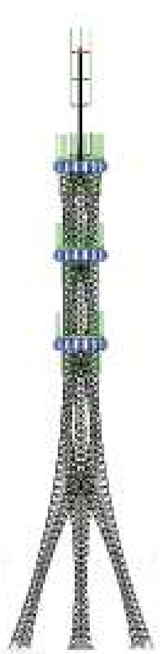
SITE TESTING FOR
SEACOAST WATER UTILITY
PALM BEACH GARDENS
HOOD ROAD WATER
TREATMENT PLANT
&
HOOD ROAD RE-PUMP PLANT
DECEMBER, 2016



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December, 2016

Gentlemen,

Thank you for the opportunity to work with you both and so many helpful members of your staff. You contacted my office with the desire to have a comprehensive grounding survey conducted on the Hood Road Water Treatment Facility as well as initially, the Hood Road Raw Water Re-pump plant. After our initial meeting and a walk through of the very basics of both of these facilities, I was able to get a first hand visual impression of the complexity of these two branches of the Utility. Once I received the 115 pages of electrical blue prints of all 4 facilities and took 4 or more days to review them, we had an additional meeting to discuss the project, its scope and the time that I now realized it would take to complete such a large undertaking. We agreed that initially the Hood Road treatment and Re-pump plants would be included in the initial assessment and on Monday the 12th of December, we started the review.

This project took 5 days of on site time. On the first 3 of the 5 days I brought in additional troops to assist with the assessment in various ways. On the first 2 days, my trusted Electrician assisted with the electrical testing on the Treatment plant site. On the 3rd day an associate from a company in the Tampa area arrived to catalog all of the various electrical devices in the treatment plant with regard to TVSS, metering and Power Factor analysis. This same associate also compiled some photographic data from 5 of the power monitor systems so that an evaluation of the power consumption, use, and VAR could be done to work on a potential payback solution for Reactive power consumption. On days 4 and 5, I worked at both the Hood Re-pump site and the Hood Treatment site by myself. A tremendous amount of data was collected in order to get a big picture about the grounding, TVSS surge arresting and potential front and back doors for damaging electrical problems that are causing problems within the various facilitates. The collected data is in the form of Excel spread sheets. These sheets are included in this report and are also provided as individual files for better viewing.

From my site walks, testing and comprehensive plans review, it is very clear to me that these facilities were designed to extremely high standards and conform to all applicable electrical codes. In a word, I have to say that the facilities are "fabulous" from a design stand point.

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My function as a consultant is to observe the operation of the plant, record testing data and develop comprehensive lists of any items that may be contributing to the damage of the facilities. While I find that the design of the electrical systems at the 2 initial locations is truly exemplary, I also find that the design of certain facets of the facility are lacking in scope and ability to protect the electrical assets.

From a power electronics standpoint, PLC control, LAN, and motor control viewpoint, most of the design of the facility conforms to what I call conventional training of the designers. This conventional training stems from an age issue of the designers, their era of training convention, and the understanding of field related experience. In this conventional training from typically a purely Electrical Engineering standpoint, many of the items that I take exception to in the design are readily corrected or modified and at minimal costs and with maximum results.

In my multiple backgrounds of Broadcast Engineering, Transmitter repairs, Antenna and Transmission Line testing and Electronic Fire mitigation plus a host of AC, DC, low and high Voltage training, I look at facilities such as these from a full circle of skill sets and not just the National Electrical Code, National Fire Prevention Association and the conventions of the training that accompanies the trades. A design convention in one skill set may be a hazard in another and be better attended to by a design change.

Each of the various electronic and electrical trades that operate within these facilities runs in to their respective damage and issues. Some times they are common and related and some times, they do not intersect from a causal stand point. This document will bring these items to light and in a prioritized manner so that the Operators and Administrators of the facilities can make educated decisions about the need for priority of the solutions offered. At no time is any solution that I bring mutually exclusive to say that you must do this or that, and that any one item or group of items must accompany another. Every item that I bring as a solution can be implemented individually and these solutions are offered in a tiered order of priority.

I will explain that solutions offered in a 4 tier plan run from tier1 which is the most important. Tier 1 items are deemed to be critical in nature. Tier 2 items are very important and should be seriously considered. Tier 3 items should be implemented as soon as is reasonable and Tier 4 items are not what I would call optional but should be brought on line as funds permit. You will observe that a solution item may be a tier 2 solution in one application and be a tier 3, or 4 solution in another application. This change in tier is typically due to the critical nature of any item and/or the nature of any available back up to the failure of a device.

Conventional systems designers create facilities such as these to adhere to the various codes for conformity but the codes often do not take in to account the potential for disaster from spikes and surges from the utility, direct lightning strike, near field lightning strike (NEMP) and in house generated spikes and surges from the switching on and off of adjunct equipment. In the case of these facilities due to the nature of the caustic chemicals, aluminum conduit is frequently used. While this type of conduit is resistant to corrosion, it offers nearly zero Mu or magnetic shielding from magnetic intrusion. PVC conduit also offers zero magnetic shielding. Due to the age of portions of the facility, open top (un-shielded) cable support trays convey the electrical conductors to the various motors and other devices. This open door lack of shielding makes every cable in the facility susceptible to magnetic incursion.

In my review of the many pages of blue print schematics and 1 line drawings of the distribution systems, I find that the designers introduction of Transient Voltage surge Suppression (TVSS) is not prudently located to insure minimal damage from problems introduced from either a front door incursion or back door intrusion. The drawings will have you believe that the facility is protected but on site observation from first hand touring clearing shows that the amount of TVSS installed in the facility is sorely lacking and only protects the middle of any of 7 systems which leaves the front and back doors wide open. These issues also dramatically affect the digital control of the facilities. Poor TVSS in association with grounding problems wreak havoc with the digital controls, SCADA, PLC's and other monitoring systems.

PLC's SCADA and plant control systems all rely on a much more delicate control ladder than the raw Voltages required to simply run motors. Whether it is LAN, (cat5 or cat6) 4-20mA, mod buss, RS-485 or another delicate transport mode, a solid ground reference is critical. Even the fiber connectivity can be compromised if the connected fiber switches are under power line or reference ground disruption attack. Filtered, on-line uninterruptable power (UPS), Star Point bonding within a control cabinet, solid ground based original neutrals within a control cluster and installation of the full host of TVSS for the various transport modes (LAN or RS) can not be under estimated. A glitch in a ground, power supply or neutral will cause operational errors, reset controls, start or stop critical processes or potentially cause a HazMat situation to occur. Most if not all of these issues can be avoided if the control and monitoring systems are glitch free.

In a facility of these physical sizes, it is important to seriously scrutinize the conventional design protocols that tie everything together. This unification of power and grounding becomes problematic. These facilities are designed in a "mat" arrangement and not a "star" arrangement. In certain physical layouts this homogenous interconnection of power and ground is a wise design criteria. Once a facility grows to the physical size and electrical complexity of these plants, it is important to re-consider this unification. Each area of a plant must be considered as an individual entity such as in a Star ground design. These individual entities within the property boundary must be able to deal with power, lighting and surge issues on their own without sharing the joy of a failure with an adjacent entity or building.

A direct strike on the water tower should stay at the water tower and not rely on spreading the "joy" to any of the other facilities such as Chlorine storage where a HazMat could occur, or the HSPS. The current installation and design is set up to share this "joy" which is a root cause for problems. Circulating currents and Ringing, cause un-told damage as the ring wave see-saw's back and forth unsuppressed through the adjacent power and control cables until it literally wears itself out, wiping out everything that it passes on the way back and forth. With proper ground system designs and TVSS, this ring wave front is suppressed quickly and the damage, no matter the source is minimized if not fully mitigated.

Clear Blue Twenty Two Failures:
There we were, making water and on a clear blue day with puffy clouds hovering at 22,000 feet, a Variable Speed Drive goes up in flames or a 400 horse motor sets off the smoke alarm. The obvious "why" question floats around and the real answer is that the lightning strike on the site that was months ago caused a carbon track in the motor, or set a "leak" in motion in a switching transistor in the VFD, and for no apparent reason other than we were making water, It Happened. This is what we intend to slow down to a dead crawl if not stop completely.

In no way do I fault any design that I have encountered in these facilities. I fault the conventions of design and the limited background of the interpretation of those design conventions from narrowed view points. We can make these problems largely disappear. Fortunately, each time there is a failure it should point us toward a trap door that we miss. It is my intention to not miss any of these traps but this is an imprecise science and every attempt to cover these egress points will be made. This work is conducted on a best effort basis and I can not warrant that complete success can be made though I do know that many of my design suggestions that will be made here are intensely successful. I rely strongly on the staff of facilities such as these for their insight and knowledge about the particular problems that present themselves that only years of involvement in working on and at facilities such as these can bring about.

I look forward to lively debate with any member of staff or the design teams. I stand by my findings and opinions and though I reserve the right to learn something from any discussion or debate, I can still change my mind on any given topic.

I am grateful for this opportunity and look forward to improving the reliability of the Utility to Make Water.

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

Thank you,

Gary A. Minker

ISSUES

GROUNDING:

Lightning and electrical fault clearing are only part of the task of the ground system. If you take for granted that the ground system is partially to be designed as a personnel safety feature, the other end of the project is lightning protection. With this end of the spectrum, the function of a properly designed system is first to stream off as much of the ground charge as possible to bring the differential of potential down to a low enough level to avoid a strike in the first place. If this can not be accomplished and a strike is imminent, the resulting strike will contain only enough energy to complete the stepped leader and the energy imparted in to the strike will be greatly reduced compared to what would have hit at first. Once struck the system needs to manage the energy and throw this energy in to a place that will not cause damage. These are the reasons for a properly designed ground system based on the size and complexity of the facility. The 2 principal designs are the Mat and Star systems.

