a good current conductor, or it may be on something that is considered a semiconducting material. These semiconducting paths are sufficiently conductive to permit the flow of charges, but they are inadequate to permit the severe stroke current to flow without extreme heating. This heating can be very dangerous when is occurs in the vicinity of flammable materials, such as petroleum or some chemical products. An adequately grounded dedicated conductor sized to safely carry lightning currents is an essential foundation for a lightning protection system on an oil & gas production site. This requires a low resistance connection to earth, low impedance conductor to carry the lightning currents and preferred points to take the direct strike of lightning. This section covers the selection and installation practices for creating the low resistance connection to earth and for creating a low impedance path to conduct the lightning current from it's point of strike safely to earth.

9.1 General Grounding Guidelines

A grounding electrode system provides a single point of zero ground reference and a single point for system interconnection. Lightning protection systems require an earth electrode (ground) system to dissipate the electrical energy of a lightning strike to the earth. The earth electrode systems may consist of single ground electrodes at each down-conductor, multiple ground electrodes, concrete-encased electrodes, ground ring electrodes, radials, plates, or any combination of the above. A low resistance earth ground is preferred.

9.1.1 Grounding Equipment

Ground rods, ground plates and radials shall be called ground electrodes in this document.

1. Ground Rods shall be 3/4" O.D. x 10' long copper clad steel ground rods unless otherwise stated in design documents. Rods shall be driven to a depth of approximately six inches below grade and covered.

2. Where soil conditions do not allow at least 10' of driven ground rod depth, chemical ground enhancement material with ground plates, and/or radial ground systems may be used. Copper ground plates 18"x18" min may be utilized in place of ground rods. They are recommended to be placed at least 18" below the soil level. They should be encased using a conductive cement based back fill material that can set around the ground plates after absorbing adequate moisture. The measured resistivity of the

back fill must be below 150 Ohm-cm. This increases the total surface area in contact with the ground plate and reduces the contact resistance. One 25lb bag of back fill above and one 25lbs bag below the plate is generally adequate to establish a low resistance ground connection. In case of a radial ground, the Class 1 multi-stand tinned copper lightning protection will be utilized. It is required that it be of 12Ft min. length and installed 18" below the ground in a trench. Two bags of back fill must be encased around the radial for best connection to ground.

3. The cable to ground rod, cable to ground plate connections must be made using a UL96 rated clamp. **[Appendix 1-A typical 6]**

4. All connectors, cable to cable splice and cable to structure clamps will be UL96 rated to handle lightning currents.

5. All connections to ground must be secured with a poly-plastic inspection well. The Well lid must be lockable and the construction material should be able to take 3000Lbs of weight. The test wells shall be min. 10" in diameter and marked for identification of grounding points. In no case shall a ground rod protrude above ground and create a tripping hazard.**[Appendix 1-A typical 5]**

9.1.2 Ground Electrode Placement and Spacing

1. For the lightning protection system on a tank battery, ground electrodes shall be driven diametrically opposed and at the farthest extents of the containment. **[Appendix 1-A typical 1]**

2. Spacing cannot exceed 100 feet between ground rods commonly connected in a lightning protection system. Each lightning protection down conductor must terminate to a ground electrode.

3. Ground rods shall not be spaced closer than twice their driven depth.

4. Where storage tanks are installed inside lined secondary containment barriers, the ground rods shall be installed outside of the containment area. The ground conductor shall be routed over the containment with the acceptable rise to run ration of 1:4. Care should be taken to route the ground cable along other piping or conduit runs to avoid creating a tripping hazard.**[Appendix 1-A typical 2a & typical 2b]**

5. Where storage tank catwalks cross outside the containment barriers, the ground rods shall be installed outside of the containment area at the foot of the catwalk. **[Appendix 1-A typical 4]**

6. A Class 1 multi-strand tinned copper lightning protection cable shall be extended

between the ground rods across the storage tank battery, following a route along the catwalk. This extension will act as a back bone to ground isolated pipe runs, thief hatch static protection equipment, in-tank static protection equipment, instrumentation , vent valves, bull plugs and any other isolated metal structures. **[Appendix 1-A typical 7]**

7. Rod to cable connections shall be made using UL 96 rated mechanical connections. All connections are to be completed strictly following the manufacturer's recommendations and inspected prior to burial or project completion.

8. Where grounding conductors are susceptible to physical damage from machinery, vehicles or other objects, they shall be protected by an appropriately sized PVC Schedule 40 conduit.**[Appendix 1-A typical 3]**

9. A ground connection shall be made at each isolated pipe rack or cable tray support element. If a cable tray exists, the tray may be used as grounding conductor, and bonded to the pipe support to meet this requirement.

10. All major equipment (flare stacks, vessels, tanks, exchangers, skids, compressors, generators, low pressure towers, separators, heater-treaters, lamp posts, communication towers, scada towers etc.) shall be grounded to a dedicated ground electrode. If the process area comprises of multiple heater treaters and separators, ground electrodes can be installed at the two ends of the process area bonded to the piping system. In case the process area has extensive automation, use a Class 1 multi-strand lightning protection cable to establish a backbone between the two ground electrodes. Route the backbone along the process piping secured at every 36". Bond each process skid to the backbone. For every 100Ft extension of the backbone, establish additional location for ground electrode.**[Appendix 1-A typical 30]**

11. For the truck load out equipment connected to the tank battery, ground electrodes shall be driven next to each load out. Each installed will be secured with an inspection well. The load-out static protection assembly will be grounded to this point using a #6 green jacked grounding cable. For truck load outs on fiberglass tanks, the ground electrode at the load out will be bonded to the nearest lightning protection ground electrode using a #6 green jacketed grounding cable. This connection is not required for truck load outs for metal tanks.

9.1.3 Industry Standards Conflict on Tank Grounding

Although some industry standards (i.e. API 2003) consider certain metallic tanks installed directly on earth to be inherently grounded. This method of grounding is not accepted. This is due to the following factors:

1. Many tanks are installed inside liners or have internal or external liner coatings

isolating the tank from earth.

2. The gravel beds generally used as foundations for tanks are not comprised of native soil, and have a high soil resistivity preventing a good connection to earth ground.

3. Tanks are often in service for extended periods (decades in some cases). These tanks tend to rust on the bottom side between the tank and earth. This corrosion is non-conductive and further insulates the tank from ground.

It is recommended that supplemental grounding be provided in the form of the Lightning Protection System.

10 Bonding and LP Conductors

A flash over of lightning current, also called side-flash, is often a source of ignition especially within a cloud of venting hydrocarbon gases. Lightning in the vicinity of a production facility can develop an electromagnetic field. The field strength rises and drops as lightning strokes happen. The rapid change in EMF strength induces current across the lightning protection conductors and metal structures. In a condition where the lightning protection conductors, metal structures, and grounding systems are bonded to each other so current can freely move across from one metal structure to another, the risk of side flash is minimized. The flash over risk is also minimal even when the protected structure is hit by lightning directly. Bonding of metal structures and grounding systems to a facility's lightning protection system is critical to minimize lightning induced ignition of hydrocarbons.

10.1 Bonding

Requirements for bonding shall comply with NFPA 780. Lightning protection system bonds should be as short and as direct as reasonably achievable. Do not paint or coat LPS bonds and conductors. All conductor must be Class I lightning protection multi-stranded tinned copper cable. In areas of high H2S concentrations, Class I lightning protection multi-strand aluminum conductor shall be used.

10.2 Proper Methods

Whether a high current magnitude is discharged along parallel conductors within close proximity or along a single conductor with sharp bends, considerable mechanical forces are produced, making secure mechanical fittings essential. Only mechanical or compression connectors will be used. Use of UL96 rated bonding lugs and pipe clamps is recommended. All isolated metal bodies such as metal fittings, metal piping, bull plug on fiberglass tanks, thief hatch on fiberglass tanks, tank stick chassis and vent valves must be bonded to lightning protection system when such isolated bodies are located in the top 50% of the height of the tank.**[Appendix 1-A typical 14 & typical 15]**

When lightning follows higher impedance paths, damage may be caused by heat and mechanical forces generated during the discharge process. Most metals, being good electrical conductors, are relatively unaffected by either heat or mechanical forces if they are of sufficient size to carry the expected magnitude of current. The metal path should be continuous and form a two-way path from each strike termination device horizontally and/or downward to connections with ground electrodes.

1. Lightning protection conductors shall be fastened to the structure upon which they are placed at intervals not exceeding 3 ft. using UL rated fasteners.**[Appendix 1-A typical 8]**

2. Lightning Protection Conductors shall maintain a horizontal or downward coursing free from “U” or “V” (down and up) pockets.

3. No bend of a conductor shall form an included angle of less than 90 degrees, nor shall it have a radius of bend less than 8 inches.**[Appendix 1-A typical 17]**

4. Class I lightning conductor shall be routed along non-conductive piping to establish a connection to all air terminals. The air terminal network on the piping must be bonded to the lightning protection system at both ends of the piping. **[Appendix 1-A typical 20]**

5. A proper bond must be established between the lightning protection conductor and the thief hatch static protection system**[Appendix 1-A typical 26]**

6. A proper bond must be established between the lightning protection conductor and the in-tank static protection system.**[Appendix 1-A typical 26]**

7. A proper bond must be established between the lightning protection conductor and all tank top gauge enclosures. **[Appendix 1-A typical 12]**

8. A proper bond must be established between the lightning protection conductor and the vent valve.**[Appendix 1-A typical 11]**

9. A proper bond must be established between the lightning protection conductor and the metal bull plug on fiberglass tanks.**[Appendix 1-A typical 13]**

10. A proper bond must be established between the lightning protection ground and the fiberglass tank load-out static protection system ground.

11. A proper bond must be established between the fiberglass tank C-Veil grounding terminal and fiberglass tank load-out static protection terminal system ground. **[Appendix 1-A typical 29]**

10.3 Equipotential Bonding with Utilities

The lightning protection system ground must be bonded to the main electrical service ground at the service entry. This is required to ensure that both the electrical distribution system ground reference and the lightning protection system ground reference exist at the same potential during a lightning event. This is a safety requirement to prevent possible flash over resulting from a difference in potential and to protect electronics in case a ground loop was to form with a path through sensitive electronics. Other metal masses that are integrated into the structure of the location (e.g., ventilators, steel doors, metal door frames, steel reinforcing bars, utilities, communications systems, etc.) shall be bonded to the nearest structural member or lightning protection system component that is integrally bonded to the earth electrode system. Grounding systems from separate utilities (Facility electrical, Instrument Ground, Telecommunications, CATV, etc.) shall be bonded together at one and only one point.

