

# AC INTERFERENCE ANALYSIS & MITIGATION SYSTEM DESIGN

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Prepared for:

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Vermont Gas System

12" Addison Natural Gas Project

Chittendon & Addison Counties, Vermont

Prepared By:



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## **EXECUTIVE SUMMARY**

This report summarizes the results of an AC interference analysis for Vermont Gas System on the proposed Vermont Gas 12" pipeline. This proposed pipeline will be subject to AC electrical interference effects from the following electric transmission circuits which will parallel and cross the proposed pipeline:

- Ten (10) Vermont Electric Power (VELCO) electric transmission circuits
- One (1) Green Mountain Power (GMP) electric transmission circuit

The proposed pipeline length under study is approximately 41.2 miles.

This final report presents the predicted AC interference pipeline potentials during future emergency peak load conditions on the VELCO circuits, as provided by VELCO. Fault conditions on these circuits were also simulated to determine AC inductive and conductive coupling effects to the proposed pipeline.

Green Mountain Power did not provide electric circuit data, therefore, based upon previous experience, ARK Engineering assumed peak emergency load currents and fault current values to predict worst-case scenarios caused by inductive and conductive AC electrical interference effects by the GMP transmission circuit to this proposed pipeline.

The results of this study indicate that AC steady state interference voltage levels are calculated above the design limit of thirty (30) Volts at non-exposed pipeline locations and fifteen (15) Volts at exposed pipeline locations at several locations along this proposed pipeline route.

For the proposed pipeline under study, a maximum computed induced AC pipeline potential of approximately one hundred and thirty-nine (139) Volts, with respect to remote earth, occurs at pipeline station number 2087+16. At this location, the proposed pipeline leaves the shared right-of-way with two (2) VELCO electric transmission circuits.

During simulated single phase-to-ground fault conditions on the electric transmission circuits, the maximum total pipeline coating stress voltage level was computed. This is the sum of the inductive and conductive AC interference effects on the proposed pipeline. The maximum pipeline coating stress voltage was calculated at four thousand six hundred and fourteen (4,614) Volts at pipeline station number 1547+10. At this location, the proposed 12" pipeline will parallel the VELCO 115 kV 'K43' electric transmission circuit.

This coating stress voltage level is below the design limit of five thousand (5,000) Volts.

The following six (6) aboveground pipeline appurtenances were analyzed for touch and step hazards due to their proximity to the electric transmission circuits:

- Williston M&R: MP 10.43
- MLV-2: MP 14.30
- MLV-3: MP 19.81
- MLV-4: MP 24.80
- MLV-5/ Plank Rd. M&R: MP 32.54
- MLV-6: MP 35.00

The computed touch and step voltages were above the IEEE Standard 80 design limit at each location. Additional AC mitigation is recommended at each site.

AC current density calculations associated with AC corrosion mechanisms were conducted for this proposed pipeline.

The AC mitigation system designs proposed by ARK Engineering in this report reduce the pipeline AC electrical interference effects to acceptable levels during steady state and fault conditions on the electric transmission circuits, for personnel safety and pipeline integrity.

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# 1. INTRODUCTION

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## 1.0 Introduction

ARK Engineering & Technical Services, Inc. was contracted to investigate AC electrical interference effects on the proposed Vermont Gas 12" pipeline. AC electrical interference effects may occur on this proposed pipeline due to the proximity of ten (10) VELCO electric transmission circuits and one (1) GMP electric transmission circuit. The proposed pipeline under study is approximately 41.2 miles in total length, and is located in Chittenden and Addison Counties, Vermont.

This report presents the computed steady state induced AC pipeline potentials for this pipeline. Simulated fault conditions on the electric transmission circuits were also modeled to determine pipeline coating stress voltages for this pipeline.

Emergency peak load and fault current values, provided by VELCO or conservatively estimated by ARK Engineering, based on industry experience, were used to predict worst-case scenarios caused by inductive and conductive AC electrical interference effects to this pipeline.

This report summarizes this analysis and outlines ARK Engineering's recommendations for mitigation of AC electrical interference effects on this proposed pipeline. The proposed mitigation system design, as outlined in this report, will reduce the AC electrical interference effects on the pipeline to acceptable limits.