In the collected data that you will see on the Excel sheets from both the Treatment Plant and the Hood Raw Water Re-pump station there are 3 methods of measurement. 2 of these are conventional pieces of test equipment. The clamp on single ended tester for ground rods and similar electrical situations, and the 3 point of fall tester. The single end clamp induces a current in to the wire or rod and measures the return of the "loop" of the circuit. This tester is often mis-used and the results are totally false. What most people wind up doing is measuring the short circuit loop of the metals in a loop or ring. This data is worthless and misleading which will always yield a reading below 1 Ohm. This should set up red flags. The 3 point tester measures what ever you connect the test clip to against the earth around the locale of the test. This catch all does not measure the local grid or ring, thing or metal group against earth if it is connected via a halo or other length or mat to other entities in the system. This again is very problematic as the readings achieved can be a total falsehood that is misleading in the nature of the actual Ohmic reading. You are in essence reading the entire distributed facility against earth balanced against the total resistance of the interconnective halo. Again, potentially bad data. The 3rd measurement device is something from the 30's. This isolated AC voltage source measures the total current between entities to discover the actual Ohmic reading of the connectivity of the test target to another test target which insures that entities are actually connected together. The prudent use of all of these devices gives you a picture of the system but depending on the design of your system, actual Ohmic readings of individual items is impossible. All of this is an interpretation.

Measurements taken and logged on the Excel sheet are location dependant and the apparatus used was selected to show the best available data for any location. In a well designed system like this, it is not uncommon to have interconnection resistances of substantially less than 1 Ohm. The 3 point testing of the entire plant at any location to earth is running an average of 5 Ohms and the single ended clamp on readings are all over the road due to poor connections and poor soils or short rods of 10 to 100 Ohms.

All of these numbers are expected and typical but not a confidence builder of how a direct strike will be handled. The installation of nearly every ground rod on the property consists of a single 10 foot rod with a CadWeld connection at the top. Due to the variable soils at these facilities, the Ohmic readings range from poor to dangerous. 10 Ohms to 100 Ohms in a 480 Volt plant yields at most, 48 Amperes of current flow in a sustained short and with Delta balanced configurations, this will not clear a fault device such as a fuse or circuit breaker.

The result will be an operating grounded leg that will drive the other 2 legs skyward toward 900 Volts. This elevated Voltage above Earth can cause un-told destruction until some fault clearing device notices that the entire service has been shoved skyward, or a technician is badly burned being un-aware that there is a fault in progress. With this kind short circuit condition, the frame of the shorted device also skyrockets to an un-safe Voltage level which can kill an unsuspecting technician. This is blessing and curse in a delta system. The power will remain on but the hazard to personnel is extreme.

At this time, the entire property at both sites is poorly grounded in this light. I recommend that an enhanced grounding system be installed at each critical area as an adjunct to the original installations. I recommend that rods be driven substantially deeper, and that each rod be augmented with a usable inspection box and not these foolish little round wells that only offer a visual indication that there is a rod down there. A photo of an example of a box and rod is attached.

Note meter box, conduit entry point and rods being assembled

All new ground rods are to be driven to a depth of a minimum of 40 feet. The rods are to be a minimum 1/2" diameter and threaded to accept couplers. A rod is driven to about 7 feet, a 2nd rod is coupled to the first rod and the joint tightened with pipe wrenches and then the joint is torch brazed. This is repeated and driven to about 10" below grade so that the inspection box can allow for the use of the clamp on meter to test the effective Ohmic rating of EACH rod individually and not as a collective. Larger diameter rods only improve conductivity by less than 5 percent in most cases.

Connection to the driven rod is Exothermic and each rod is recorded in a table to show the driven depth which tracks any rods driven to an insufficient depth. The Exothermic connections are to be a minimum of 6 inches above the soil in the bottom of a box or on top of a slab to allow the use of the clamp on meter system for testing. Annual clamp on testing is conducted to insure that glassification of any rod has not occurred.

If this glassification should occur, a new rod is simply driven in the same meter box and Exothermically welded to the existing system and tested. I recommend large meter or valve boxes with the lid set just below the grass level to avoid lawn mower damage.

Boxes in vehicular traffic areas can be heavy duty to support wheeled traffic. In a perfect world, I would locate and cut the tie connection between entities and let any 1 entity rely on its new enhanced ground system and keep any problems within its pervue and not share the love to another adjoining entity. I recommend that the inspection boxes be piped with PVC between them so that any damage to the connecting cables can be easily remedied as the lengths of wire buried a few inches below grade has a nearly zero contribution to the grounding profile. The bonding conductor can be insulated THHN and be gauge 4/0. This is good, low reactance wire and is cheaper than bare braid. Any connections that rise up to connect to an apparatus should be connected with a 2 hole, 3 band crimped lug with anti-corrosive goop injected in to the barrel. Only stainless steel hardware is to be used for fastening.

Many of the entities in these facilities rely on stray and random piping or conduit connections to achieve a ground. Of particular note are the 2, 20,000 gallon Diesel tanks located near the Process Plant. These 2 tanks are not actually grounded and only have casual lightning static terminals protruding above them. The filler box connection is not grounded and relies on the piping to achieve static dissipation.

It is the geometry of the deep driven rods that makes them effective. Long rods have a much lower resistance but it is about the charge dissipation geometry that makes the difference. Short 10 foot rods radiate energy in a spherical pattern which throws very little energy deep in to the core of the earth away from other entities. Longer rods present a descending directive cardioid pattern to the discharge of the energy. This is also true in how a rod or group of rods absorbs charge. If the adjacent rod systems throw a strike charge in a cardioid pattern downward, much less energy is available to be picked up by a passive adjacent system.

There are a number of areas of deficiency in the ground rod department. Starting at the beginning, the 2 FPL meters that monitor the power consumption for the Treatment Plant have short, loose, defective ground rods with loose clamps and poor Ohmic readings. Of the only 6 single ended ground rods at the Treatment Plant, none of them have Ohmic readings below 10 Ohms and several of them have loose clamps. Most of them have corroding clamps as they are made of the wrong materials including common electroless steel fasteners. None of these rods will clear a fault at any service voltage from 120VAC to 277VAC, let alone a 480 phase short. The new "delta" driven rod trio at the HSPS generator output has a reading of 4.7 Ohms but again, even a 277 Volt failure will only draw 59 Amperes which arguable will also not clear a safety device.

The common deficiency of ground system design is to only focus on the resistance. While every ground designer focuses on this low resistance, it should not be the primary consideration. While grounding systems are centered on 60 Hertz which has little difference in this genre down to Direct Current (DC), lightning is far from this close inductive reactance relationship.

Standard calculations of Ohms Law or Kirchhoff's law can apply but these embedded systems are also for Lightning. Grounding of AC faults, and managing of lightning does not follow these simpler mathematic calculations. Lighting emulates a Radio Frequency signal. (RF) This initial strike and ringing energy emulates an RF carrier wave of between 200 Megahertz and 500 Megahertz.

These are very high frequencies and conventional thinking in the design of a ground system causes problems. If the math is run to take in to account the Inductive Reactance of the rise time of the front of a lightning wave, the measured DC or low frequency resistance of 5 or 10 Ohms is blown totally away by the now actual hundreds to thousands of Ohms in Inductive Reactance augmented by the measured values shown in the Excel tables herein. At these levels of Ohmic value, a lightning strike will stay in the thousands to tens of thousands of Volts in level and damage will reign supreme. Careful design of a ground system that takes into account this Inductive Reactance is exponentially more effective than a poorly derived mechanical design. An effective grounding system is not just about AC power fault clearing, it is about managing RF frequency energy.

AIR TERMINALS:

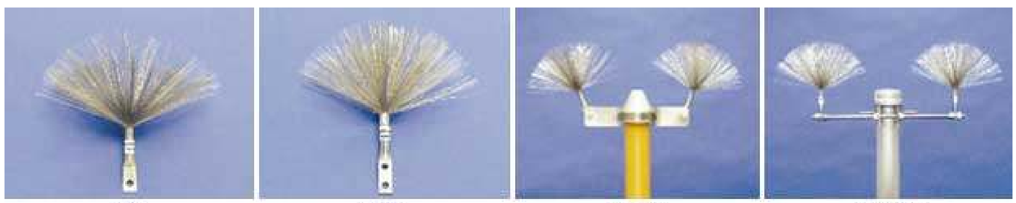
Another of the common hostile discussions is the lighting dissipation array, or Static Air Terminal. Ben Franklin tried very hard to kill himself to prove a point that too many designers are not grateful for. The debate over pointed rods verses rounded rods reigns king as does the theory whether lightning goes from the top down or the bottom up. I am of the camp that says any sharp object will stream Ions and electrons at a higher level than a rounded object. I call VandeGraff and Tesla to the witness stand. A sharp rod of a single point will eventually passivate by natural wear of the streaming of ions and will eventually lose its pointed stature. The fuzzy bottle brush style of air terminal will always have a sharp point somewhere on the device and while lots of sharp points that are not too close together will stream more ions, hence the ground charge better than a single point. A single point is more effective than a blunted or rounded rod. Birds be damned, this is about the safety of the personnel and equipment at the site so that we can make water. The birds can sit somewhere else. I recommend that all of the air terminals on the facilities be changed out. Structures such as the Treatment Plant water tower need special care as there are tall antennas mounted up there that must be attended to carefully so as to not affect their operation.. Care should also be taken to insure that all of the joiners of lightning braid be corrosion free.