10.4 Equipotential Bonding with Instrumentation

The SCADA system is often connected to an isolated(clean) ground to minimize noise into the data transmission network. The control panel is generally isolated from the control circuit and is grounded to the electrical ground. All field instrumentation cables are generally shielded and the shields are grounded to the isolated ground on the control panel side while the shields are floated on the instrument end. The instrument chassis is isolated from the control cables. The instrumentation enclosures are bonded to the lightning protection system ground. During lightning events – direct or indirect, currents are induced in the lightning protection system conductor. There is a high risk of flash over at the control panel between the control panel enclosure and control circuits and also between the instrumentation enclosure and instrumentation control circuit.

Since a direct bonding cannot be established between the electrical ground, lightning protection ground and isolated ground, appropriate surge protection devices are installed on both sides of the instrumentation control cables. These serve as an alternate to bonding to prevent the possible flash over that may damage electronics or ignite fire.

11 Lightning Protection

Oil & gas production sites often report incident of fire due to lightning. On occasion, there are direct strikes on production sites. It is recommended that such strikes are provided dedicated attachment points with a conductor network that can safely ground the lightning currents. Most of the times an ignition lights fire to flammable vapors due to nearby lightning events. The process of a lightning event is associated with a rising and falling electromagnetic field. All electrical conductors within this field are stressed, as voltage from one point to other rises, a flow of current is induced. If metal structures on a production site are not adequately bonded to each other and adequately grounded, arcing and current flash over occurs across the structures. These events can ignite flammable vapors. Voltage stress on structures can attain high values that they start to generate streamers. Streamer formation is a high energy event and can ignite flammable vapors.

11.1 Protection Method

As per IEEE std 142 - 3.3.3.3.3 Lightning Protection Methods - Charge transfer system, The theory of operation has been consolidated and an orderly, logical, and consistent relation has been developed. The dissipation array, with its multitude of sharp points, produces a delay in the development of the upward leader. The charged cloud reduces the field potential in the area. Should a lightning stroke's step leader approach, the delay of the upward streamer inhibits contact with the downward leader forcing the downward leader to attach itself to some other upward streamer that has progressed upward earlier. The system depends on an extensive network of earthing, i.e., ground connections, to assure a low-impedance connection to earth. This low impedance and ground coverage allows this charge to the earth to flow unimpeded.

As per IEEE std 142 - 3.3.3.4 recommended practices for direct protection

1. On the perimeter of a building with a flat or gently sloping roof, 0.25 m (10 in) terminals should not be separated more than 6 m (20 ft), and 0.6 m (2 ft) terminals should not be separated more than 7.5 m (25 ft).
2. All air terminals should be connected by down conductors and should form a two-way path from each air terminal to make connection to the grounding electrode (voltages double at an open circuit or end, in a lightning down conductor).
3. The possibility of a direct stroke to the vicinity of a vent or leak is taken care of by an air terminal of suitable length
4. Bend radii should be as long as possible, not less than 20 cm (8 in), since sharp bends increase the reactance of the conductor. Reactance is much more important than resistance because of the very high frequency of the surge front.
5. If the structure has electrically continuous metallic columns, these columns will act as down conductors. The air terminals must be interconnected by conductors to make

connection with the columns.

6. The average distance between down conductors should not exceed 30 m (100 ft).
7. Every down conductor must be connected, at its base, to an earthing or grounding electrode.
8. The ground rod should be placed in undisturbed or firmly packed soil. This electrode can be concrete encased. Ground terminals should make contact with the earth from the surface downward to avoid flashing at the surface.

11.2 Air Terminal Type

1. Dissipation air terminals will be used. The dissipation array construction will be of stainless steel material attached to the top of a ½" copper air terminal. The charge transfer brushes on the dissipation array will be soft stainless steel tines facing upwards not more than 3" in length. The air terminals should be tested in a recognized HV laboratory for emission current and documented delay in break down time as compared to a regular air terminal of same size. **[Appendix 1-A typical 19]**
2. Air terminal bases shall be UL 96 rated products selected for the application.
3. Class 1 multi-strand tinned copper cightning protection cable will be utilized. The specially constructed LP cable provides larger surface area with multiple strands that offer lower impedance to the flow of high frequency lightning currents.
4. LP cable clamps will be UL 96 rated clamps to secure the LP cable network at every 36" as required by NFPA 780 and IEC 62305. Lightning currents are high energy currents that induce high force on the cable during the flow. Lightly secured cable can break loose and create side flash current and ignite flammable vapors. Lightning current also generates high heat so plastic cable ties and similar unrated products can melt or burn.
5. All LP down conductors will terminate into a ground rod secured within an inspection test well.

11.3 Air Terminal Placement

1. The dissipation air terminals shall be used and positioned at a spacing no larger than 5 mtr (15 ft.) as per Level I spacing recommended in IEC 62305. Recommended spacing shall be 10 ft not exceeding 15Ft. Place air terminals along the outside perimeter of the battery using the outermost piping and/or catwalk handrail(s).**[Appendix 1-A typical 18]**

2. All tall vertical equipment (vessels, tanks, exchangers, skids, compressors, generators, low pressure towers, separators, heater-treaters, lamp posts, communication towers, etc.) shall be protected with air terminals using the spacing requirements above.**[Appendix 1-A typical 24]**

    a. Large Diameter Closed Roof Tanks: Place air terminals along the perimeter of the storage tank at the recommended spacing. Add a dissipater at the center of the tank. If the distance from the outer perimeter to Tank center is more than 15Ft, add a center ring of terminals with same spacing.

    b. Heater Treater: A single dissipater at top directly is recommended. Keep the dissipater away from the exhaust stack.

    c. Vertical Separator: A single dissipater at top directly mounted to the piping is recommended.

    d. Vapor Recovery Tower: A single dissipater at top directly mounted to the piping is recommended. Space terminals along the piping if there are multiple VRT.

    e. Compressor: Treat the compressor top as a roof and install dissipater air terminal at each corner not more than 2Ft from the edges. Maintain the spacing of 10Ft not exceeding 15Ft.

f. Generator: Treat the generator top as a roof and install dissipater air terminal at each corner not more than 2Ft from the edges. Maintain the spacing of 10Ft not exceeding 15Ft.

g. Lamp Post: Furnish each Lamp Post with a dissipater air terminal positioned such that it is at least 10" above the lights. If the Lamp Post is metal, no down conductor is required. For wooden lamp post, connect the air terminal to a LP down conductor and terminate the conductor to a dedicated ground rod secured within a test well. **[Appendix 1-A typical 21]**

h. Communication Tower: Furnish each communication tower with a dissipater air terminal positioned such that it is at least 10" above the tower top. If there are any antennas on the top, the air terminal must be installed on an offset and at least 10" higher than the antenna to avoid any interference. connect the air terminal to a LP down conductor and terminate the conductor to a dedicated ground rod secured within a test well.

i. LACT Unit Tower: Furnish each LACT unit tower with a dissipater air terminal positioned such that it is at least 10" above the tower top. If there are any antennas on the top, the air terminal must be installed on an offset and at least 10" higher than the antenna to avoid any interference. connect the air terminal to a LP down conductor and terminate the conductor to a dedicated ground rod secured within a test well.

j. SCADA Tower: Furnish each SCADA tower with a dissipater air terminal positioned such that it is at least 10" above the tower top. If there are any antennas on the top, the air terminal must be installed on an offset and at least 10" higher than the antenna to avoid any interference. connect the air terminal to a LP down conductor and terminate the conductor to a dedicated ground rod

secured within a test well.

3. If the piping is an electrically continuous metal pipe, the air terminals can be installed directly on the piping. If the piping is non-conductive, connect all air terminals using the Class I lightning conductor. The conductor is to be secured at intervals of no more than 36".

4. air terminals must be at least 10" above the structure they are mounted to or protecting. Install 24" offset air terminals on all vent valves.**[Appendix 1-A typical 22]**

5. Replace existing Wind Sock assembly with a customized Windsock with integrated dissipater Assembly. **[Appendix 1-A typical 23]**

6. At least two down conductors are recommended for a network of air terminals. Add additional down conductor for every 100Ft of roof top LP cable. All LP down conductors will terminate into a ground rod secured within an inspection test well.

12 Static Protection

At oil & gas production and SWD sites, fire incidents are often reported due to ignition that may have occurred due to electrostatic discharge. This document provides a set of recommendations to control possible static electricity accumulation for purposes of preventing fires and explosions. The purpose of this document is to assist the user in identifying the key areas at risk of static generation, accumulation, and discharge; and apply suitable products and practices. As per NFPA 77 – 7.1.2 Ignition hazards from static electricity can be controlled by neutralizing the charges, the primary methods of which are grounding isolated conductors and air ionization.

12.1 Key Areas of Static Accumulation

1. Fiberglass Tanks and Lined Steel Tanks
2. Thief Hatch
3. Truck Load Out

12.2 Fiberglass Tanks and Lined Steel Tanks

The movement of volatile fluids in and out of an insulated tank generates static charge that accumulates on the fluid surface and on the walls of the insulated tank. Inductive neutralizers (per IEEE std. 142 – 3.2.6.4) must be installed within the tank to increase the rate of static relaxation.

- The fluids within the tanks can be highly corrosive. It is recommended that inductive neutralizers selected be made of non-corrosive but conductive materials. They need to be in contact with the fluid along the full length of the storage tank. The neutralizer shall be a conductor with little or no capacitance to store static charge. An accumulated charge will always will be at risk to discharge instantly, creating a source of ignition. Conductors such as metal brushes, metal rods, and metal chains all have the ability to store charges which can result in discharge and ignite flammable vapors and liquids.