The conclusions in this report are based upon field data, pipeline data provided by Vermont Gas System, and power line data provided by VELCO or assumed by ARK Engineering for the GMP circuit. Calculations and analysis were performed using state-of-the-art modeling software.

## 1.1 Joint Facility Corridor Overview

The proposed 12" pipeline will travel through Chittenden and Addison Counties, Vermont. This proposed pipeline is approximately 41.2 miles in length. All station numbers outlined in this report are based on the pipeline alignment plans - Vermont Gas Proposed 12" Pipeline Addison Natural Gas Project - EPSC Plan issued 4/16/2013.

The areas of concern where the proposed pipeline will parallel or cross the electric transmission circuits, are outlined below:

- At pipeline station number 69+50, the pipeline will cross the VELCO 115 kV K22 electric transmission circuit.

- At pipeline station number 159+00, the pipeline will cross the VELCO 115 kV 'K21' electric transmission circuit.
- From pipeline station number 328+00 to 333+50, the pipeline will parallel and cross the 'GMP' electric transmission circuit.
- At pipeline station number 456+50, the pipeline will cross the VELCO 115 kV 'K24' electric transmission circuit.
- From pipeline station number 535+00 to 606+50, the pipeline will parallel the VELCO 115 kV 'K23' electric transmission circuit.
- At pipeline station number 606+50, the pipeline will pass in front of the VELCO 'Taft's Corner' electric substation.
- From pipeline station number 606+50 to 717+00, the pipeline will parallel and cross the VELCO 115 kV 'K27' electric transmission circuit.
- At pipeline station number 606+50, the pipeline will pass in front of the VELCO 'Williston' electric substation.
- At pipeline station number 717+50, the pipeline will pass the VELCO 115 kV 'K33' electric transmission circuit which ties into the VELCO 'Williston' electric substation.
- From pipeline station number 718+50 to 1854+50, the pipeline will parallel and cross the VELCO 115 kV 'K43' electric transmission circuit.
- From pipeline station number 1813+50 to 1854+50, the pipeline will parallel and cross the VELCO 115 kV 'K64' electric transmission circuit.
- At pipeline station number 1857+00, the pipeline will pass in front of the VELCO 'New Haven' electric substation.
- From pipeline station number 1859+00 to 2087+75, the pipeline will parallel and cross the VELCO 115 kV 'K63' electric transmission circuit.
- From pipeline station number 1859+50 to 2087+75, the pipeline will parallel and cross the VELCO 115 kV 'K370' electric transmission circuit.

When metallic pipelines are located in shared rights-of-way with high voltage electric transmission circuits, the pipelines can incur high induced voltages and currents due to

AC interference effects. This situation can cause a number of safety issues if not mitigated effectively. The possible effects of this AC interference can include: personnel subject to electric shock up to a lethal level, accelerated corrosion, arcing through pipeline coating, arcing across insulators, disbondment or degradation of coating, or possibly perforation of the pipeline.

AC interference simulation programs were used as part of this project to model the right-of-way (ROW) and estimate the levels of induced and conductive AC voltage on the proposed pipeline. These programs can also be used to evaluate the effectiveness of any proposed mitigation system design.

## 1.2 Objectives & Project Tasks

The primary objectives of this study were as follows:

- 1.2.1 Determine the AC electrical interference effects to the proposed pipeline during steady state and fault conditions on the eleven (11) electric transmission circuits.
- 1.2.2 If required, recommend AC mitigation methods to reduce the induced steady state AC pipeline potentials and touch voltages to less than 30 Volts at all buried locations on the pipeline.
- 1.2.3 If required, recommend AC mitigation methods to reduce the induced steady state AC pipeline potentials and step and touch voltages to less than 15 Volts at all above ground appurtenances.
- 1.2.4 If required, recommend mitigation methods to reduce fault-induced coating-stress voltages on the pipeline to less than 5,000 Volts, for protection of the pipeline coating.
- 1.2.5 If required, recommend mitigation methods for aboveground pipeline locations, such as valve sites and meter stations.
- 1.2.6 Assess the induced AC density on the pipeline for the potential threat of AC corrosion effects.
- 1.2.7 Perform calculations to determine the likelihood of AC corrosion effects to this proposed pipeline, based upon the installation of an AC interference mitigation system.