Example of badly corroded joiner


Improper ground connector as seen in multiple locations

Beveled top rod

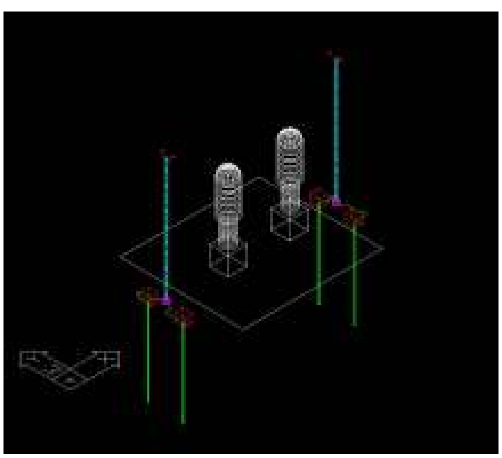
How not to connect a lamp post to earth.

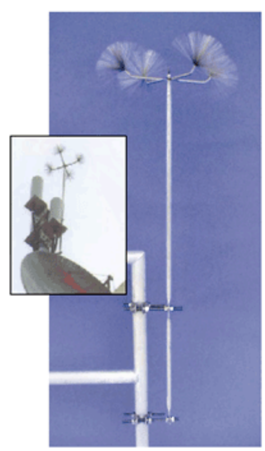


SDE-1 SDE-2 SDE-22A SDE-22B

Images courtesy of LBA Group

In addition to the myriad of Air Terminals already installed at the Treatment facility, the two sets of vertical shaft pumps are un-protected. The concentrator pumps and the other pair of vertical shaft units nearby need to have diversionary target array Static Air Terminals. A drawing is provided at the end of this document. A direct strike on any of these 4 pumps could be devastating to water production.





The grounding rods for these protective target terminals is not to be connected to the existing halo and is to be driven independently to a depth of 40 feet. I recommend the installation of 18 foot tall target pipes with the fuzzy style of static dissipation arrays mounted on them.

These Air Terminal units from LBA are perfectly suited for this use. They are to be installed as shown in a supplied drawing that is included in this document. These targets are NOT to be attached to the grounding grid tails system and are to have their own ground systems installed that are identical to the twin tails recommended for the remote well head transformers. Each rod feed wire is a single run of exothermically welded connections ran through PVC piping from the base of the target to the test box where the CadWeld remains a minimum of 5 inches above the soil level for testing with a clamp on meter. Any existing Static Terminals on equipment of this type is to be removed. The motors may remain connected to the existing halo system.

These target stanchions are easily fabricated by a company like Palm Beach Iron Works and then sent out to be hot dip galvanized. The stanchions should be set on to small concrete foundations or lighting pole pre-form cylinders. The target pipes should be a continuous pipe without a splice or threads, The meter boxes are part number,

http://www.homedepot.com/p/DURA-12-in-x-17-in-x-12-in-Deep-Rectangular-Valve-Box-in-Black-Body-Green-Lid-120/203473554

Conventional PVC pipe is used to serve the conductors from the box to the pole base.

PLC AND SCADA GROUNDING:

Within the control boxes for the various PLC and SCADA controls on the properties, it is important to realize that many of these systems are based on a solid ground return. This ground return is established through the DIN mounting rail connections. This connection is equally important for the in line LAN type CAT type data cable TVSS units as they derive their path to earth for surge energy through this DIN rail grounded connection. Each DIN rail within a control cabinet should not only be securely mounted with self cutting screws and locking dragon tooth style washers to insure that the screws do not back themselves out in a high vibration scenario but each DIN rail should also have 2, gauge 10 green wires properly ring crimped on to either end of the target rail.

These crimped grounding wires should then run to the local (not remote) cabinet ground which should be shared securely with stainless steel bolted hardware that is properly secured to the electrical ground of that cabinet or control system.

Within each data or control cabinet it is important that in the case of control system that requires a derived neutral for 120 VAC service components that this neutral be securely attached to the ground bond of the cabinet to insure that this new and separately derived neutral is stable and securely situated at a zero (0) Volts reference. The various Voltages of these embedded data systems rely on a stabile reference to earth-ground at zero Volts as do the various TVSS arrestors situated within these cabinets. Every cabinet should have a properly, electrically grounded method of TVSS installed for Every data cable that leaves the control cabinet. No metallic control or data cable should leave the control cabinet without being intercepted by a properly chosen TVSS device that is securely affixed to a reference ground. This reference ground should be a "STAR" type bond designed to secure the systems and cables within any localized control situation that is continuously assembled such as a side by side or continuous running length of control cabinet racking. This contiguous ground is also essential for all MCC or other mains power Voltage switch or protective equipment and Variable Speed Drives or related hard start or WYE/DELTA motor starters.

A Star type bond is essential for the security of these clusters of control equipment. Every attempt must be made to insure that all cabinetry and movable panels associated with any mains Voltage system or control cabinet are bonded to ground and the earthing cable. Daisy chaining of grounds, neutrals or other bonds is not recommended. Every control cluster and mains Voltage group in these plants can conform to the Star type of ground bonding which also incorporates any derived neutrals. A secure method of combining ground conductors to conform to the Star bond is shown in this photo below. To assist this connection to the DIN mounting rail, these WAGO style blocks have an accessory that also bonds the blocks to each other.

Star ground in PLC cabinet

Tie link push in type jumper from WAGO

Photo of LAN Cat-x style surge product
Note DIN rail electrical contacts

ANTENNA TREATMENT:

All externally mounted and exposed antennas on the properties must incorporate a properly selected and bonded TVSS device of some type. These coaxially mounted devices should utilize the proper type of connectors and not allow for the use of any type of gender or inter-series adaptors. These TVSS devices should either be drilled in to a properly grounded metallic panel and secured with a locking washer and nut, or they need to be bonded with a minimum gauge 6 green wire and crimped ring type terminal. These ground cables should be secured to a dedicated Star ground or earthing system. The locations of these TVSS devices should be prior to entry to a building or cabinet and if possible a secondary TVSS device should be incorporated just prior to the target or source receiver or transmitter.

Proper coaxial cable selection is required to insure proper operation of the target device and low losses of the Radio Frequency (RF) signals. If possible depending on the type of coaxial cable a small tight loop of coax is recommended. These loops of coax should have a minimum of 4 turns of cable tightly held in place with large tie wraps spaced every 2 inches. The tie wraps should not be pulled tightly enough to deform the coax cable but to hold the shape of the coil. This presents a high reactance path to surges. The TVSS devices should be placed after these oils and prior to entry to the building.

Image courtesy of Huber-Suhner

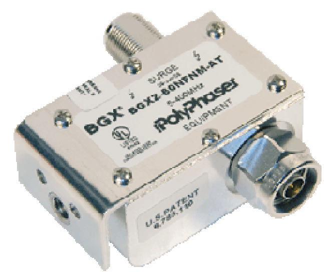


Image courtesy of Polyphaser

All exposed antennas should have a Static Air Terminal mounted above it so as not to interfere with the operation of the antenna. Bottle brush (fuzzy) type Air Terminals are recommended. All antenna supporting structures, railings, towers, masts or other objects must be properly grounded to an independent earthing grid that is not associated with the adjacent or contiguous grounding system of a building. This grounding method is to insure that a direct strike on the supporting structure is dissipated in to the earth and not shared with an adjacent or contiguous structure. The antennas located on the maintenance shop to the West of the Process Treatment Plant has antennas that are improperly located with respect to each other and the grounding of that structure is tied to the building steel. This is a recipe for disaster. Air Terminals must not be grounded to an antenna cable. Terminals must have a PVC conduit run downward to the earthing connection and not contact the coaxial or data cable feeders.

CABINET WIRING PROBLEMS;

Mains Voltage and control cabinetry must be devoid of extraneous wire that is un-terminated or used. Extraneous wire is a source for spark ignition from near field lighting strikes (NEMP) and can cause a hazard of safety to personnel that may work on these cabinets. Examples of adjacent Variable Speed Drives are shown below. There are numerous instances of this problem throughout the facilities.

Example of hazardous wiring

Example of proper cabinet housekeeping

In one case, there is a Variable speed Drive that is evidently having some kind of problem with the primary controller. This piece of static self adhesive stripping was found glued to the already bonded frame of the controller and drooped to the bottom of the cabinet where it was poorly wrapped around the ground bond bar in the lower portion of the cabinet. I can not imagine what the technician thought he would accomplish with this static strip. The lower part of the static strip can be seen in the photo above which shows the hazardous wiring. I wonder if the two issues are related? If a control cable has excess conductors, they should be tie wrapped in a neat and controller manner so as not to be able to arc, or contact other metallic structures of the cabinetry.

Example of how not to suppress static problems in
An apparatus

TRANSIENT VOLTAGE SURGE SUPPRESSION: (TVSS)

In addition to the grounding issues found, the problem of Transient Voltage Surge Suppression within the plants is very likely causing issues from multiple sources. The obvious issue of Lightning mitigation ranges from Rule 1, where we try to avoid the strike at all, Rule 2, if you are going to get hit, minimize the energy of the strike, and rule 3, manage the damage by directing the energy to a harmless place. If we can make these 3 rules golden, we have readily solved half of the electrically related damage issues. The other damage causes are from energy imparted to the facilities by the power provider, and switching or failure faults that are generated within the facility.

EXTERNALLY SOURCED SURGES:

Electrical failures from the power provider come in 2 basic flavors. The first is a spike or surge that is once again lightning sourced. The second is switching or transient switch errors. While this energy is supposed to be snubbed by the Utility prior to you receiving the power, we know from years of experience that the ground rod on the incoming service is there to protect the Utility equipment and not you, the customer.