- Inductive Neutralizer shall be attached to the tank through a bolt on the thief hatch. A bonding lug shall be installed above the flange of thief hatch to bond the thief hatch and static inductive neutralizer to the facility lightning protection grounding system.
  [Appendix 1-A typical 25a & typical 25b and typical 25c]

12.3 Thief Hatch

Static discharge across thief hatch lid and flange

The thief hatch lid and flange are connected through a pin that allows the lid to rise and

fall back into the seal after it releases the pressure in the tank. The event when the pressure is released, volatile gases escape. The sudden separation of two conductive surfaces (lid and the flange) generates a risk of static discharge. With adequate oxygen mix with escaping volatile gases, the static discharge can ignite the gas. Similar risk exists when an operator may open the thief hatch without ensuring that the tank is not under pressure and the operator and thief hatch assembly are at ground potential.

1. A stainless steel flexible bonding strap is recommended to be installed between the thief hatch lid and flange. The bond keeps the lid and flange at the same potential even when the two are physically separated. The bonding strap needs to be of adequate width (around 1") and a braided construction is preferred to provide flexibility. **[Appendix 1-A typical 27]**

2. The bonding strap is attached to a bonding lug on the thief hatch flange. The lug is bonded to the facility lightning protection grounding system.**[Appendix 1-A typical 16]**

12.4 Truck Load Outs

Truck Load out Grounding and Bonding

1. Each truck load out should have a dedicated ground rod installed. The ground rod will be ¾" x 10ft installed inside an inspection well. Bond the ground rod to fill pipe using #6 green Insulated multi-strand grounding cable. Attach the truck load out cable to the fill pipe clamp, the truck load out cable assembly will use a large UL96 rated bonding blamp.**[Appendix 1-A typical 28a]**

2. For load-out stations on fiberglass tanks, the truck load out ground rod shall be bonded one of the lightning protection ground rods using #6 green insulated multi-strand grounding cable routed along the fill pipe using the shortest route. If a C-Veil exists, this cable should also bonded to the C-veil grounding terminals using #6 green insulated multi-strand grounding cable.

3. For load-out stations on steel tanks, verify electrical continuity between The truck load out ground rod and one of the lightning protection ground rods. If continuous, no additional bonding is required. Otherwise establish a bond using #6 green insulated multi-strand grounding cable routed along the fill pipe using the shortest route.

4. All truck grounding points shall be marked with the proper signage to indicate location of bonding point. This is to provide visual indication to the operators to bond truck chassis and visually verify that the bond is grounded to a ground rod. **[Appendix 1-A typical 28b]**

5. The truck load out cable shall be attached on the trucks at the designated grounding lug provided.

13 Surge Protection

Lightning discharges will produce electromagnetic pulses that can be coupled onto conductors servicing the structure. The discharges on power utility lines directly induce transient into the power feed. The discharges also lead to rise in ground potential rise and are a source for ground transients. These induced transients can be adequate to cause dangerous over-voltages, resulting in fires or damage to critical electrical and electronic hardware. Surge protection devices protect facilities against induced surges on power, communication, data and process control lines.

13.1 Electronics Often Damaged on a Production Facility

1. **Information Technology Systems**
   a) RTU/ Control Panel
   b) Electric Actuators
   c) Pressure Transmitters
   d) Level Transmitters
   e) Flow Meters

2. **Power Supply Systems**
   a) Power Generator ATS
   b) Outdoor Lighting
   c) LV Drives
   d) UPS
   e) DC Power Supply

13.2 Common Modes of Lightning Damage to Electronics

1. **Lightning strike to the network of power, phone and communication cable wiring**. This network, especially if it is elevated, is an effective collector of the lightning surges. The wiring then conducts the surges directly into the facility, and then to the connected equipment.

2. **Lightning travels through the ground (soil), reaching underground cables or pipes.** This is another route for lightning to come into a facility. This induces surges in underground cables and into the ground reference for electrical and

electronics.

3. **Lightning strikes to, or near, the external wiring network common to most outdoor facilities**. Power Generators, satellite dishes, exterior lights, gate control systems, flare control panel, drive panel, RTU Panel, and security systems can all be struck by lightning, and the lightning surges will then be carried by the wiring damaging critical circuits and operations.

4. **Lightning may strike nearby objects (open field, trees, another facility) that are close to, but not directly connected to the facility**. In this situation, the lightning strike radiates a strong electromagnetic field, which can be picked up by wiring (power and instrumentation cables), producing large voltages that can damage equipment.

5. **A direct lightning strike to the structure**. This type of strike can severely damage a structure without a lightning protection system (LPS), and will generally damage most electronic equipment connected to the facility. The structural damage can normally be prevented by a properly installed LPS, but the LPS alone provides little protection for the electronic equipment.

13.3 Basic NEC Requirements for Lightning Protection of Electronics

1. The main facility ground is used as the central ground point to which all lightning currents will be conveyed. Independent, unbonded ground rods are not accepted.

2. The NEC requirements are intended to remove most lightning surge currents from all signal wires entering the facility from utilities. For coaxial cables, only the sheath must be grounded; for telephone & communication wiring a special building entrance protector limits the impulse voltage between wires and ground to less than ~1000 V. Sheaths of coaxial cables from antennas must also be bonded to the building ground.

3. The NEC requirements for connecting all metal piping and large metal parts of the structure to the building ground serve two purposes: If there is metallic buried water piping, bonding it to the building ground improves the quality of that ground. Also, in the rare event of a direct strike to the piping, or to a metallic part of the structure, the ground bond conducts the lightning currents safely into the building ground. This greatly reduces the voltage differences between the parts of the structure, and therefore decreases possible injury to the residents, and reduces the possibility of a fire within the structure due to surge currents and voltage flash overs.

4. The NEC allow for increased protection in high-lightning areas by the optional installation of the following:

    - A structural lightning protection system (LPS)
    - Surge protectors on the AC power wiring
    - Additional surge protectors on signal wiring
    - “Supplementary protection” (also called “Point-of-Use” protection) at the equipment to be protected.

13.4 Recommended Specifictations for SPD on Information Technology Systems

1. **SPD Class**: All SPD devices installed in the Control/RTU panel or on the field instrument side have conductors that are exposed to coupling from direct lightning strikes. All these devices are recommended to be Type 1 SPD devices with combined lightning current and surge arrester capability.
2. **Operating Voltage & Frequency**: Selected device should match the requirements of the operating voltage & frequency of the circuit that it is to protect.
3. **Total Rated Lightning Impulse Current**: Lightning Impulse Current Internationally is rated as an impulse of 10/350 micro seconds. The recommended withstand capability is 10kA per unit.
4. **Rated Lightning Impulse Current per Line**: The recommended withstand capability per line is 2.5kA per unit.
5. **Total Nominal Surge Current**: Surge Current is rated as an impulse of 8/20 micro seconds. The recommended withstand capability is 20kA per unit.
6. **Nominal Surge Current per Line**: The recommended withstand capability is 10kA per line.
7. **Voltage protection Level Line – Line**: This is the surge voltage that a SPD will allow to pass through. The recommended voltage protection level is operating voltage + 50VDC
8. **Voltage protection Level Line – PE**: The recommended voltage protection level is less than 600VDC.
9. **Series Impedance per line**: Surge protection devices are generally installed in series on the control panel side. The series impedance can lead to signal loss. The recommended series impedance is less than 1 ohm. At the field equipment, the SPD devices will be installed in parallel. The series impedance will not be

applicable in selection.

10. **SPD Monitoring system**: The SPD construction should allow possibility to monitor it's integrity as preventative maintenance.
11. **Enclosure Material**: For SPD devices installed inside the control panel enclosure, IP20 rated enclosure is adequate. Field installed devices will be rated for IP67 and if required rated for EX environments.
12. **Test Standards**: UL 497B & IEC 61643-21
13. **Approvals**: UL, CSA, GOST

At the engineering stage, all field instrumentation will be listed with specifications for their controls and power input. Appropriate SPD devices of Type 1 will be identified based on the recommended parameters. These SPD devices in the field are generally installed in parallel to the field instrumentation as close as possible to the instrument being protected. The SPD devices must be grounded as per the recommendations of the instrument manufacturer (generally the signal reference ground). Devices such as pressure transmitter, flow transmitter, level transmitter, electrically driven actuators fall in this category.

All field instrumentation is generally controlled remotely. The control cable network with the RTU/ Control Panel generally has a fused field termination area. The PLC control cards in the control panel are selected based on the filed instrumentation to be monitored and controlled. The communication & control protocols can differ. SPD devices are selected for each type of control circuit and installed on the field terminal area. It is advised that the SPD units are hot swappable and can be monitored for preventative maintenance. The control panel is exposed to surges through the communication antenna coaxial cable, external AC power source and/or external DC power source. Appropriate SPD devices must be selected for each of these surge sources. While most of the Control Panel SPD devices will be grounded to the control panel isolated ground terminal, special care must be taken for the grounding of SPD devices on antenna coaxial cable. This device must be grounded directly to the control panel chassis ground and NOT to the isolated ground.

13.5 Recommended Specifications for SPD on Power Supply Systems

a. **Approvals**: ANSI/UL 1449-2006 (a.k.a. UL 1449 3rd Edition) and IEC 61643

b. **SPD Class:** All panels in the field ware to be considered as service entrance panels as they are generally all exposed to direct lightning. SPD shall be Type 1 SPD.

c. **Nominal Discharge Current Rating:** 20 kA per mode for all modes is recommended

d. **Max. Surge Current Rating:** 200kA rating is recommended

e. **The Maximum Continuous Operating Voltage (MCOV):** It is recommended that the MCOV does not exceed more than 25% of the nominal operating voltage.

f. **The SPD shall have Voltage Protection Ratings (VPRs) as follows:** Voltage protection rating is the part of surge voltage that the SPD allows to pass through. Devices must be tested for impulse current, combination surge wave forms and ring wave forms. Rating are recommended to be presented in detail for each mode of protection for each surge wave form.

g. **Monitoring:** LED indicator lights for power and protection status.

h. **SPD Design:** Modular design is not recommended for service panel protectors. Integrated circuits, permanently-mounted, parallel connected are most recommended.

i. Capable of sustaining 115% of nominal RMS voltage continuously without degrading.

j. All Service panel SPD devices are recommended to have the capability to filter EMI/RFI inductions. Please note that the filtering capability must be removed on the SPD devices installed on LV Drives.