- 1.2.8 If AC corrosion effects are likely, based upon these calculations, determine if additional mitigation is required to reduce or eliminate the likelihood of AC corrosion effects.

The project tasks associated with this portion of the AC interference analysis and mitigation study consist of the following:

- 1.2.9 Soil Resistivity Analysis - Soil Resistivity measurements were taken along the proposed pipeline. An equivalent multi-layer soil model was obtained from these measurements using the modeling software. This model was then applied to subsequent simulation steps. This task is described in Chapter 2, and detailed results are presented in Appendix A.
- 1.2.10 Inductive Interference Analysis - Circuit models for the proposed pipeline and electric circuits were developed and used to determine magnetically induced pipeline potentials during steady state and fault conditions on the electric transmission circuits. This task is described in Chapter 3, and detailed results are presented in Appendix B.
- 1.2.11 Conductive Interference Analysis - The effects of single line-to-ground faults of nearby electric transmission circuits on the proposed pipeline in proximity was studied. These results were used to calculate coating-stress voltages along the pipeline. This task is described in Chapter 3, and detailed results are presented in Appendix B.

### **1.3 A BRIEF PERSPECTIVE ON ELECTROMAGNETIC INTERFERENCE MECHANISMS**

The flow of energy transmitted by electric power is not totally confined within the power conductors. However, the spatial density of energy in the environment surrounding these circuits decreases sharply with an increase in distance from the conductors. Metallic conductors such as pipelines that are located near electric transmission circuits may capture a portion of the energy encompassed by the conductors' paths, particularly under unfavorable circumstances such as long parallel exposures and fault conditions. In such cases, high currents and voltages may develop along the conductors' lengths. Energy may also flow directly from power installations to pipeline installations via conductive paths common to both.

The electromagnetic interference mechanisms at low frequencies have been traditionally divided into three (3) categories: capacitive, inductive and conductive coupling. These categories and their possible effects are illustrated in Figure 1-1.