The utility operates hundreds of miles of specially tuned lightning antennas that encircle your facilities. The surge arresting program that the Utility engages in is designed to minimize their casualty losses, and if properly built and sized heavily enough, those spikes just pass right on through to you on a daily basis. I note that some of the spike counters on the embedded TVSS devices are blank. The simple math shows that even with a transformer turns ratio of 27.5:1 (13,200 / 480) a line spike of a measly clamped and suppressed 50,000 Volt strike still transforms down to a whopping 1850+ arc event Volts that rocket through the switchgear and associated Variable Frequency Drives. TVSS is the front line of defense to this type of damage. In the design of the Hood Road Treatment Plant, there is no TVSS on any of the 4 primary front line services. The interrupting switchgear for services FPL1, FPL2, FPL3, and FPL4 have no strike counters or suppression of any kind that directly protects the bus bars and racked circuit breakers, let alone any of the directly fed Variable Speed Drives from these 4 centers. Properly installed TVSS on the mains disconnective switchgear will also surge protect energy coming from or going to the backup generator system.

INTERNAL CONDITIONS OF EMBEDDED TVSS:

The only large-medium format TVSS systems in the plant are mounted in Motor Control Centers MCC1, MCC2, MCC4, MCC4, MCC5, MCC6, and MCC7. These Motor Control Centers are dozens of feet if not hundreds of feet in cable feeder length from the FPL mains service buss bar disconnects and associated apparatus. Timing, Placement, lead length, bend radius, wire gauge, and type of safety disconnect (fused or circuit breaker) are everything when it comes to TVSS. The speed of propagation of surge energy in typical wiring is around 100,000 Meters per second. A typical spike only lasts .01 seconds at the most. In the time that it takes to traverse the wiring from the FPL mains disconnects to the current locations of the TVSS systems, an arc event could occur in the up front switchgear before the spike even makes it to the location of the embedded TVSS systems. Though the one line schematics show that the embedded systems should protect an entire service, the reality of the installation is that the surge devices only protect the MCC panels that they are mounted in to. I must also inject the caveat that I have not had the opportunity to inspect the embedded units for proper installation in regard to any of the above interconnective wiring criteria.

INTERNALLY SOURCED SURGES:

Destructive surge energy can be sourced from within the facility. When a facility has the number and sheer size of swinging armatures that are in play at these facilities, a mechanical failure of a motor, bearing, pump or other load can throw a dynamic Back Electro Motive Force (Back EMF) in to the power distribution system. This possibility is also accompanied by various failure modes of VFD's along with hard starting WYE/DELTA motor starters and simple hard start contactor closures.

In smaller environments, I have seen problems with a photo copier that would wipe out computer power supplies all over the building. In these facilities, there are motors that operate in the hundreds of Amperes current ranges at Horse Power ratings from fractional to 450HP. Swinging mass of this size is capable of generating thousands of Volts of spike, surge, or sinus energy backwards in to the system. It is again for this exact reason that the timing and placement of internal TVSS is critical and can not be left to only the devices mounted in the Motor Control Centers.

PLACEMENT OF TVSS DEVICES:

As a priority adjunct to the 7 known TVSS devices in the Hood Road Treatment Plant, I feel that it is imperative that additional surge suppression be installed in a number of locations. These adjunct units depend critically on their connection to a proper frame and service return ground system. Not one or the other.

Control Cabinets and PLC's:
Uninterruptable Power Supplies should be installed in to every cabinet that houses any data sourcing, control system, 4-20ma systems, and communications of any type. Fast acting "On Line" type units convert energy to Direct Current and this Voltage is used to both charge the internal batteries and run the output inverter so that there is a zero cross switching time. If a surge is encountered by these types of UPS, the energy is either absorbed, or the UPS will sacrifice itself to save the load equipment. Many DIN rail power supplies and wall warts are fire hazards when not protected by a quality UPS. Every attempt should be made to catalog the current of Watts VA draw on any small format power supply to insure that they are not operating above 75 percent capacity. Thermal InfraRed testing can be helpful in this area as can a simple clamp on DC rated small jaw Ammeter or line testing device such as this unit below.

http://www.homedepot.com/p/P3-International-Kill-A-Watt- EZ-Meter-P4460/202196388?cm_mmc=Shopping%7cTHD%7cG%7c0%7cG-BASE-PLA-D27E-Electrical%7c&gclid=COWr1tPsitECFVc8gQodNg0GMQ&gclsrc=aw.ds

http://en-us.fluke.com/products/clamp-meters/fluke-773-process-calibration-tool.html

Motors, Pumps, and Transformers:
Most designers only think of motors and other swinging mass loads as just this. These rotational devices are not just consumers of energy in exchange for work. These devices are the end of the line (and some times the source) for any dynamic surge that enters the feeder wiring either directly generated or by EMP.

These facilities have thousands of feet of open tray and PVC conduit conductor feeders that are a ready recipient for NEMP. It is critical that all intercessory step up and down transformers be equipped with TVSS at a minimum on the primary 480 Volt incoming service side. In certain locations it is also imperative that the secondary at 120/240, or 120/208 WYE service also be treated with TVSS systems. These smaller devices suffer serious damage in a strike event that may not appear right away. The earlier explanation of Clear-Blue-22 (page 5) describes the situations that can occur to have an operational device simply go up in flames for no apparent reason.

Mains FPL Disconnects:
The front line of defense and a major source of safety is the FPL mains disconnects numbers 1 through 4. These mains bus configurations directly feed 10 Variable Speed Drives that operate the critical path pumps of the Nano and Membrane filter systems. There are 10 Rockwell VFD's operating seven 400 Horse Power pumps and three 450 Horse Power pumps. These are critical service units and a failure of any one of these is detrimental to the ability to make water. The current embedded TVSS units do nothing to protect these valuable assets. By the same token due to the length of some of the feeders associated with a large number of the VFD's in the Treatment and Re-pump plants, TVSS is also recommended for the output of the VFD units as well as a similar sized TVSS for the input wiring boxes of all of the motors. Suppressing the Mains will also help to protect the large format UPS's in the electrical room as well as the air conditioners in the mains power room, and generator battery chargers. The NiCad starting batteries and the Transfer switch operating batteries are very delicate when it comes to stability of their chargers.

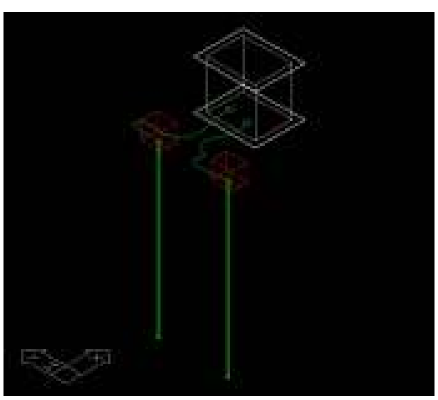
All excess length open tray and underground or floor PVC conduit feeders should have TVSS installed on both the end of line at the motor box and the source hard starter, or VFD. Surge suppressing both ends of these lines will save problems with burning contacts of large format contactor starters as well as keep gremlins out of the Transistorized switching outputs of the VFD's

HOOD ROAD RAW WATER RE-PUMP STATION:

The examination elements of the hood Road Raw Water Re-pump Facility directly emulate the findings of the Hood road water treatment Plant in all respects. There are however several exacerbated issues at this facility. With 12 fresh water deep wells, I find that there are several issues that need to be magnified. Where these issues exist at the Treatment Plant, they are critical and are a Tier 1 top priority to attend to. In most areas, I find that the Re-pump facility is in good condition but these items are pronounced

In the well fields the transition to a Medium Voltage (4160VAC) distribution system is in process. This new design is a considerable step in the right direction for insuring proper Voltage level delivery to each remote well pump. This design incorporates the latest technology and has some new safety features instilled but the items that I find here are serious safety issues for the equipment and personnel working on it. Foremost is the lack of verifiable ground stability of the called out single 10 foot driven reference rod located at the step down transformer. Ordinarily a high or medium Voltage delivery system has the advent of numerous fault clearing grounded objects to refer to. These numerous objects run the gamut from accidental earthing contact to deliberate bonding of neutrals and other large metallic items. In this design, there is very little metallic contact with the earth and in this design that is singularly fused or protected for the full 300 kVa feed to the one step up transformer, a single 10 foot rod, even multiplied by the distributed and highly inductance reactive runs out to the remaining 11 well heads is an insufficient in this design case rendering it un-testable, and therefore an un-verifiable installation of a safety device. Granted, there is a large gauge bare bonding wire that appears to be looped through the well area and in all likely hood tied to the distribution ring but even a minor fault in the locally serving step down transformer will elevate the metals of a well head and cabinet above ground to lethal levels which will never be seen by the protective device serving the master step up transformer.

I recommend that 2 new ground rods be driven externally to the locked up terminus area of the transformer that incorporate 2 separated inspection boxes that allow access to the individual rods and tails with a clamp on ground test meter. The two rods should NOT be tied together in a pseudo-delta configuration. Tying the rods together will not allow the value of each rod to be examined individually with the clamp on ground test device. These large format meter boxes fed with PVC conduit should pop up in the terminus area of the transformer and each rod on separate tails can bond to the ground terminal of the transformer in conjunction with the designed rod and loop through the pump and controls. Due to the need to be able to trip a fault event, these rods should be screwed and brazed while driven to a recommended depth of 40 feet. The CadWelded exothermic tail connections must bond via 3 band, crimped compression lugs to the transformer frame.