At the engineering stage, the power distribution one-line diagram is drawn and the voltage rating of each distribution panel and electrical load is listed. Devices such as the ATS, UPS, LV Drive and area lighting are considered the critical equipment being protected. Suitable SPD devices are identified based on their voltage rating, power supply configuration and space available to mount the SPD device. In a commercial facility where these loads will generally be located inside a building the SPD Class can be Type 2 or Type 3. At production sites where all these devices are in the open, only Type 1 SPD devices are recommended. Most frequently, lightning transients travel on the power utility. A single level of protection at the equipment level is inadequate to filter the surge levels to safe limits. A primary SPD device is recommended at the main service panel in additional to one at each load. This serves as the first line of defense.

14 Appendices

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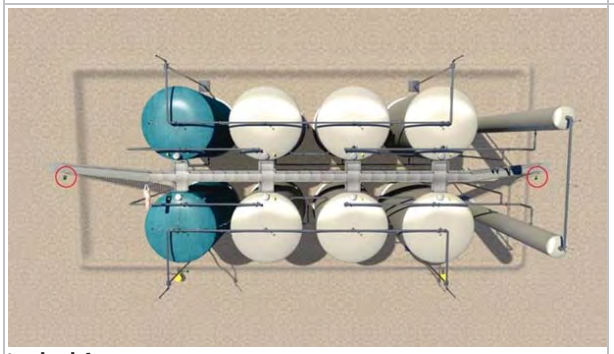
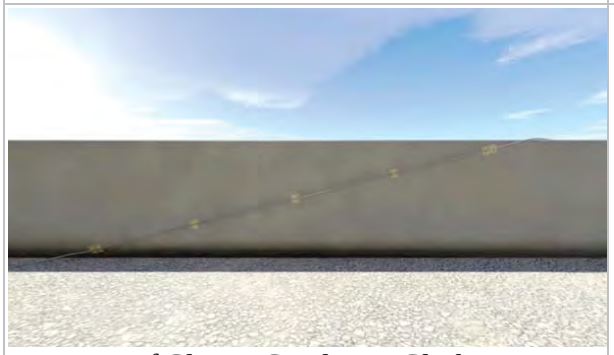
14.1 Appendix 1-A -Typicals

Typical Installations Drawings:

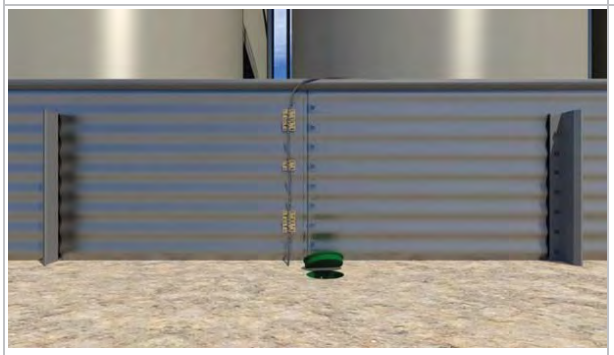


typical 1



1:4 Ratio of Class 1 Conductor Climbing Interior Containment Wall

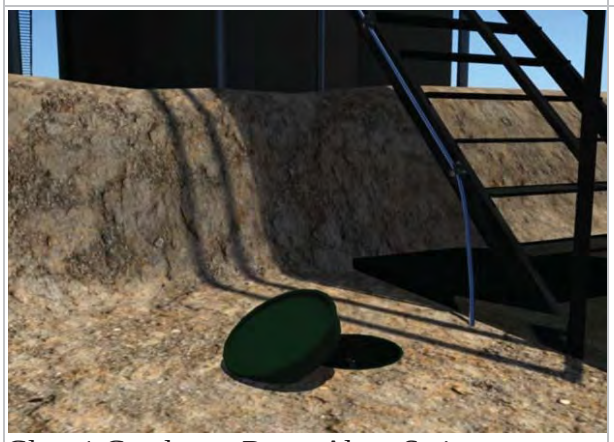
typical 2a



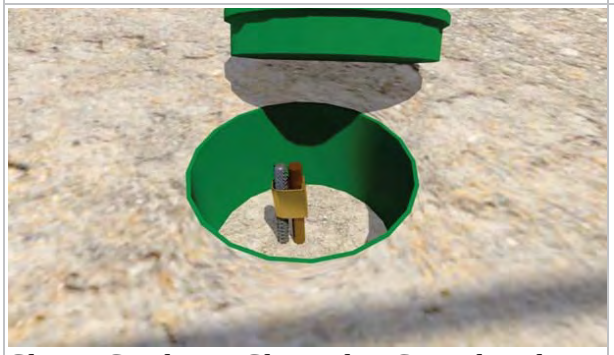
Class 1 Conductor Routing on Exterior Containment Wall to Ground Rod and Test Well

