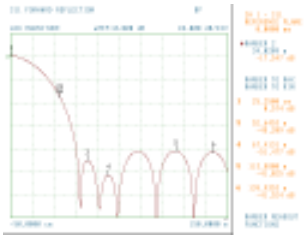

Lovelace Gas Service Inc.
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July 6, 2016

Hello Garry,
Thank you for the opportunity to work with you and Anderson on the possibility of reinforcing your grounding system at the shop on Colonial Drive. There is a procedure that I have used for this kind of work for many years that I will share with you. The initial visit to a facility is to become familiar with the layout, protection needs, known failure points, and new upcoming or potential needs. This information is critical to the next phase which is documentation. Having already been to the site before the inspection date, I was fairly familiar with the layout and a check of Google Earth and the great site plan that Anderson lent to me, I have a good picture of the spacing between the objects that need to be protected as well as now I have quite a photographic library of the tower and the items on the site. I spent about a half hour across the street from 2 locations on route 50 taking photos of the tower in detail and then once I met with Anderson, we took photos of the various conditions around the site.

I have designed around 100 systems and while some of the techniques are common in my designs, each design is custom tailored for every unique aspect of a client. The way that I charge for these services is a simple 3 tiered approach.

1.
Visit the site and become acclimated to the needs. This is typically a charge of $1,000.00 for the survey and write up. I am discounting this for you to $500.00. I appreciate your help and the Shropshire's recommendations to use your company for my office/home gas needs.

2.
If you choose to have me write up a plan of action and design a mitigative grounding system which includes parts lists, AutoCAD layouts and a complete narrative, this usual cost for a site of this complexity is $2,000.00. I would reduce the cost to $1,450.00 as this phase of work takes me several days to complete.

If you desire to have me work with the installation contractor of your choice to supervise the installation and perform testing on the installed system, which includes an Excel spread sheet of the AutoCAD layout that has the resistance testing results documented, this work is lower in cost at $500.00 per day, which I will discount down to $450.00 per day of construction plus 1 additional day for system testing. I will include the report preparation at no charge.

I believe that it is important to keep work and relationships in the family so to speak.

In reviewing the photos and after talking with Anderson at length about a number if facets of the tower and tenant grounding, I also am including some thoughts about your computer and telephone set up safety. We also touched on the need to tidy up the two tenant rooms from an electrical standpoint as well as air conditioning and housekeeping.

THE TOWER:
This is an interesting installation from the standpoint that this is an elevated guy wire system that is not short guyed, and the guy back tensioning method is a bit un-usual but very nice and effective. Provisions for grounding of the tower are in place with attachable tabs as well as the Fan Heads at the guy anchors. Though the tabs on the Fan Heads have not been utilized, it is good to know that they are available for use.

Without actually climbing the tower, the visual impression of the structure is very good as is the condition of the steel, the guy wires and elevated guy system. The tower base is in good visual condition with no cracking or spalling as are the six anchors point piers. The grounding that is in place seems to be comprehensive in that it takes advantage of all of the above ground visual indicators of completeness with a few exceptions. The tower is complete in the approach and layout of the grounding wires, trailers and leads along with the associated Heliax grounding bars but I take issue with the gauge of the wire used. Back about 30 years ago, some fool (who I know) convinced the world that tinned and bare #2 solid wire was the way to go for grounding. Unfortunately, the power company feels the same way when grounding a power pole but they ho ho ho this when working in real situations and sub-stations.

The anchors have a combination of large and small wire applied to them with some portions of the anchors grounded and other adjacent items not grounded. The application of the grounding wires to the actual guy wires is fairly ineffective though I do admit that the anchors are not spalled or cracked.

Anderson and I spent some time walking the site with my clamp on ground loop tester and we tried to get a feel for what the soil resistivity is as well as how effective the grounding system is that is already in place. This tester induces currents in to a ground rod and measures its actual impedance (AC) as it relates to the entire rest of the system. It measures this on single ended items like a rod or piece of metal that I can clamp its 1" jaw around. All in all the site displays a wide range of rod impedances (resistance) that run from 65 Ohms to 250 Ohms on any one measured object. The storage tanks and the supposed anodes are all over the map in these ranges and I did not measure any current flow on the anode lines (if that is what they are) to indicate that they are still active. I have not seen anode lines connected to the same bolted connection as the ground connection so I am not sure of the status of the other wire on each of the 3 tanks. I did find some disturbingly rusted bolts on the connections to the tanks.

The guy anchors are in need of considerable attention to draw off strike energy. Though guy wires attach to the tower in intervals, this interval in length also bleeds off strike energy in steps of time that are delayed by microseconds which makes a good ground system work better, and a deficient one, handle the shock load.

A strike on the top of the tower will direct the majority of the energy straight downward due to the physics of lighting liking to continue on the same directed path (down) that it took initially. The basically dead short of only about .1 Ohms of series resistance that the tower presents to a strike promotes this directivity of the energy. Fortunately, you have large diameter guy wires with good solid friction connections at the tower sockets. These multiple guy wires present similarly low resistances, and low inductance, to the energy and in an animation the strike will illuminate each descending guy level at the energy descends down the tower steel. Though the wires try to shunt this energy off at increasingly sharp take off angles, suffice to say that the amount of energy applied to the base to the tower is about 40% to 60% reduced due to this parallel electrical circuit. The complex relationship of DC resistance and AC inductance works in concert here to channel the energy to multiple grounding points in order to lessen the potential for Voltage rise, current flow, and damage.