This configuration will give the transformer a testable and verifiable new ground system that will add a significant measure of safety to the installation for the equipment and personnel. In the new work wells. Both the step up and step down transformers must receive this grounding upgrade as a serious safety issue. The 2 new systems have good bonding attended to with the looped large gauge bare conductor but the installation of the ground loop is not consistent. See photos below.

PROPERLY CADWELDED GROUND CONNECTIONS WELL HR6

CORRODING SCREW SET TERMINAL

As shown in the photos, HR-6 has a definitive exothermic distribution system that is crimp lug connected to the target devices. The HR-5 installation is barely a few months old and the use of the improper screw type lug is already rendered totally worthless. Crimped on lugs while robust, should be filled with a non-corrosive inhibitor such as NoALox and should be bolted to the target devices out of direct rain contact and if this is unavoidable, the lug barrel should face downward so as to not pool water. Only stainless steel fasteners should be utilized for these connections. The bolted lug connections can also be sprayed with a galvanizing agent to provide an additional measure of protection and sacrificial material to corrosion in the case of any dissimilar metals contact.

The discharge piping of all of the 12 well heads is very poorly bonded to the pump head casing. This is a safety issue. All exposed metals should be bonded. The tie between the discharge piping and the well body is casual though the restraint rods attached around the shock bellows. There are wide ranging inconsistencies in the Ohmic value of these accidental connections. Some are securely clamped as seed in the photo below and others are much poorer due to being a tension only connection and not bi-laterally clamped as below.

MOTOR SLEEVING AND DISCHARGE

GENERATOR FRAME:

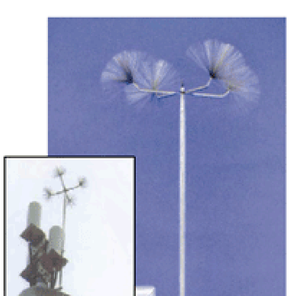
During testing of the generator area I find that various parts of the generator frame and support components are not bonded together electrically. This is a manufacturing defect that has likely existed since the machine was delivered. The radiator frame, control box, bus bar cage and I-beam frame are not contiguous and could pose a hazard for a technician working on the machine while it is running with the exciter on and making rated Voltage whether under load or not.

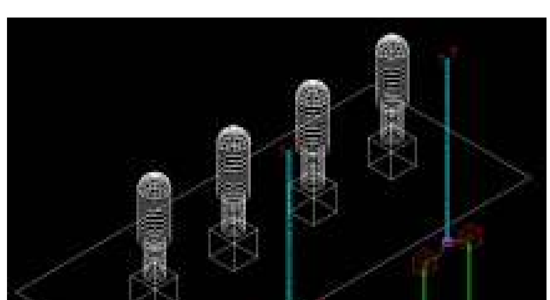
MCC 1 PANEL FRONT BONDS:

During testing of the contiguous grounding of various distribution panels, I find that virtually the entire front face of the Motor Control Center 1 (MCC1) is not bonded to the electrical system. I am not quite sure how this situation can exist as this is a unified chassis though the panels are on hinges. This poses a serious shock safety hazard to personnel working on the equipment or simply passing through the room.

TRANSFER PUMP PROTECTION:

The 4 transfer pumps at the facility used to be somewhat protected with static air terminals located on motors number 1 and 4. These are the only two motors that has the terminals installed and the only two motors that have ground tails that tie them to the ground system directly. This can cause an inverse reaction in a galvanic way with respect to the other two motors. All motors should be treated the same way. As they all have exemplary Ohmic continuity to the master electrical ground. To assist with lightning protection for the transfer pumps I recommend the addition of 2 grounding tails that are exactly identical to the existing tails on motors 1 and 4. This will balance any minor galvanic or ion flow issues between the motor frames. Static air terminals are not to be reinstalled on the motors. I recommend the installation of 18 foot tall target pipes with the fuzzy style of static dissipation arrays mounted on them. These units from LBA are perfectly suited for this use. They are to be installed as shown in a supplied drawing that is included in this document. These targets are NOT to be attached to the grounding grid tails system and are to have their own ground systems installed that are identical to the twin tails recommended for the remote well head transformers.





SUGGESTED TERMINAL STYLE FOR THIS USE
WWW.LBA GROUP.COM

LARGER IMAGE IN CONTAINED AT END OF DOCUMENT IN DRAWINGS SECTION

These target stanchions are easily fabricated by a company like Palm Beach Iron Works and then sent out to be hot dip galvanized. The stanchions should be set on to small concrete foundations or lighting pole pre-form cylinders. The target pipes should be continuous lengths of pipe without threads or splices. The meter boxes are part number,

http://www.homedepot.com/p/DURA-12-in-x-17-in-x-12-in-Deep-Rectangular-Valve-Box-in-Black-Body-Green-Lid-120/203473554

Conventional PVC pipe is used to serve the conductors from the box to the pole base. If greater protection is preferred, the number of targets on this pump group can be increased to four with the additional two terminal targets placed on the North side of the pump slab taking care to avoid all piping when driving the rod systems.

PLC AND CONTROL CABINET BONDING:

PLC and Control cabinetry must be devoid of extraneous wire that is un-terminated or used. Extraneous wire is a source for spark ignition from near field lighting strikes (NEMP) and can cause a hazard of safety to personnel that may work on these cabinets. Examples of adjacent Variable Speed Drives are shown below. There are numerous instances of this problem throughout the facilities.

Example of hazardous wiring

Example of proper cabinet housekeeping

TVSS ISSUE:

The input 480 volt Delta mains power that is fed to the step up transformer for distribution of the 4160 mains Voltage to the remote well heads must have a substantial TVSS unit installed at the step up transformer. This TVSS unit will not only protect the primary and secondary of the transformer but will suppress problems that could damage the new underground duct feeder. TVSS units must also be installed on the output of each well head step down transformer to eliminate problems from the primary power system feed as well as NEMP induced in to the duct feeder. Though this is supposed to be a shielded cable, this shield is actually a ground return and makes for a moderate to poor NEMP barrier.

ADDITIONAL AREAS OF NEED;
Please refer to the Treatment Plant evaluation for these same concerns

GROUNDING
EXTERNAL ANTENNA
AIR TERMINALS
PLC, SCADA CONTROL BONDING AND GROUNDING
CABINET HOUSEKEEPING-WIRING
TVSS ISSUES

PACO TVSS REPORT

PACO VAR REPORT

PACK METERING REPORT

GROUNDING TESTING

DATA

HOOD ROAD WATER

TREATMENT PLANT

	A	B	C	D	E	F	G
1	LOCATIONS	TYPE OF TEST	OHMIC VALUE CONTINUITY	3 POINT	CLAMP		
2	FRONT STREET GATE 1						
3	E SIDE GATE AND FRAME			73			
4	W SIDE GATE AND FRAME			23			
5	E MOTOR ARM			2.3			
6	W MOTOR ARM			2.1			
7	CARD READER ARM			1532			
8	FENCE AND GATE HAS NO RODS, ONLY ELECTRICAL GROUND						
9	NEED SURGE ARRESTING ON WIRED CONTROLS AND LOOPS						
10							
11	SIDE STREET GATE 1						
12	N SIDE GATE AND FRAME			29			
13	S SIDE GATE AND FRAME			32			
14	E MOTOR ARM			2.3			
15	W MOTOR ARM			2.3			
16	CARD READER ARM			1314			
17							
18	PRIMARY TRANSFORMERS						
19	TEST SETUP OHMS REFERENCE		0.309				
20	GND TEST METERS 1-2 TO 3-4 GROUND RODS		0.068				
21	TRAN SFORMERS 1-2				40.5		
22	TRANSFORMERS 3-4				55.5		
23	GROUND ROD CLAMPS LOOSE OR DAMAGED						
24							
25							
26							
27	TRANSFORMER 1		0.01	0.15			
28	1 TO 4		0.01				
29							
30	TRANSFORMER 2		0.01	0.15			
31	2 TO 3		0.01				
32							
33	TRANSFORMER 3		0.01	0.15			

	A	B	C	D	E	F	G
34	3 TO 4						
35							
36	TRANSFORMER 4		0.01	0.15			
37	4 TO 2		0.01				
38							
39							
40	PROCESS BUILDING						
41	MAINS DISCONNECT 1		0.008	1.36			
42	ROOM EARTHING REFERENCE						
43							
44	MAINS DISCONNECT 2		0.008				
45	ROOM EARTHING REFERENCE			1.34			
46							
47	MAINS DISCONNECT 3		0.006				
48	ROOM EARTHING REFERENCE						
49							
50	MAINS DISCONNECT 4		0.008				
51	ROOM EARTHING REFERENCE						
52							
53	MCC 1-2 FRAME		0.008				
54	TRANSFORMER 1		0.008				
55	LP PANEL 1		0.008				
56	UPS 1 PANEL		0.024				
57	VFD ROW		0.021				
58	UPS FRAME 1		0.026				
59	UPS FRAME 2		0.012				
60	LAKESHORE BATT BACKUP		0.026				
61	AIR HANDLER 1		0.006	USED POWER FRAME FOR EARTH REF			
62	AIR HANDLER 2		0.005	USED POWER FRAME FOR EARTH REF			
63	AIR HANDLER 3		0.02				
64	HEAT EXCHANGER AHU1		0.004	WELL BONDED TO SERVICE			
65	HEAT EXCHANGER AHU2		0.004	WELL BONDED TO SERVICE			
66	HEAT EXHANGER AHU3		0.03				