typical 2b

Class 1 Conductor Secured by Conduit
typcial 3

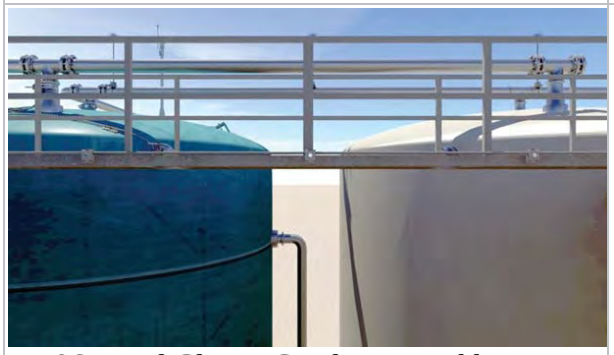


Class 1 Conductor Route Along Stairway to Ground
typical 4

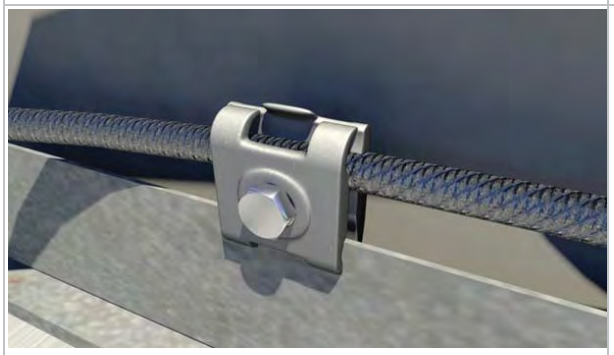


Class 1 Conductor Clamped to Ground Rod in Test Well
typical 5

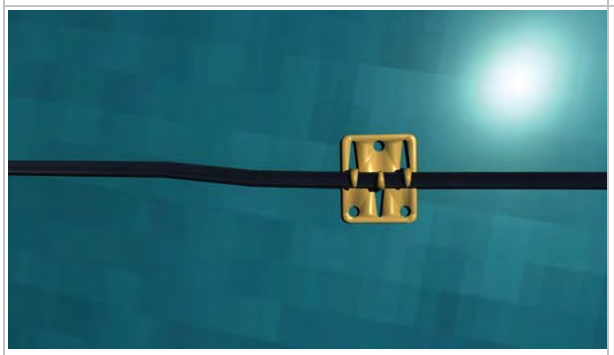
UL 96 Rated Ground Rod Clamp
typical 6



UL 96 Rated Class 1 Conductor Backbone secured every 36"
typical 7

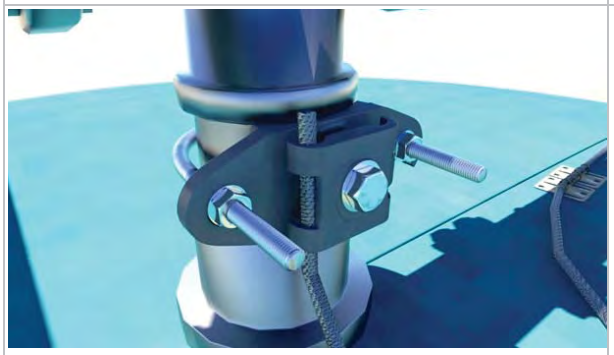


UL 96 Rated Catwalk Clamp Securing Class 1 Conductor
typical 8

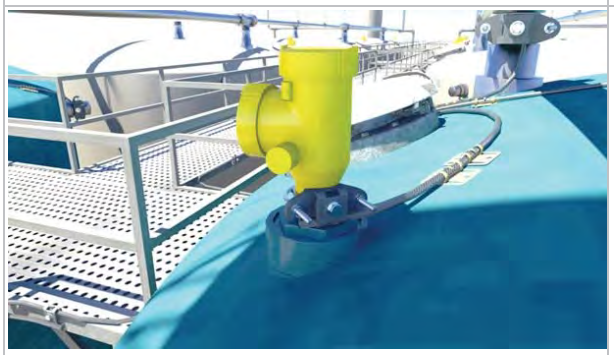


UL Rated Adhesive Clamp Securing Class 1 Conductor
typical 9

UL Rated Parallel Splice for Class 1 Conductor
typical 10



UL Rated Pipe Clamp Securing Class 1 Conductor on Fiberglass Tank
typical 11

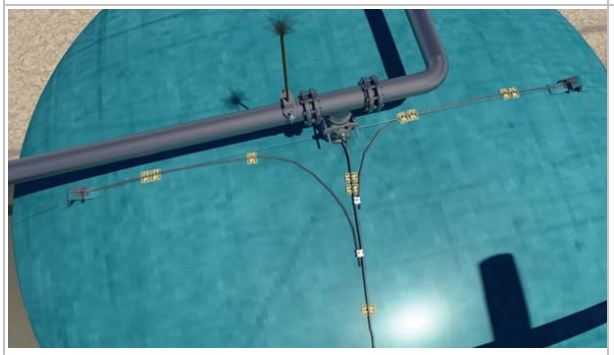


Fiberglass Tank Top Bonding
typical 12

Metal Bull Plug on Fiberglass Tank Bonded with Class 1 Conductor

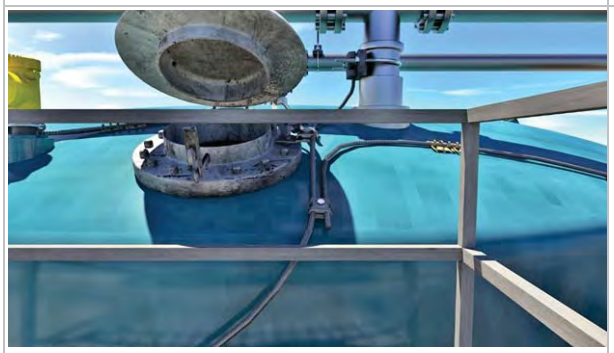
typical 13

typical 14



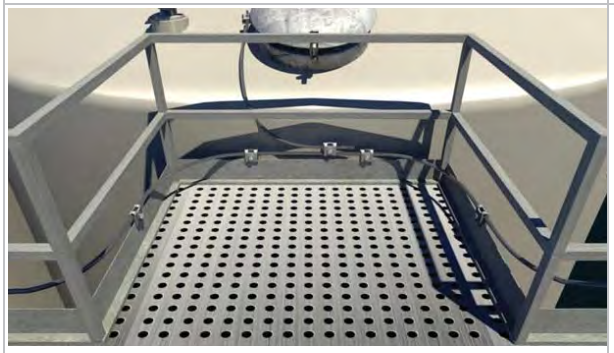
Fiberglass Tank Top Bonding

typical 15

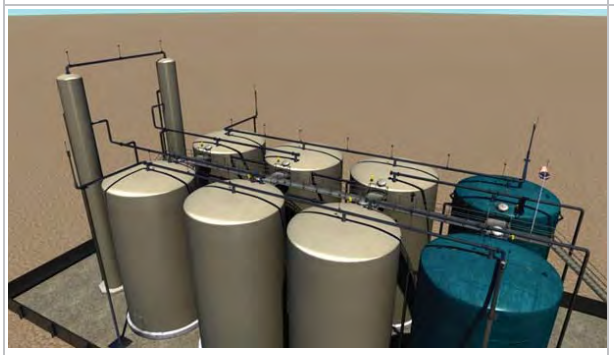


Thief Hatch and Vent Pipe Bonding

typical 16

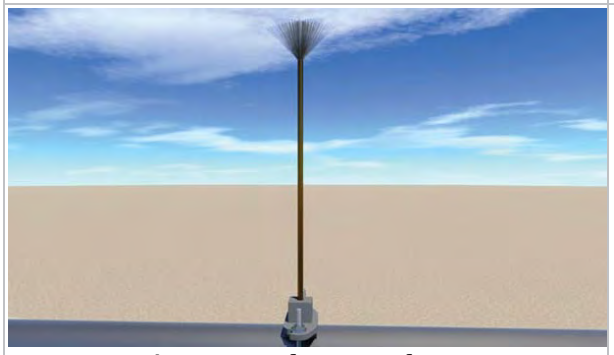


typical 17



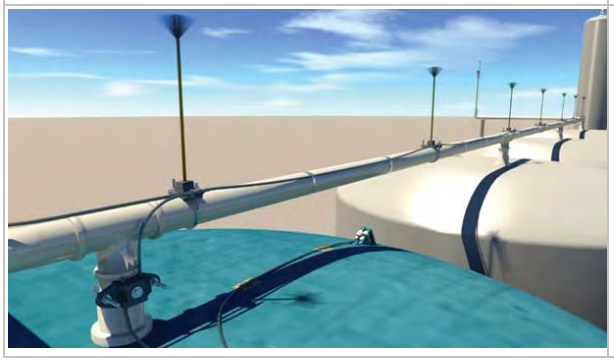
Air Terminal Placement

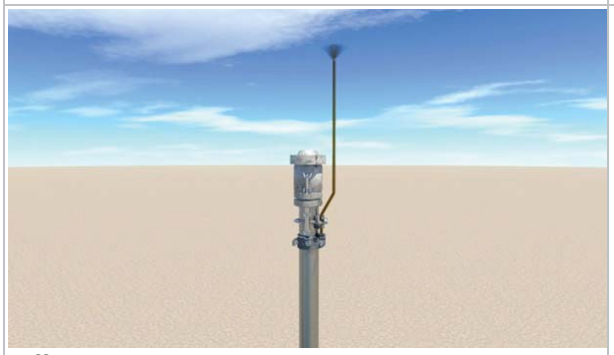
typical 18



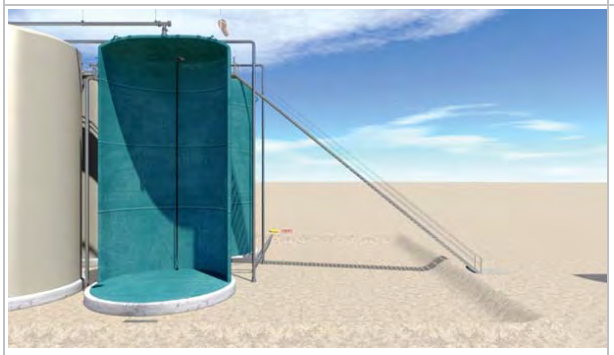
Dissipation Air Terminal Mounted on Vent Pipe

typical 19

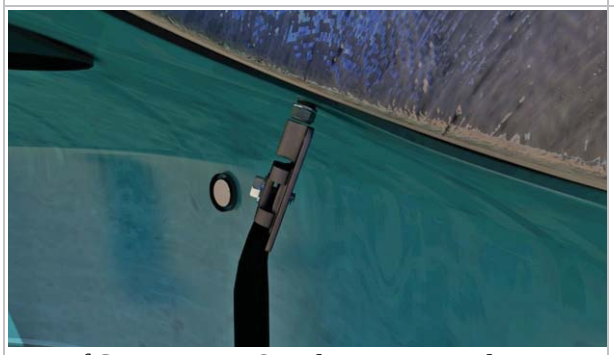


Dissipation Air Terminals Bonded with Class 1 Conductor on Fiberglass Pipe **typical 20**	
 Dissipation Air Terminal on Wooden Light Pole **typical 21**	
 Offset Dissipation Air Terminal above Vent Valve **typical 22**	
 Dissipation Wind Sock Assembly **typical 23**	

Dissipation Air Terminal above Process Tanks
typical 24

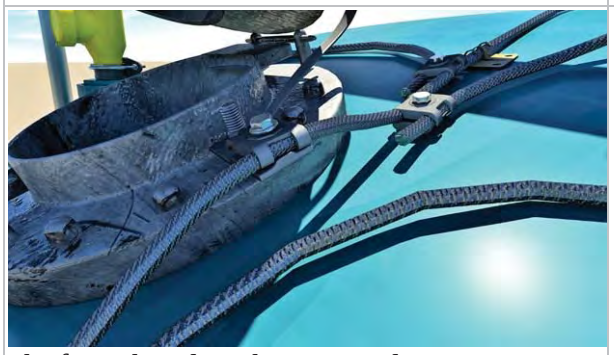


Tank Cutaway showing Inductive Neutralizer
typical 25a



Top of Static Lasso ® Inductive Neutralizer Inside Tank
typical 25b

Base of Static Lasso ® Inductive Neutralizer Inside Tank
typical 25c

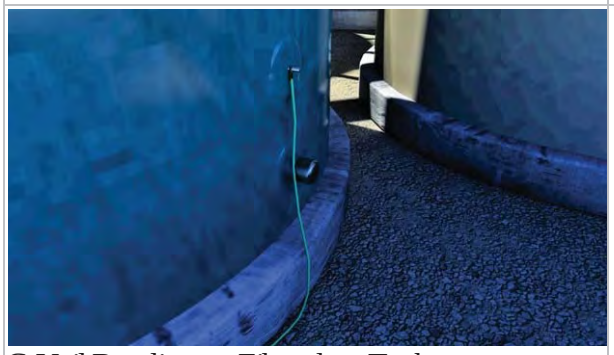


Thief Hatch and Tank Top Bonding
typical 26

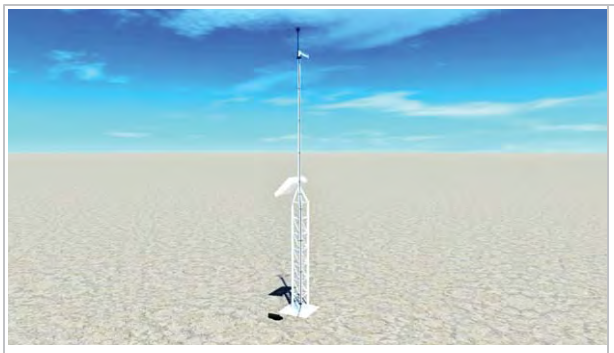
Thief Hatch Lid to Flange Bonding
typical 27

Truck Load Out Static Bonding
typical 28a

Truck Load Out Static Bonding
typical 28b



C Veil Bonding on Fiberglass Tank
typical 29



Dissipation Air Terminal Above SCADA Tower
typical 30

14.2 Appendix 1-B - Standards

Section 9.0 - Grounding requirements
• NFPA780 sec.4.13.2.3.1: The ground rod shall extend vertically not less than 10Ft into the earth. • NFPA780 sec.4.13.5.2: Each radial shall be not less than 12Ft in length buried not less than 18” below grade. • NFPA780 sec.4.13.6.1: A ground plate shall have a min. thickness of 0.032” and a min. surface area of 2Sq.Ft • NFPA780 sec.4.13.1.1: Each down conductor shall terminate as a grounding electrode. • NFPA780 sec.4.13.2.4: where multiple connected ground rods are used, the separation between any two ground rods shall be at least the sum of their driven depths. • NFPA77 sec.12.1.4: The tank and all associated equipment, such as piping, pumps, and filters, should be grounded. • NFPA77 sec.12.2: Loading of tank vehicles, summary of precautions as per table 12.2
Section 10.0 - Bonding and LP conductors
• NFPA780 sec. 4.10: Conductors shall be fastened to the structure upon which they are placed at intervals not exceeding 3Ft. • NFPA780 sec.4.9.4.1: U & V Pockets • NFPA780 sec. 4.9.5 Conductor Bends • NFPA780 sec.4.9.3.2: Permanent exterior metal handrails and ladders that are subject to direct lightning strikes and are electrically continuous shall be permitted to be used as main conductors where the min. thickness is 0.064”. • NFPA780 sec. 4.14.3 Common bonding interconnection shall include all building grounding electrode systems, including lightning protection, electric service, communication, and antenna system grounding electrodes.
Section 11.0 - Lightning Protection
• NFPA780 Table 4.1.1.1.1: Class 1 Copper Air Terminal Solid 3/8” dia.min; Aluminum ½” min. Class 1 Main conductor copper cross section 57,400 circular mils with 17AWG size of each strand; Aluminum cross section 98,600 circular mils with 14AWG size of each strand. • NFPA780 sec.4.7.2.2: Strike termination devices shall be placed on ridges of pitched roofs and around the perimeter of flat or gently sloping roofs at intervals not exceeding

20Ft.