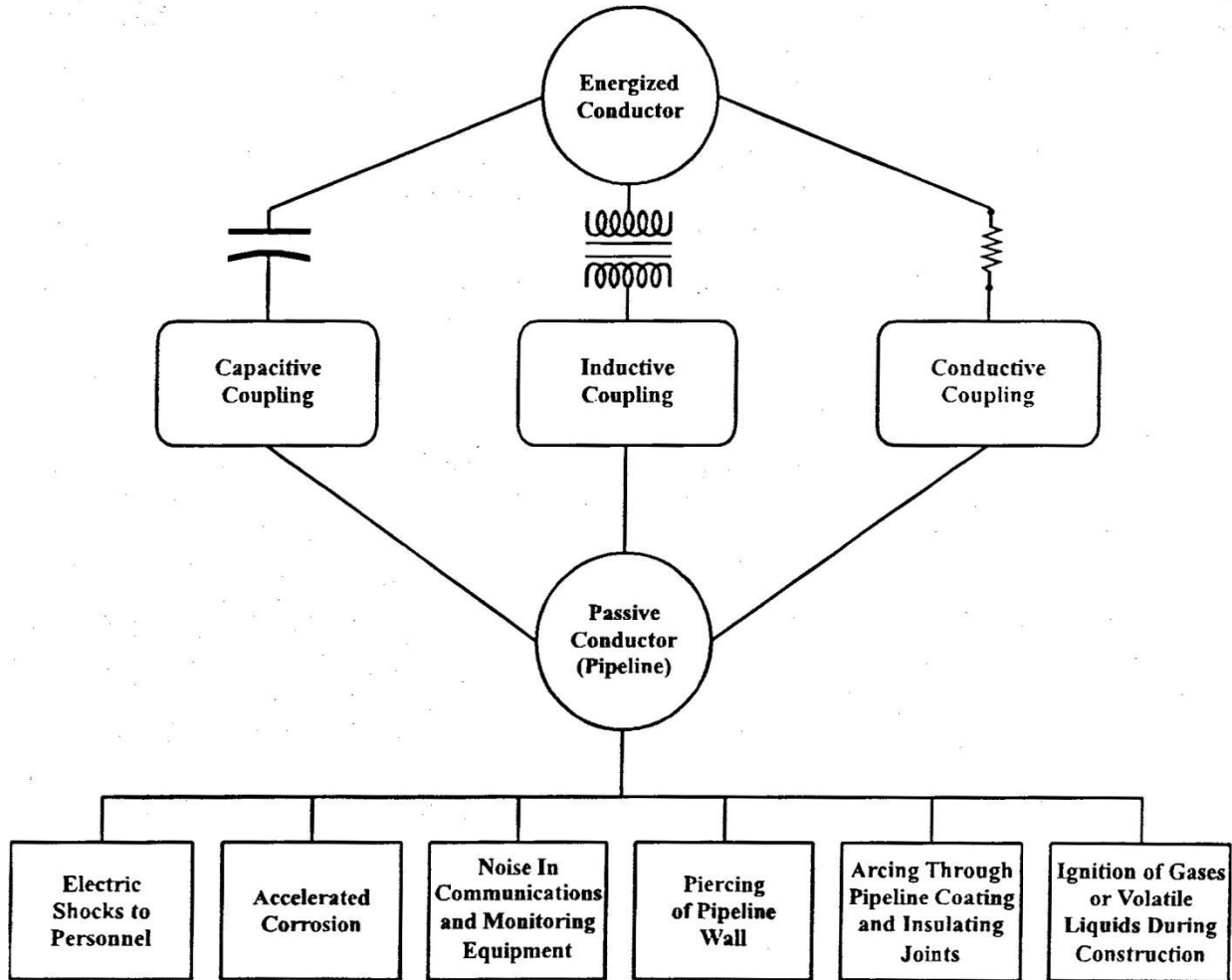


Figure 1-1: Interference Mechanisms and Effects on Pipeline

### 1.3.1 Capacitive Coupling

**Mechanism:**

Electrostatic or capacitive coupling results from the electric field gradient established between energized transmission line conductors and the earth. When the transmission line voltage is very high, a significant electric field gradient exists in the neighborhood of the transmission line. Large conductors, which are near and parallel to the transmission line and insulated from the earth, are liable to accumulate a significant electric charge, which represents a very real danger for personnel. Typically, such conductors include: equipment isolated from the earth, vehicles with rubber tires, aboveground pipelines, or pipelines under construction in dry areas when no precautions have been taken to establish adequate grounding for the pipeline lengths not yet installed in the ground. Hazards range from slight nuisance shocks to ignition of nearby volatile liquids with the accompanying risk of explosion, or electrocution of personnel.

## **Mitigation Measures:**

Buried pipelines are relatively immune to interference due to capacitive coupling because, despite even an excellent coating, the length of exposure to the surrounding soil makes for an adequate ground to dissipate any significant charge that might otherwise accumulate. Aboveground pipelines, including pipelines under construction (which may or may not be buried in part) do not naturally have this protection. One means of protection is periodic grounding to earth, via ground rods, or other ground conductors judiciously placed so as to be unaffected by ground currents emanating from nearby towers during a fault.

### **1.3.2 Inductive Coupling**

#### **Mechanism:**

Electromagnetic or inductive interference in a passive conductor (pipeline) results from an alternating current in another energized conductor (power line), which is more or less parallel to the first. This level of interference increases with decreasing separation and angle between the conductors, as well as with increasing current magnitude and frequency in the energized conductor. The combination of a high soil resistivity and passive conductors with good electrical characteristics (good coating, high conductivity and low permeability) also result in high-induced currents.