	A	B	C	D	E	F	G
67							
68	GEN CAB 1		0.008				
69	GEN CAB 2		0.008				
70	GEN CAB 3		0.008				
71							
72	PROCESS GENERATOR 1 TO EARTH			1.7			
73	FRAME			1.2			
74	GENERATOR EARTHING CONDUCTOR			1.1			
75							
76	PROCESS GENERATOR 2 FRAME			1.6			
77	GENERATOR EARTHING CONDUCTOR			1.12			
78							
79	PROCESS GENERATOR 3 FRAME			1.7			
80	GENERATOR EARTHING CONDUCTOR			1.12			
81							
82	PROCESS BUILDING						
83	MEMBRANE PUMP NUMBERS						
84	NF FEEDERS						
85	GROUND REFERENCE TO EARTH, ROOM			2.5			
86	PUMP 1		0.04				
87							
88	PUMP2		0.04				
89							
90	PUMP3		0.04				
91							
92	PUMP4		0.03				
93							
94	PUMP5		0.04				
95							
96	PUMP6		0.03				
97							
98	PUMP 7		0.04				
99							

	A	B	C	D	E	F	G
100	R O FEEDERS						
101	PUMP 1		0.05				
102							
103	PUMP 2		0.04				
104							
105	PUMP 3		0.04				
106							
107	AIR COMPRESSOR		0.06				
108							
109							
110	HSPS PUMPS						
111	PUMP 1		0.009				
112							
113	PUMP 2		0.044				
114							
115	PUMP 3		OUT OF SERVICE				
116							
117	PUMP 4		0.018				
118							
119	PUMP 5		0.03				
120							
121	PUMP 6		0.044				
122							
123	PUMP 7		0.018				
124							
125	PUMP8		0.011				
126							
127	PUMP 9		0.024				
128							
129	PUMP 10		0.005				
130							
131	PLC CABINET		0.024				
132	COMPRESSOR		0.043				

	A	B	C	D	E	F	G
133	GENERATOR 850		0.038				
134	GENERATOR 800 GROUND ROD		0.02				
135	GENERATOR 800 GROUND ROD	CLAMP BROKEN			26.8		
136	TRANSFORMER GROUND ROD			62			
137							
138	HSPS ELECTRICAL ROOM						
139	MCC5		0.003				
140							
141	MCC6		0.002				
142							
143	MCC7		0.003				
144							
145	INBOUND MAINS RACK AND GEN INPUT		0.011				
146							
147	VFD RACK WEST		0.003				
148	VFD RACK EAST		0.029				
149							
150	XFER SWITCHBATTERY BOX		0.048				
151							
152	ACU 8A		0.038				
153	ACU 8B		0.029				
154							
155							
156	CHEMICAL STORAGE NORTH WEST			0.16			
157	LONE SINGLE ENDED GROUND ROD N.E COR				10.6		
158	N HALO RING TO TRANSFORMERS		0.035				
159	S HALO RING TO TRANSFORMERS		0.035				
160							
161							
162	DIESEL FUEL TANKS						
163	MAINS FUEL TANK NORTH EAST		0.061	0.17			
164	HALO CONNECTION		0.041				
165	TANK HAS NO RODS						

	A	B	C	D	E	F	G
166							
167	MAINS FUEL TANK SOUTH EAST		0.059	0.17			
168	HALO CONNECTION		0.041				
169	TANK HAS NO RODS						
170							
171							
172	CARBON DIOXIDE STORAGE			1.05			
173	CO2 TO HYDROXIDE HALO		0.05				
174							
175							
176	CHEMICAL STORAGE SOUTH			1.09			
177	TO HYDROXIDE HALO		0.05				
178	GROUND ROD				78		
179							
180	HSPS BUILDING						
181	TRANSFORMER VAULT		UTILITY LOCKED, NOT ACCESSIBLE				
182							
183	GENERATOR 1 NORTH		0.04	2.2			
184							
185	GENERATOR 2 SOUTH		0.02	2.1			
186							
187	HSPS OUTDOOR BLUE VERTICAL PUMPS						
188	NORTH MOTOR HSPS 11		0.078	1.3			
189							
190	SOUTH MOTOR HSPS 12			1.3			
191	MOTOR TO MOTOR		0.069				
192							
193							
194	CONCENTRATE BOOSTER PUMPS						
195	PUMP 1 NORTH			1.5			
196	FRAME TO FRAME		0.01				
197							
198	PUMP 2 SOUTH			1.5			

	A	B	C	D	E	F	G
199	FRAME TO FRAME		0.1				
200							
201							
202	CLEAR WELL GROUP						
203	BLOWER 1		0.1				
204							
205	BLOWER 2		0.1				
206							
207	BLOWER 3		0.1				
208							
209	BLOWER 4		0.1				
210							
211	BLOWER 5		0.1				
212							
213	BLOWER 6		0.1				
214							
215							
216	WATER TOWER STORAGE TANK		0.2				
217	TANK BRAID TO HSPS TEMP GEN BOND						
218	NOISE IN 3 POINT TEST, UNSTABLE			4.6			
219							
220	HYPOCHLORITE STORAGE		0.1	2.9			
221							
222							
223	ON SITE WELLS						
224	WELL F1			1.6			
225	NO VISIBLE GROUND RODS						
226							
227	WELL F2			2.9			
228	NO VISIBLE GROUND RODS						
229							
230	WELL F3			1.3			
231	NO VISIBLE GROUND RODS						

	A	B	C	D	E	F	G
232							
233	WELL F4		NO WELL, FUTURE				
234							
235							
236	INJECTION WELL SOUTH EAST						
237	POWER PANEL ONLY			2.6			
238	GROUND ROD				32.8		
239							
240	WATER STORAGE TANKS ON SITE	NOT TESTED AS A GROUP					
241							
242	STREET LIGHTING	NOT TESTED AS A GROUP					
243							
244	END OF ENTITIES						

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GROUNDING TESTING

DATA

HOOD ROAD

RAW WATER

RE-PUMP PLANT

HOOD									
GROUNDS ARE SHARED TO ACHIEVE SUB 5 OHM READINGS. NO ONE GROUND IS LOW OR GOOD									
							CONTINUITY	3 POINT	CLAMP
CAMERA SYSTEM								10.4	
MASTER BOARD TO EARTH									
PHONE ROOM SINGLE END GROUND ROD									57
GENERATOR							0.008	6.6	
FRAME BADLY BONDED									
LIFT STATION							0.109	6.77	
READING ERRATIC									
TRANSFER PUMPS									
ALL WITHIN SIMILAR NUMBERS									
ONLY PUMP 1 AND 4 HAS A GROUND BRAID, NEEDS HAIRY STATIC LINE									
PUMP 1							0.01	4.88	
PUMP 2							0.012	4.86	
PUMP 3							0.012	4.92	
PUMP 4							0.01	4.88	
PUMP HR 1								5.1	
PUMP AND PIPING NOT BONDED									
READINGS ERRATIC									

PUMP HR 5								3.71	
READING WANDERS									
PUMP HR 6								3.56	
GROUND ATTACHED									
PUMP HR 8								5.34	
ELECT FRAME AND PIPING IS NOT BONDED WELL									
NO GROUND RODS									
READING FAIRLY STABLE FOR RUNNING MOTOR									
PUMP HR 9									
ELECT FRAME AND PIPING IS NOT WELL BONDED								7.4	
GROUND RETURN READING WANDERS + - 2 OHMS									
PUMP HR 11								4.68	
ELECT GFRAME AMD PIPING IS GOT BONDED WELL									
NO GROUND RODS									
PUMP HR 12								4.41	
ELECT FRAME AND PIPING NOT WELL BONDED									
NO GROUND RODS									
PUMP HR 13								4.7	
ELECT GFRAME AMD PIPING IS GOT BONDED WELL									
NO GROUND RODS									
UNSTABLE GROUND READINGS									
PUMP HR 14								4.7	
FRAME AND PIPING NOT WELL BONDED									
NO GROUND RODS									
PUMP HR 16								5.6	
FRAME AND PIPING NOT WELL BINDED									

NO GROUND RODS									
FAIRLY STABLE FOR RUNNING MOTOR									
PUMP HR 17								4.34	
FRAM E AND PIPING NOT WELL BONDED									
NO GROUND RODS									
PUMP HR 18								5.3	
FRAME AND PIPING NOT WELL BONDED									
GROUND RETURN WANDERS + - 1.5 OHMS									
TRANSFER SWITCH							0.01	6.5	
PUMP 4160 STEP UP DISCONNECT							0.015	2.8	
4160 STEP UP TRANSFORMER							0.021		
MAINS DISCONNECT							0.004	4.3	
MCC HR 1								3.1	
FRONT PANELS NOT GROUNDED									
MCC HR 2							0.062	2.7	
TRANSFORMER							0.015	2.6	
VFD 1							0.005		
VFD 2							0.005		
VFD 3							0.005		
VFD 4							0.006		

PERMANGANATE TOWER							OUT OF SERVICE		
DATA CABINET							LOW READING		
NEEDS DEDICATED BOND WIRES AT EACH END OF DIN RAILS TO GROUND BONDS									
DID NOT WANT TO TRIP OUT PLC CIRCUITS WITH HIGH CURRENT TEST									
LIGHTNING RODS ARE ROUNDED									