- NFPA780 sec 4.10: Conductors shall be fastened to the structure upon which they are placed at intervals not exceeding 3Ft.
- NFPA780 sec.4.9.10: At least two down conductors shall be provided on any kind of structure.
- NFPA780 sec. 4.9: Main conductor shall interconnect all strike termination devices and shall form two or more paths from each strike termination device downwards, horizontally, or rising at no more than ¼ slope to connections with grounding electrodes.
- NFPA780 sec. 4.9.10.2: The average distance between all down conductors does not exceed 100Ft.

Section 12 - Static Protection

- NFPA77 sec. 8.1.2.3: A charge drawn from the ground to the needlelike tips ofan inductive neutralizer produces a concentrated electric field at the tips. This produces a localized electrical breakdown of the air. The flow of ions produced constitutes a neutralizing current.
- NFPA77 sec. 12.1.8.1: Tank gauging rod should be bonded securely and directly downward to the bottom of the tank by a conductive cable or rod to eliminate a spark gap.
- NFPA77 sec. 12.1.11.1: Metal tanks with nonconductive coatings or linings should be treated as nonconductive tanks. The tank should be bonded to the filling system.
- NFPA77 sec. 12.2 Loading of Tank Vehicles: Tanks trucks should be bonded to the fill system, and all bonding and grounding should be in place prior to starting operation.

Section 13 - Surge Protection

- NFPA780 sec. 4.20.2.2: SPD shall be installed at entrances of conductive communications and antenna systems.
- NFPA780 sec. 4.20.3.2.2: Signal, data and communications SPD shall have a maximum discharge current rating of at least 10kA when installed at the entrance.
- NFPA780 sec. 4.20.2.1: SPD's shall be installed at all power service entrances
- NFPA780 sec. 4.20.3.1.2: SPD shall have a nominal discharge current of at least 20kA per phase.
- NFPA780 sec. 4.20.5.1: SPD short circuit rating shall be coordinated with the available fault current rating of the panel to which it is connected.

14.3 Appendix 1-C - Approved Materials

APPROVED MATERIAL LIST			
Category	Item	Model	Description
SURGE PROTECTION DEVICES		ACX-NFF3	Coaxial N Type 50 Ohm F-F 3Ghz Type 1
		AC200-1S1	120/240 Split Phase
		AC200-3Y1	120/208V Three Phase WYE
		AC200-3Y2	277/480V Three Phase WYE
		AC200-3Y3	347/600V Three Phase WYE
		AC200-3N4	480V Three Phase DELTA
		AC60-120-15	single phase 60ka with EMI/RFI Filter, 120Vac 15amp, terminal strip connected
		AC60-12DC-30	single phase 60ka with EMI/RFI Filter, 12Vdc 30amp, terminal strip connected
		AC60-24DC-30	single phase 60ka with EMI/RFI Filter, 24Vdc 30amp, terminal strip connected
		ADI-BC12	Type 1 Control Circuit SPD 10kA, for 12Vdc 1amp 2 wire devices with RFID Life Check
		ADI-BC24	Type 1 Control Circuit SPD 10kA, for 24Vdc 1amp 2 wire devices with RFID Life Check
		ADI-BAS	Base unit for Control Circuit SPD
		ADI-LC	Hand Held Life Check Instrument for Control Circuit SPD
		API-EX-1x24	Type 2 EX rated Field instrument SPD, 10kA, for 12Vdc and 24Vdc 2 wire devices
		API-EX-2x24	Type 2 EX rated Field instrument SPD, 10kA, for 12Vdc and 24Vdc 4 wire devices
GROUND RODS & CLAMPS		FLUX 4291	Soil Enhancement Backfill, resistivity 100 ohm.cm, conductive cement, 25Lbs bag. 42 bags per pallet
		GND120	10" Polyplastic Test Well
		GND102	3/4" x 10' Copper Clad Ground Rod
		GND202	0.32" Thick 18"x18" Copper Ground Plate with 5/8" ground rod
		GND201	2 screw large surface area ground rod clamp fits 3/4" Ground Rods
STAINLESS STEEL BASES		LPS201	Stainless Steel Hose Clamp Fits 2" To 3" Pipe
		LPS204	Stainless Steel Hose Clamp Fits 2" To 10" Pipe
		LPS102	Air Terminal Base for HandRail Stainless Steel
		LPS1011	Air Terminal Base for Horizontal Piping Stainless Steel
CABLE FASTENERS		LPC802T	Cable Clip Adhesive Brass lead coated
		LPC803T	Cable Strap Srew Down with 3/16" dia screw
		LPC901	M-1 Gray Adhesive 10.1oz
BONDING LUGS & SWIVELS		LPC530T	Bonding Lug Brass Lead coated 9/16" mounting hole
		LPC530TA	Bonding Lug Brass Lead coated 7/8" mounting hole
		LPC601FFT	Swivel F-F Lead Coated 0-90 degree 1/2" threads
		LPC601FMT	Swivel F-M Lead Coated 0-90 degree 1/2" threads
PIPE CLAMPS		LPC519T	Pipe Clamp lead coated brass fits upto 1" Pipe
		LPC521T	2" Pipe Clamp U Bolt fits 1" to 2" O.D. Tinned Copper
		LPC522T	3" Pipe Clamp U Bolt fits 2" to 3" O.D. Tinned Copper
		LPC523T	4" Pipe Clamp U Bolt fits 3" to 4 1/2" O.D. Tinned Copper
		LPC524T	6" Pipe Clamp U Bolt fits 4 1/2" to 6 3/4" O.D. Tinned Copper
		LPC525T	8" Pipe Clamp U Bolt fits 6 3/4" to 8" O.D. Tinned Copper
BONDING CLAMPS		LPC510T	Hand Rail Clamp, lead coated brass, fits 5/8" Beam
		LPC512T	C-Clamp, lead coated brass, fits up to 1" thick metal beam, 8" sqaure surface contact
SPLICES & CONNECTORS		LPC4011T	Parallel Splice single bolt lead coated bronze fits 1 1/2" wire
		LPC412	Bonding Lug Bimetallic for copper-aluminum conection at thief hatch,

		with 5/16" mounting hole
AIR TERMINAL BASE	LPC304T	Dual Mount base adhesive or screw down; horizontal/vertical Lead coated Brass
	LPC332T	Dual Mount U-Bolt Base with Pipe Clamp and cable connector, fits 1.9"-3" OD Pipe, Lead Coated Brass
	LPC333T	Dual Mount U-Bolt Base with Pipe Clamp and cable connector, fits 2.75"-4.5" OD Pipe, Lead Coated Brass
	LPC334T	Dual Mount U-Bolt Base with Pipe Clamp and cable connector, fits 4.5"-6.75" OD Pipe, Lead Coated Brass
	LPC308T	Pipe Clamp Mounting base, horizontal/vertical, fits 1 3/4" to 2 1/2" OD. Lead Coated Brass
	LPC342T	Dual Mount U-Bolt Base with Pipe Clamp no cable connector, fits 1.9"-3" OD Pipe, Lead Coated Brass
	LPC343T	Dual Mount U-Bolt Base with Pipe Clampno cable connector, fits 2.75"-4.5" OD Pipe, Lead Coated Brass
	LPC344T	Dual Mount U-Bolt Base with Pipe Clamp no cable connector, fits 4.5"-6.75" OD Pipe, Lead Coated Brass
STATIC GROUNDING CABLE	LPC161	Static Grounding Cable Green CPW 6 THHN
FLEXIBLE STRAPS	LPC140	STAINLESS STEEL FLEXIBLE STRAP 1/2"X12"
	LPC141	STAINLESS STEEL FLEXIBLE STRAP 1/2"X19 1/2"
	LPC144	STAINLESS STEEL FLEXIBLE STRAP 1/2"X16" Hole size 5/16"x1/2"
	LPC144	STAINLESS STEEL FLEXIBLE STRAP 1/2"X16" Hole size 5/16"x5/16"
	LPC145	STAINLESS STEEL FLEXIBLE STRAP 1/2"X12"
	LPC146	STAINLESS STEEL FLEXIBLE STRAP 1/2"X18" hole size 5/16"x9/16"
	LPC147	STAINLESS STEEL FLEXIBLE STRAP 1/2"X18" hole size 5/16"x15/16"
	LPC148	STAINLESS STEEL FLEXIBLE STRAP 1/2"X18" hole size 5/16"x5/8"
LIGHTNING PROTECTION CABLE	LPC110	CLASS 1 LIGHTNING PROTECTION CONDUCTOR COPPER TIN PLATED
	LPC131	CLASS II LIGHTNING PROTECTION CONDUCTOR COPPER TIN PLATED
DISSPATION AIR TERMINALS	DIS101	AIR TERMINAL COPPER, SS DISSPATERS 1/2"X12"
	DIA102	AIR TERMINAL COPPER, SS DISSPATERS 1/2"X18"
	DIS103	AIR TERMINAL COPPER, SS DISSPATERS 1/2"X24"
	DIS104	AIR TERMINAL COPPER, SS DISSPATERS 1/2"X36"
	DIS105	AIR TERMINAL COPPER, SS DISSPATERS 1/2"X48"
	DIS105OFFSET	AIR TERMINAL COPPER, SS DISSPATERS 1/2"X48" OFFSET
	DIS106	AIR TERMINAL COPPER, SS DISSPATERS 1/2"X60"
	DIS106OFFSET	AIR TERMINAL COPPER, SS DISSPATERS 1/2"X60" OFFSET
	LPC901	AIR TERMINAL COPPER WITH WIND SOCK , SS DISSPATERS 1/2"X10", ADAPTER TO FIT 1/2" OR 3/4" PIPE
LOAD OUT BONDING	LOADOUT15	LOAD OUT BONDING ASSMEBLY 15' WITH SS SAFETY CABLE AND 4" CLAMP TO FIT 4"-4 1/2" OD PIPE
	LOADOUT20	LOAD OUT BONDING ASSMEBLY 20' WITH SS SAFETY CABLE AND 4" CLAMP TO FIT 4"-4 1/2" OD PIPE
	LOADOUT25	LOAD OUT BONDING ASSMEBLY 30' WITH SS SAFETY CABLE AND 4" CLAMP TO FIT 4"-4 1/2" OD PIPE
	LOADOUT30	LOAD OUT BONDING ASSMEBLY 40' WITH SS SAFETY CABLE AND 4" CLAMP TO FIT 4"-4 1/2" OD PIPE
	LOSIGN6X9	LOAD OUT BONDING POINT SIGN, ALUMINUM 6"X9"
IN-TANK STATIC NEUTRALIZER " STATIC LASSO"	SL-12-15	STATIC LASSO - IN-TANK INDUCTIVE NEUTRALIZER, CONDUCTIVE COPPER FIBER LENGTH 13'6" + ANCHOR WEIGHT 15LBS
	SL-15-15	STATIC LASSO -IN-TANK INDUCTIVE NEUTRALIZER, CONDUCTIVE COPPER FIBER LENGTH 16'6" + ANCHOR WEIGHT 15LBS
	SL-16-15	STATIC LASSO - IN-TANK INDUCTIVE NEUTRALIZER, CONDUCTIVE COPPER FIBER LENGTH 17'6" + ANCHOR WEIGHT 15LBS
	SL-18-15	STATIC LASSO -IN-TANK INDUCTIVE NEUTRALIZER, CONDUCTIVE COPPER