The anchors need to be dually addressed. The elevated guy point intercepts 3 of the lower strike guy wires. This base pier is not grounded. I am actually amazed that none of the 3 elevated piers are damaged. The remainder of the guy wires channel the strike energy directly to the bank anchor Fan Head which is also not grounded at all. Each of the anchor points has a badly laid out grounding wire arraignment to the guy wires which creates poor conduction and directivity of flow as well as a poor range of ground impedance when checked with the clamp on tester. The zig zag of the trailing tail creates a very high inductive path that inhibits the flow of the strike current. The top of the tower will also need to be addressed with some recommended antenna movement and the addition of a lightning dissipation array that works very hard to keep the top beacon from becoming a pop corn kernel. The rod and dissipaters that are at the top currently will be relocated.

More is not better:
In the case of this site, more grounding is not always better. We do not know what the actual configuration of the grounding system is. We do not know for sure what the depths of the various devices or rods are. Short of standing out there with a Volt meter during a strong storm, a change in design is recommended. This site is high in elevation and yet the surface soils are usually always damp. This should contribute to very low testing readings but at the numbers measured, this is not the case. I am of the belief that the grounding system has deteriorated to a point where it is largely ineffective. I know that work was done on the base of the tower ground as it relates to the green house, and though the base ring measures well, what I am actually measuring is the ring loop resistance from rod to wire to the next rod and then to the electrical ground of the site. This number is totally misleading and even if tested with the "point of fall" type of tester, we will come up with the same low numbers but will not know the actual effectiveness of the tower base system to contain, divert and manage a tower strike. The average ground elevation of the site is around 74 feet. This is interesting since the average water table in this area is about 70 feet. This explains why the site is usually damp on the surface. This will influence the length of the ground rod drive design.

If you desire to have a new plumb and tension run on this tower, I have the best contractor in the business in state for a while. I would be happy to get a quote from him that would include a report.

RECOMMENDATIONS:

Tower:

A full grounded rod and ring is recommended for the base of the tower. Due to the nature of the gas storage on the site, I will tailor the design in accordance to help to protect the 3 large storage tanks.

This driven rod design incorporates inspection boxes to facilitate system testing and on-going maintenance. If a rod should become glassified, the inspection box allows for a new rod to be driven right next to the degraded one and properly connected with CadWeld methods. New trailing tails should be designed for the tower as well as the connections. All of the associated ground bars should be re-tailed and addressed and will likely remain on the old system to afford some separation of the strike energy unless a lightning bolt originates from inside on the of the tenant buildings. Then we will have other serious issues to think about.

GUY ANCHORS:

The guy anchors protection is a 2 prong design. Due to the elevated design of the anchors, 2 ground systems with inspection boxes will be designed. The first rod set and box will pick up the elevated pier as well as re-attach the guy wires to a properly installed trailing tail that is designed to promote current flow downward to the ground rod system. The Fan Head will sport a new ground rod design along with testing and inspection boxes to address the energy that arrives directly from the guy wires that are not intercepted by the elevated pier.

TANKS:

Some research will need to be done in to the existence of an anode system on the tanks and piping. I have an associate that specializes in Anodic and Cathodic protection systems. These systems are actually electrically powered and can provide a good way to prolong the life of the piping network at the site. While I am not initially concerned about galvanic deterioration of the tower anchor system or tanks, the piping may want to be inspected for corrosion. If you want to have my associate contact you, please let me know. He is independent from my office.

COMPUTERS AND PHONES:

While talking with Anderson, I see that the computer system is distributed through the office on some version of LAN cable with RJ-45 connections. These long runs of cable are a concern for blowing out the interconnected devices primarily from near field lightning strike energy (NEMP). This magnetic pulse can induce hundreds of Volts of energy in to a wire that normally only handles signals at 1Volt. I would be happy to make recommendations to you that can help to keep surges down to a minimum and help insure that the computers do not sustain damage from these strikes. I can also assist you with UPS selections for the server and work stations. You may want to also install a parallel surge suppression system on your various electrical services. I usually recommend an inserted series type device but this requires a major re-wire of the service. There are parallel surge suppressors that are pretty effective at minimizing surge energy from NEMP and from spike that the power company shares with you.

TENANT SPACES:
I want to recommend that we form a plan to tidy up the tenant spaces from an installations, wiring, grounding and house keeping stand point. There are issues in the green house that need to be addressed. There are cables that only go some where on one end. There are badly run and daisy chained grounds. Cables run amok everywhere and there is too much storage in these spaces. The Nextel shelter needs an evaluation of the flame thrower TV transmitter. This space is warm and damp and this needs to be addressed. The various tenant leases need to reflect their use of power and the facility in concert with their affect on the environment within a space as well as their contribution to the electrical bill. I would be happy to review the tenant leases with you and to evaluate and possibly form a plan to tidy up the spaces, generate additional rental area and make the rooms more habitable for the tenants.

If you have any questions about this work, please feel free to call my office at any time.

Thank you,

Gary A. Minker