GROUNDING TESTING

PHOTOS

HOOD ROAD

WATER TREATMENT

PLANT

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FPL METER CAN GROUND SYSTEM., 1 OF 2, SHALLOW ROD, POOR OHMIC VALUE

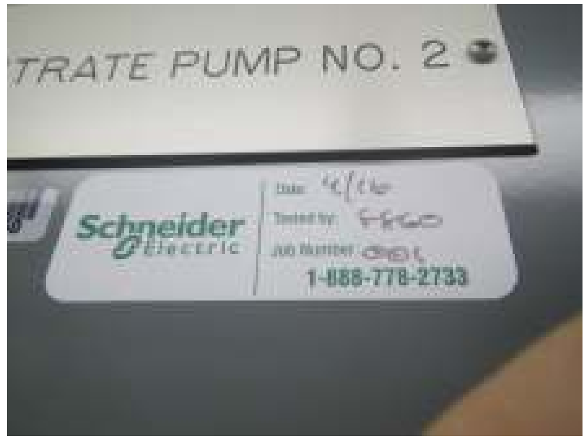
HSPS VFD

FPL METERING GROUND RODS

INSIDE OF HSPS VFD

INSIDE OF HSPS VFD

INSIDE OF HSPS VFD, ARC AND SHOCK HAZARD, UN-TERMINATED WIRES, POOR SERVING



SCHNEIDER PHONE NUMBER

ROCKWELL TECHNICIAN INSTALLED A STATIC STRAP ON A FULLY GROUNDED CHASSIS FOR AN UNKNOWN REASON

EXAMPLE OF EMBEDDED TVSS IN MAINS ROOM, MCC 1, 2

HAPS VFD WIRING

CONTROL ROOM VIDEO SYSTEM, CAMERAS NEED ADDITIONAL TVSS

EXAMPLE OF SYSTEM WIDE CAT 5-6 LAN SURGE TVSS, REQUIRES FULLY GROUNDED DIN RAILS

SINGLE END GROUND ROD, 1 OF ONLY 6 ON SITE

MCC 5 IN HSPS

MCC 6 IN HSPS

MCC 7 IN HSPS


SINGLE END GROUND ROD


FRAME GROUND TIE


SINGLE ENDED GROUND ROD


3


BROKEN GROUND CLAMP AT HSPS GENERATOR

HSPS PUMP 2, BAD OUTBOARD BEARING AND CLOGGED AIR FILTERS, MOTOR TEMP 212+

AIR CONDITIONERS, HSPS ELECTRICAL ROOM

SINGLE END GROUND ROD


CORRODING STATIC ARRAY SPLICE


CO2 SUPPLY SYSTEM


CO2 TANK GROUND LUG


POWER MONITOR SYSTEM SQUARE D NEEDS MOD BUS TO LAN CARDS ORDERED AND INSTALLED WITH SOFTWARE


C02 TANK

INFRA RED SURVEY PORTAL ON MAINS DISCONNECTS

EXAMPLE OF TEST CONNECTION ON MEMBRANE PUMP

BLOWER ROOM, CLEARWELL

EXAMPLE OF TEST CONNECTION ON MEMBRANE PUMP

BLOWER ROOM, CONCENTRATOR VFD

BLOWER ROOM

CONCENTRATOR VFD, BLOWER ROOM

BLOWER ROOM, CLEARWELL ELECTRICAL ROOM

SINGLE ENDED GROUND ROD, 1 OF ONLY 6

DIESEL TANKS

INJECTION WELL ELECTRICAL PANELS

DIESEL TANKS, STATIC RODS, TANKS NOT DIRECT GROUNDED. GROUND ONLY THROUGH PIPING


DEFECTIVE ROUNDED STATIC ROD


DIESEL FILL PORTAL NOT GROUNDED


CHEMICAL TANKS NOT PROPERLY GROUNDED


TANK INDIRECTLY GROUNDED THROUGH DISSIMILAR METALS LADDER ATTACHMENT


UN-GROUNDED STATIC TIE WIRE, TANK NOT BONDED


TANK INDIRECTLY GROUNDED THROUGH DISSIMILAR METALS LADDER ATTACHMENT

EXAMPLE OF NUMEROUS LIGHTING POLES NOT WELL GROUNDED THROUGH PAINT

TANK NOT GROUNDED, STATIC WIRE NOT ATTACHED TO TANK

EXAMPLE PHOTO

EXAMPLE PHOTO

UN-GROUNDED TRANSFORMER WITH NO TVSS

POOR GROUND CONNECTION


SINGLE ENDED GROUND ROD


POOR GROUND ON STREET LIGHT


DEFECTIVE STATIC TERMINAL


EXAMPLE PHOTO


DEFECTIVE STATIC TERMINAL,
ROUNDED NOT EVEN BEVELED


FRANK

GROUNDING TESTING

PHOTOS

HOOD ROAD

RAW WATER

RE-PUMP PLANT

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COMCAST CABLE FEEDER GROUNDED THROUGH UPS. UPS DOES NOT HAVE A DEDICATED GROUND, ONLY THROUGH PLUG

PERMANGANATE SITE OFF LINE

SINGLE END GROUND ROD IN TELEPHONE SHELF

PERMANGANATE SITE OFF LINE

SINGLE END GROUND ROD IN TELEPHONE SHELF, POOR OHMIC VALUE

WIRING IN PLC CABINET SHOWS MULTIPLE GROUND BONDS

EXAMPLE OF GROUND STAR IN PLC CABINET. THIS SHOULD BE REPEATED IN ALL CABINETS

DEFECTIVE STATIC TERMINAL

MICROWAVE COAX TVSS WITH POOR GROUND CONNECTION AND NO TVSS AT ENTRY POINT TO BUILDING

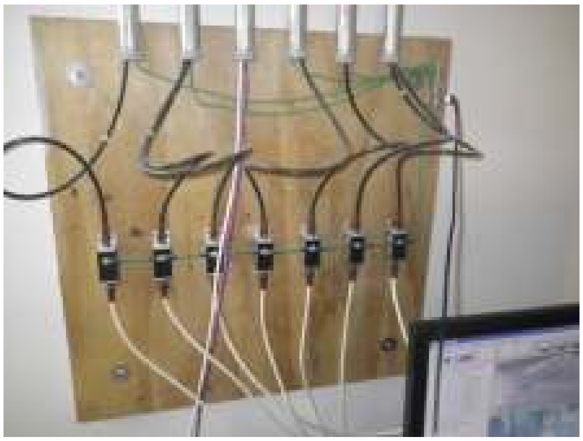
DEFECTIVE STATIC TERMINAL

NO SURGE TVSS ON LAN FEEDERS TO PROTECT FIBER SWITCH

EXAMPLE OF CONNECTION FOR CONTINUITY TESTING

LIFT STATION CONTROL

TRANSFER PUMP ROW, NEEDS OVER BRIDGE STATIC LINE



CAMERA TVSS PANEL IS NOT BONDED TO A REAL ELECTRICAL GROUND AND RELIES ON COAX CONNECTIONS TO UNKNOWN LOCATION

BROKEN STATIC TERMINAL CONNECTION PUMP 1 AND 4 OF TRANSFER PUMPS.