		FIBER LENGTH 19'6" + ANCHOR WEIGHT 15LBS
	SL-20-15	STATIC LASSO -IN-TANK INDUCTIVE NEUTRALIZER, CONDUCTIVE COPPER FIBER LENGTH 21'6" + ANCHOR WEIGHT 15LBS
	SL-24-15	STATIC LASSO -IN-TANK INDUCTIVE NEUTRALIZER, CONDUCTIVE COPPER FIBER LENGTH 25'6" + ANCHOR WEIGHT 15LBS
	SL-30-15	STATIC LASSO -IN-TANK INDUCTIVE NEUTRALIZER, CONDUCTIVE COPPER FIBER LENGTH 31'6" + ANCHOR WEIGHT 15LBS
	SL-33-15	STATIC LASSO -IN-TANK INDUCTIVE NEUTRALIZER, CONDUCTIVE COPPER FIBER LENGTH 34'6" + ANCHOR WEIGHT 15LBS
ALUMINUM PARTS FOR HIGH H2S AREAS	LPA101	CLASS 1 LIGHTNING PROTECTION CONDUCTOR ALUMINUM
	LPA110	CLASS II LIGHTNING PROTECTION CONDUCTOR ALUMINUM
	LPA140	ALUMINUM FLEXIBLE STRAP 3/4"X12 " hole size 5/16"x5/16"
	LPA144	ALUMINUM FLEXIBLE STRAP 1"X16 " hole size 5/16"x1/2"
	LPA146	ALUMINUM FLEXIBLE STRAP 1"X18 " hole size 5/16"x9/12"
	LPA4011	PARALLEL SPLICE ALUMINUM SINGLE BOLT, FITS 1 1/2"
	LPA4111	STRAIGHT SPLICE BIMETTALIC, ALUMINUM TO COPPER
	LPA510	HAND RAIL CLAMP, ALUMINUM, FITS 5/8" BEAM THICKNESS
	LPA512	BONDING CLAMP, ALUMINUM, 8" SQUARE CONTACT SURFACE
	LPA519	U-BOLT PIPE CLAMP, ALUMINUM, FITS OD PIPE - UP TO 1"
	LPA521	U-BOLT PIPE CLAMP, ALUMINUM, FITS OD PIPE - 1" TO 2"
	LPA522	U-BOLT PIPE CLAMP, ALUMINUM, FITS OD PIPE - 2" TO 3"
	LPA523	U-BOLT PIPE CLAMP, ALUMINUM, FITS OD PIPE - 3" TO 4 1/2"
	LPA524	U-BOLT PIPE CLAMP, ALUMINUM, FITS OD PIPE - 4 1/2"" TO 6 3/4"
	LPA530	BONDING LUG, ALUMINUM, WITH 3" SQUARE SURFACE CONTACT, 9/16" HOLE
	LPA530A	BONDING LUG, ALUMINUM, WITH 3" SQUARE SURFACE CONTACT, 7/8" HOLE
	LPA603FF	SWIVEL F-F 1/2" TO 1/2", ALUMINUM
	LPA601FM	SWIVEL F-M 1/2" TO 1/2", ALUMINUM
	LPA802	CABLE HOLDER STAMPED ADHESIVE, ALUMINUM
	LPA803	CABLE HOLDER SCREW DOWN 1/2" WIDE 3/16" HOLE, ALUMINUM

14.4 Appendix 1-D - Site Commissioning

			REMARKS
SITE INFORMATION	DATE		
	OPERATOR NAME		
	NAME OF SITE		
	COORDINATES OF SITE		
	LP INSTALLATION DATE		
	LP INSTALLATION CONTRACTOR NAME		
	INSPECTOR NAME		
	INSPECTION COMPANY NAME		
TANK BATTERY	H2S LEVEL		
	TANK BATTERY CONFIGURATION		
	CONTAINMENT LINER YES/NO		
	CATWALK LADDER OUTSIDE CONTAINMENT YES/NO		
	CATWALK LADDER AT BOTH ENDS YES/NO		
	NUMBER OF ADDITIONAL LADDERS		
	NUMBER OF LOAD OUTS		
	OUTMOST TANK TOP PIPES STEEL/ FIBERGLASS		
ELECTRONICS	RTU PANEL POWER 120VAC/12VDC/24VDC		
	MAIN SERVICE ENTRY 480VAC/120-208VAC/277-480VAC		
	VFD POWER RATING 480VAC		
LAMP POST	NUMBER OF LAMP POSTS		
	LAMP POST METAL/WOOD		
PROCESS EQUIPMENT	HEATER TREATER VERTICAL/ HORIZONTAL		
	SEPARATOR VERTICAL/ HORIZONTAL		
	NUMBER OF TRAINS		
	LEVEL OF AUTOMATION LOW/HIGH		
OTHER EQUIPMENT	TANK SIZE (HEIGHT/ DIAMETER/ VOLUME)		
	GENERATOR SIZE (LENGTH/ WIDTH/ HEIGHT)		
	COMPRESSOR SIZE (LENGTH/ WIDTH/ HEIGHT)		
		COMMENTS	MODEL NUMBER
TESTS	SOIL RESISTIVITY TEST REPORT		
	FALL OF POTENTIAL & 62% GROUND ELECTRODE RESISTANCE TEST		
	LOAD OUT		
	TANK BATTERY LIGHTNING		

	PROTECTION GROUND ELECTRODE		
MAIN CONDUCTOR	TYPE OF WIRE CLASS 1 / CLASS II AL/ CU		
	ONE CONTINUOUS LENGTH FROM ONE END TO ANOTHER		
	ROUTED ALONG TOE KICK		
	FASTNEDED AT EVERY 3FT WITH APPROVED CLAMP		
	GROUND ELECTRODE AT BOTH ENDS OF THE CATWALK		
	NUMBER OF ADDITIONAL GROUND ELECTRODES		
	TYPE OF GROUND ELECTRODE - ROD/ PLATE		
	APPROVED GROUND CLAMP - YES/ NO		
	APPROVED INSPECTION WELL - YES/ NO		
	TANK TOP CONNECTIONS		
	METAL PIPE		
	THIEF HATCH		
	BULL PLUG ON FIBERGLASS TANK		
	ENARDO VAVE		
	TANK STICK CHASSIS		
	APPROVED TANK STICK SURGE PROTECTION DEVICE		
	OTHER ISOLATED METAL FITTINGS		
THIEF HATCH	TYPE OF THIEF HATCH BONDING STRAP - SS/ 1"WIDE/ 12"-18" LONG		
	APPROVED BONDING LUG - YES/ NO		
	MATERIAL OF BONDING LUG - AL/ CU		
	MATERIAL OF BONDING CABLE - CLASS I/ CLASS II AL/CU		
IN-TANK	IN-TANK STATIC DRAIN INSTALLED YES/ NO		
	TYPE OF DRAIN - CARBON / SS		
TANK BATTERY AIR TERMINALS	TYPE OF AIR TERMINAL - DISSIPATION / 1/2" X 18"		
	PLACED ON OUTERMOST PIPING/ HANDRAIL - YES/ NO		
	SPACED NOT MORE THAN 15FT APART - YES/NO		
	CONDUCTOR RUN ALONG THE PIPING CONNECTING AIR TERMINALS - YES/ NO		
	TYPE OF PIPING - METAL - FIBERGLASS		
	APPROVED AIR TERMINAL BASE -		