PROPERLY CADWELDED GROUND CONNECTIONS WELL HR6

BOLTED GROUND CONNECTION

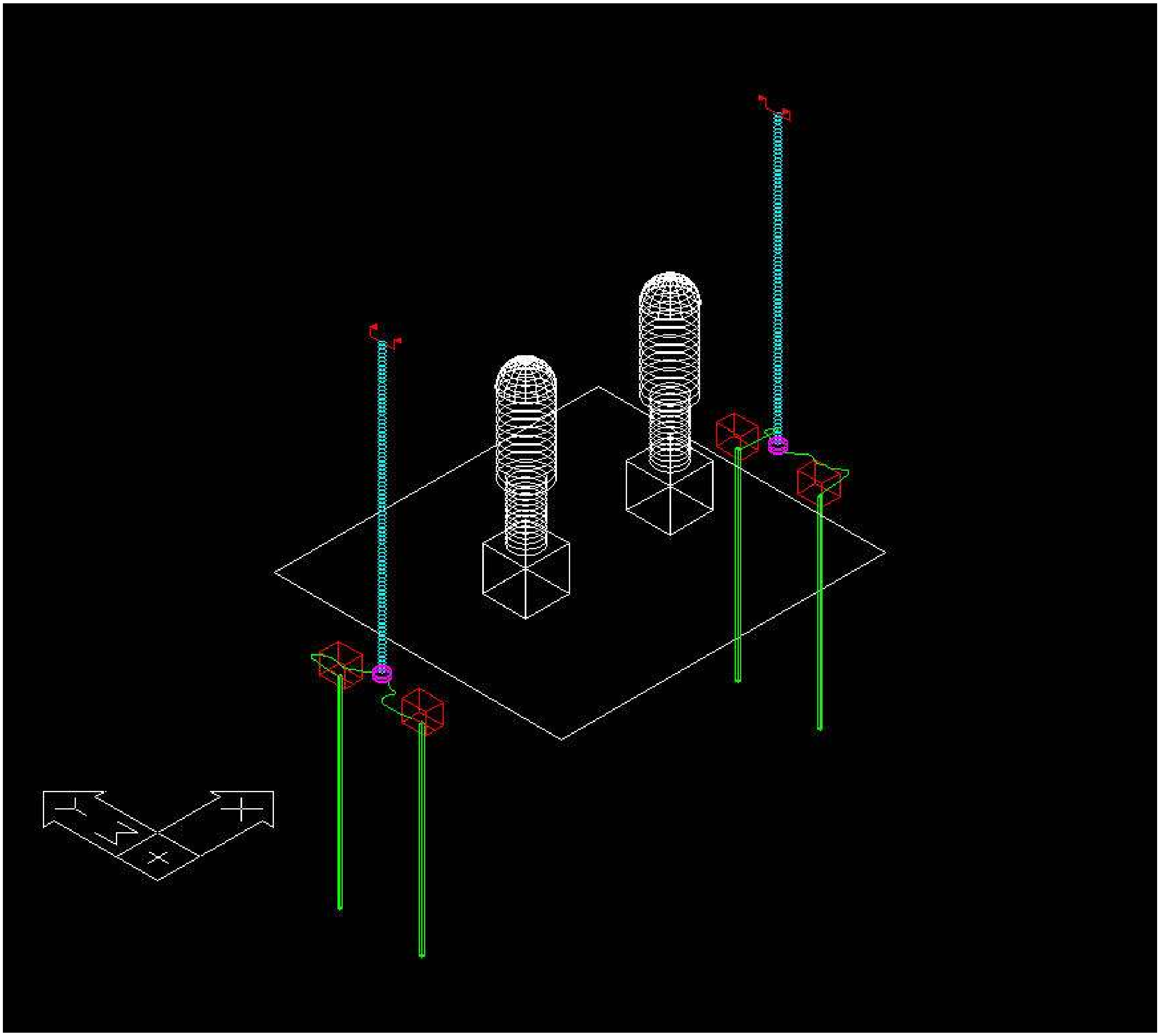
WELL EXAMPLE OF SUBMERGED DRIVE

CORRODING SCREW SET TERMINAL

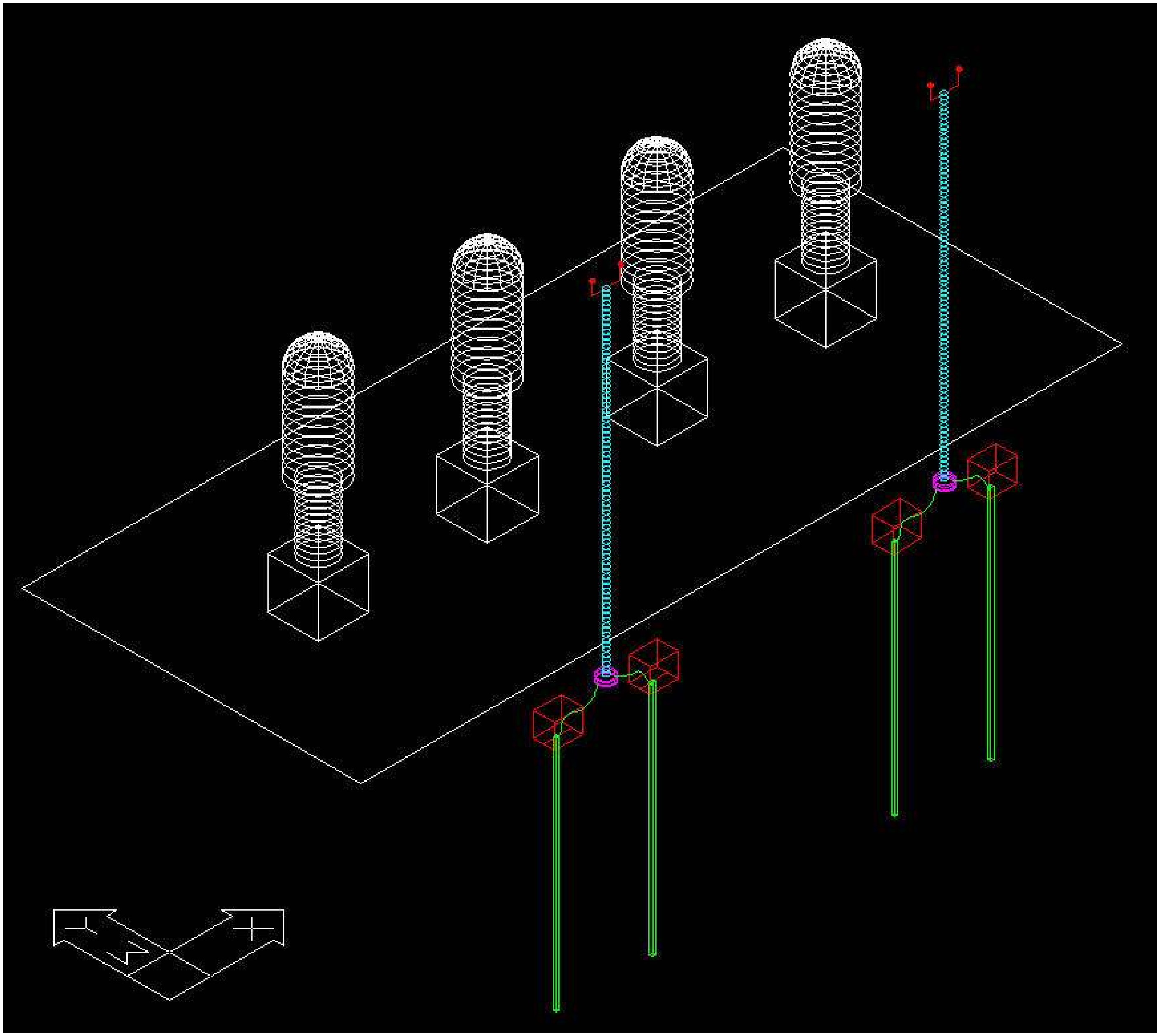
MOTOR SLEEVING AND DISCHARGE PIPING NOT WELL BONDED


MICROWAVE LINK WITHOUT STATIC TERMINAL, SEGREGATED TERMINAL GROUND, OR TVSS PRIOR TO ENTRY TO BUILDING

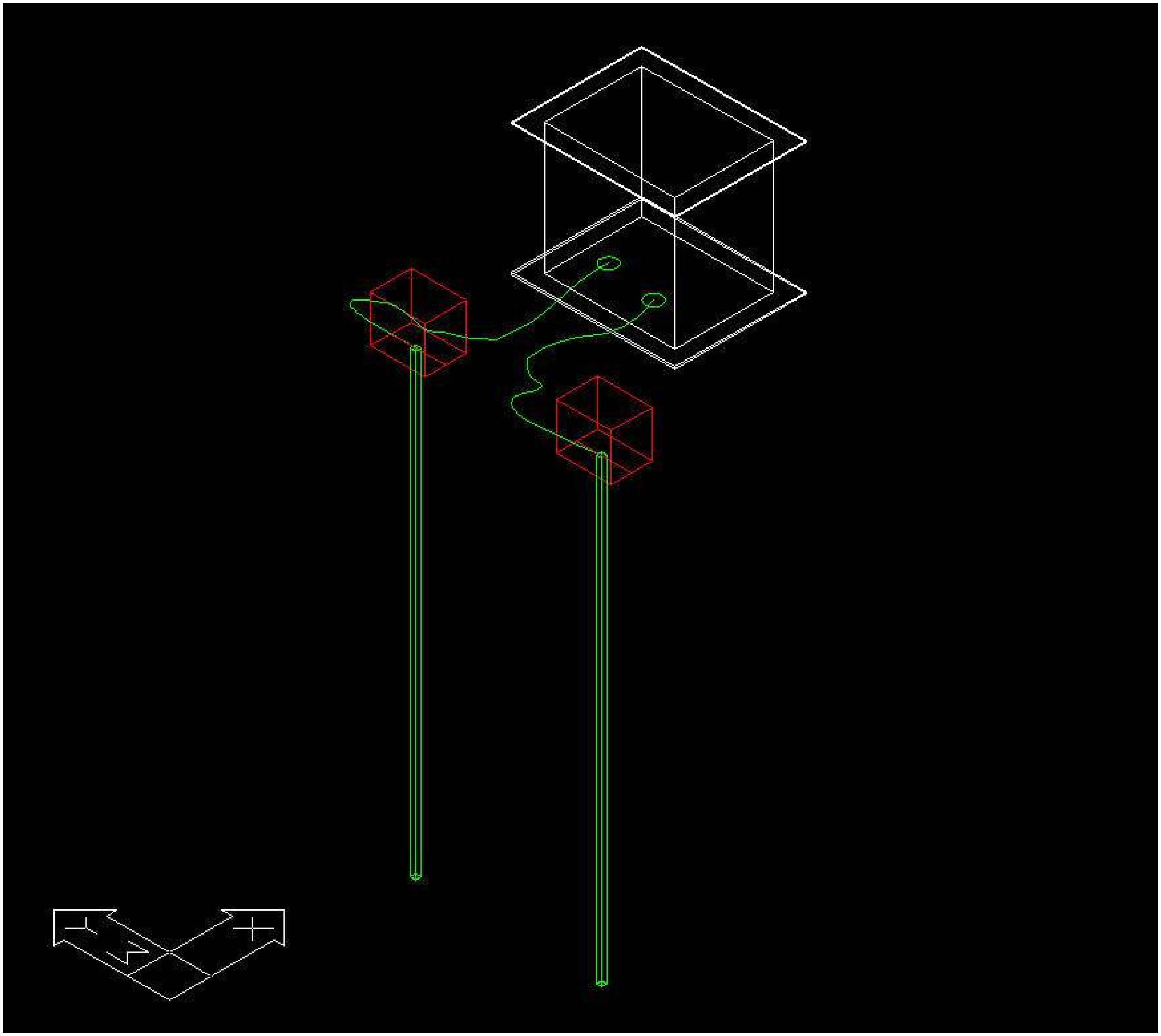
DRAWINGS



SUGGESTED STATIC AIR TERMINAL LAYOUT FOR EXPOSED VERTICAL SHAFT PUMPS



SUGGESTED LAY OUT OF STATIC AIR TERMINAL TARGETS FOR HOOD ROAD RE-PUMP STATION TRANSFER PUMPS



SUGGESTED GROUNDING OF STEP DOWN AND STEP UP TRANSFORMER IN THE HOOD ROAD RE-PUMP FACILITY