	YES/NO		
	APPROVED CABLE CLAMPS ALONG THE PIPE - YES/ NO		
	PIPING BONDED TO BACKBONE AT BOTH ENDS - YES/NO		
	NUMBER OF DOWNCONDUCTOR RUNS BESIDES TWO AT BOTH ENDS		
	APPROVED OFFSET AIR TERMINALS ON VENT VALVES - YES/NO		
	APPROVED WINSOCK AIR TERMINAL - YES/NO		
LOAD OUT	APPROVED ASSEMBLY - YES/NO		
	APPROVED PIPE CLAMP - YES/NO		
	DEDICATED GROUND ELECTRODE INSTALLED - YES/NO		
	TYPE OF GROUND ELECTRODE - ROD/ PLATE		
	APPROVED GROUND CLAMP - YES/ NO		
	APPROVED INSPECTION WELL - YES/ NO		
	CABLE TYPE #6 COPPER FLEXIBLE GREEN JACKET - YES/NO		
PROCESS AREA	GROUND ELECTRODES AT EACH CORNER FOR PROCESS AREA - YES/ NO		
	NUMBER OF ADDITIONAL GROUND ELECTODES IN PROCESS AREA		
	TYPE OF GROUND ELECTRODE - ROD/ PLATE		
	APPROVED GROUND ROD CLAMP - YES/NO		
	APPROVED INSPECTION WELL - YES/ NO		
	CABLE TYPE CLASS 1 TINNED COPPER - YES/NO		
	APPROVED CABLE TO EQUIPMENT CLAMP - YES/NO		
	TYPE OF AIR TERMINAL - DISSIPATION / 1/2" X 18"		
	PLACED ON PIPING OF EACH EQUIPMENT - YES/ NO		
LAMP POST	GROUND ELECTRODE AT EACH LAMP POST - YES/NO		
	TYPE OF POST - METAL/ WOOD		
	TYPE OF DOWNCONDUCTOR CLASS 1 TINNED COPPER - YES/NO		
	APPROVED CABLE CLIPS - YES/NO		

	CLIPS EVERY 3 FT - YES/NO		
	CABLE ROUTED STRAIGHT WITH NO SLACK - YES/NO		
	TYPE OF GROUND ELECTRODE - ROD/ PLATE		
	APPROVED GROUND ROD CLAMP - YES/NO		
	APPROVED INSPECTION WELL - YES/ NO		
	CABLE TYPE CLASS 1 TINNED COPPER - YES/NO		
	APPROVED CABLE TO EQUIPMENT CLAMP - YES/NO		
	TYPE OF AIR TERMINAL - DISSIPATION / 1/2" X 18"		
	PLACED CENTER OF EACH LAMP POST AT LEAST 10" HIGER THAN LAMPS - YES/ NO		
RTU PANEL	APPROVED SPD AT POWER ENTRY - YES/NO		
	SPD GROUNDED TO ISOLATED GROUND POINT - YES/NO		
	APPROVED SPD FOR COMMUNICATION ANTENNA ENTRY - YES/NO		
	SPD GROUNDED TO CONTROL PANEL EQUIPMENT GROUND - YES/NO		
	APPROVED SPD FOR EACH CONTROL CIRCUIT - YES/NO		
	SPD GROUNDED TO ISOLATED GROUND POINT - YES/NO		
MAIN SERVICE & VFD	APPROVED SPD AT MAIN SERVICE PANEL - YES/NO		
	SPD GROUNDED TO MAIN SERVICE GROUND - YES/NO		
	SPD CONNECTED IN PARALLEL TO LEAD LENGTH NOT MORE THAN 8" - YES/NO		
	APPROVED SPD AT EACH VFD - YES/ NO		
	SPD CONNECTED TO GROUND TERMIMNAL OF VFD POWER ENTRY - YES/NO		
	SPD CONNECTED IN PARALLEL TO LEAD LENGTH NOT MORE THAN 8" - YES/NO		

14.5 Appendix 1-E - Preventative Maintenance

Assets	Inventory	Compliance Questions	Response	Remarks	Image
Tank Battery	**Tank battery**	**General**			
		Any notable corrosion?			
		Any notable physical damage?			
		Grounding			
		Clamp-On meter reading?			
		Approved Ground Rod or Plate?			
		Approved Clamp?			
		Cable secured to Rod?			
		Test Well Installed /Intact?			
		At least two ground points (one each at opposite sides of battery)?			
		Ground Electrode at base of every stair?			
		Spacing between electrodes less than 100'?			
		Number of Electrodes?			
		Bonding			
		Approved Conductor?			
		Routed along toe kick?			
		Fastened at every 3'?			
		Approved Clamps?			
		Proper Routing?			
		Physical Damage?			
		Air Terminals			
		Approved air terminals?			
		Approved bases?			
		approved clamps?			
		outermost pipe/handrail?			
		Spacing no more than 15'?			
		offsets at vent valves?			
		air terminals on windsocks?			
		Conductor on non conductive pipe?			
		Bonded to backbone at intervals no more than 100'?			
	Steel Tanks	approved thief hatch strap?			
		approved lug			
		approved conductor?			
		strap properly between lid and flange?			
		conductor between lug and backbone?			

		lasso installed ?			
		Any notable corrosion?			
		Any notable physical damage?			
	Fiberglass tanks	approved thief hatch strap?			
		approved lug			
		approved conductor?			
		strap properly between lid and flange?			
		conductor between lug and backbone?			
		isolated metal bodies bonded back?			
		lasso installed?			
		if C-veil exists, C-VEIL TERMINAL connected to site ground?			
		Any notable corrosion?			
		Any notable physical damage?			
process equipment		GROUND ELECTRODES AT EACH CORNER FOR PROCESS AREA - YES/NO			
		GROUND ELECTRODE SPACING LESS THAN 100FT - YES/NO			
		APPROVED GROUND ELECTRODE - YES/NO			
		APPROVED GROUND ROD CLAMP - YES/NO			
		APPROVED INSPECTION WELL - YES/NO			
		APPROVED CABLE - YES/NO			
		APPROVED CABLE TO EQUIPMENT CLAMP - YES/NO			
		ANY NOTABLE CORROSION - YES/NO			
		ANY PHYSICAL DAMAGE - YES/NO			
		APPROVED AIR TERMINAL - YES/NO			
		PROPER AIR TERMINAL PLACEMENT- YES/NO			
load outs		APPROVED ASSEMBLY - YES/NO			
		APPROVED PIPE CLAMP - YES/NO			
		APPROVED SIGNAGE - YES/NO			
		ANY NOTABLE CORROSION - YES/NO			
		ANY PHYSICAL DAMAGE - YES/NO			
		DEDICATED GROUND ELECTRODE INSTALLED - YES/NO			
		APPROVED GROUND ELECTRODE - YES/NO			
		APPROVED GROUND CLAMP - YES/NO			
		APPROVED INSPECTION WELL - YES/NO			
		APPROVED CABLE - YES/NO			
lamp posts		GROUND ELECTRODE AT EACH LAMP POST - YES/NO			

		TYPE OF POST - METAL/ WOOD			
		ANY NOTABLE CORROSION - YES/NO			
		ANY PHYSICAL DAMAGE - YES/NO			
		APPROVED DOWN CONDUCTOR - YES/ NO			
		APPROVED CABLE CLIPS - YES/NO			
		CLIPS AT EVERY 3 FT - YES/NO			
		CABLE ROUTED STRAIGHT WITH NO SLACK - YES/NO			
		APPROVED GROUND ELECTRODE - YES/ NO			
		APPROVED GROUND ROD CLAMP - YES/ NO			
		APPROVED INSPECTION WELL - YES/NO			
		APPROVED CABLE TO METAL POST CLAMP - YES/NO			
		APPROVED AIR TERMINAL - YES/NO			
		APPROPRIATE PLACEMENT OF AIR TERMINAL - YES/ NO			
compressors		GROUND ELECTRODE AT EACH COMPRESSOR - YES/NO			
		ANY NOTABLE CORROSION - YES/NO			
		ANY PHYSICAL DAMAGE - YES/NO			
		APPROVED GROUND ELECTRODE - YES/ NO			
		APPROVED GROUND ROD CLAMP - YES/ NO			
		APPROVED INSPECTION WELL - YES/NO			
		APPROVED CABLE TO METAL CHASSIS CLAMP - YES/NO			
		APPROVED AIR TERMINAL - YES/NO			
		APPROPRIATE PLACEMENT OF AIR TERMINAL - YES/ NO			
FLARE		GROUND ELECTRODE AT EACH FLARE - YES/NO			
		ANY NOTABLE CORROSION - YES/NO			
		ANY PHYSICAL DAMAGE - YES/NO			
		APPROVED GROUND ELECTRODE - YES/ NO			
		APPROVED GROUND ROD CLAMP - YES/ NO			
		APPROVED INSPECTION WELL - YES/NO			
		APPROVED CABLE TO METAL CHASSIS CLAMP - YES/NO			
RTU		APPROVED SPD AT POWER ENTRY - YES/ NO			
		SPD GROUNDED TO ISOLATED GROUND			

		POINT - YES/NO			
		APPROVED SPD FOR COMMUNICATION ANTENNA ENTRY - YES/NO			
		SPD GROUNDED TO CONTROL PANEL EQUIPMENT GROUND - YES/NO			
		APPROVED SPD FOR EACH CONTROL CIRCUIT - YES/NO			
		CONTROL CIRCUIT SPD GROUNDED TO ISOLATED GROUND POINT - YES/NO			
		GROUND ELECTRODE AT RTU - YES/NO			
		ANY NOTABLE CORROSION - YES/NO			
		ANY PHYSICAL DAMAGE - YES/NO			
		APPROVED GROUND ELECTRODE - YES/NO			
		APPROVED GROUND ROD CLAMP - YES/NO			
		APPROVED INSPECTION WELL - YES/NO			
		APPROVED CABLE TO CONTROL PANEL CLAMP - YES/NO			
MAIN SERVICE PANEL		APPROVED SPD AT MAIN SERVICE PANEL - YES/NO			
		SPD GROUNDED TO MAIN SERVICE GROUND - YES/NO			
		SPD CONNECTED IN PARALLEL TO LEAD LENGTH NOT MORE THAN 8" - YES/NO			
		APPROVED SPD AT EACH VFD - YES/NO			
		SPD CONNECTED TO GROUND TERMINAL OF VFD POWER ENTRY - YES/NO			
		SPD CONNECTED IN PARALLEL TO LEAD LENGTH NOT MORE THAN 8" - YES/NO			
		GROUND ELECTRODE AT MAIN SERVICE PANEL - YES/NO			
		ANY NOTABLE CORROSION - YES/NO			
		ANY PHYSICAL DAMAGE - YES/NO			
		APPROVED GROUND ELECTRODE - YES/NO			
		APPROVED GROUND ROD CLAMP - YES/NO			
		APPROVED INSPECTION WELL - YES/NO			
		BOND FROM TANK BATTERY LIGHTNING PROTECTION GROUND ELECTRODE - YES/NO			
		APPROVED CABLE TO CONTROL PANEL CLAMP - YES/NO			