Peak potential values occur at discontinuities in either the energized or the passive conductor. When a transmission line and a pipeline are interacting, such discontinuities take the form of rapid changes in separation between the pipeline and transmission line, termination of the pipeline or an insulating junction in the pipeline (which amounts to the same thing), sudden changes in pipeline coating characteristics, a junction between two (2) or more pipelines or transposition of transmission line phases. Note that the induction effects on pipelines during normal power line operating conditions are small compared to the induction effects experienced by a pipeline during a power line fault. The most severe kind of fault is a single-phase-to-ground fault during which high currents circulate in one of the power line phases and are not attenuated by any similar currents in other phases. Hence, mitigation methods, which suffice for single-phase fault conditions, are often adequate for other conditions. It must be noted however, that the longer duration of the resulting potentials in the pipeline during steady state conditions makes the problem important to investigate from a perspective of human safety.

Unlike conductive interference, which tends to be a rather local phenomenon, inductive interference acts upon the entire length of the pipeline that is near to the power lines. Note, however, that conductive interference can involve long sections of a pipeline if several towers adjacent to the faulted tower discharge a significant portion of the fault current, or if a ground conductor connected to the pipeline (anode) and located near a faulted tower, picks up current from the soil.

The large potentials induced onto a pipeline during a fault can destroy insulated junctions, pierce holes in lengths of coating, and puncture pipeline walls. Equipment electrically connected to the pipeline, such as cathodic protection devices, communications equipment, and monitoring equipment can be damaged, and personnel exposed to metallic surfaces, which are continuous with the pipeline, can experience electrical shocks. Accelerated corrosion is another possible result. Implementing appropriate mitigative measures, as discussed below, can prevent this situation.

Although a pipeline equipped with mitigative measures appropriate to deal with phase-to-ground faults does not usually present a great safety hazard during normal conditions, several problems can still exist due to low magnitude induced alternating currents. Accelerated corrosion of steel can result if not offset by increased cathodic protection. This may mean a shortened life for sacrificial and impressed current anode beds. Small amounts of AC can also render impractical the use of a pipeline as a communication channel for data such as pressure and temperature readings to pumping and compressor stations.

### **Mitigation Measures:**

**Pipeline Coating Resistance** - The coating resistance of the pipeline should be chosen as low as corrosion considerations permit. Pipeline coating resistance plays an important role in determining pipeline potentials during a fault condition. During a fault condition, on an electric transmission circuit, the pipeline coating conducts significant amounts of current and should be regarded more as a poor grounding system than an insulator. When this perspective is assumed, it is seen that lowering pipeline coating resistance and bonding grounded conductors to the pipeline steel are two (2) applications of the same principle.

**Pipeline Section Length** - In theory, the potential induced electromagnetically in a pipeline section insulated at both ends is roughly proportional to the length of the exposed region. When this relationship no longer holds, the pipeline is said to have exceeded its characteristic length. The maximum potential value in a section (with respect to remote ground) occurs at each extremity with roughly the same magnitude and opposite phase. This means that each insulating junction is subjected to a stress voltage that is double the peak value in the section. If insulating junctions are inserted frequently enough along a pipeline, then the section size is kept to a minimum, and consequently, so are the peak voltages in the pipeline. This constitutes one possible mitigation method. However, this thorough segmentation can result in very high construction and pipeline cathodic protection costs.

**Grounding** - Grounding of a pipeline, as a protection against the significant voltages that appear during an electrical fault condition, is one of the most effective mitigation measures available. A pipeline should be grounded at appropriate locations throughout its length. Typical grounding locations include: all termination points, both extremities of a segment which is grounded at both ends by an insulating junction, just before and just after a pipeline crosses a power line at a shallow angle, and any other important point of discontinuity likely to result in high induced voltages during a fault condition. Such points include locations where the passive conductor:

- Suddenly veers away from the power line.
- Suddenly changes coating characteristics.
- Emerges from the earth, or returns to the earth.

Other locations where high-induced voltages are likely include points where power line phases are transposed and points where two (2) or more pipelines meet.

In order not to load cathodic protection installations significantly, grounds should be made of an adequate sacrificial material such as zinc or should be made via solid-state-isolator or polarization cells. These DC decoupling devices (DCD) should be properly sized, spaced and physically secured to withstand the current resulting during a power line fault. Caution should be taken to locate grounds far enough away from any nearby power line structure, so that the soil potential near the ground does not rise to undesirable values during a power line fault condition. Soil potentials drop off rather quickly around a faulted structure injecting currents into the earth, so this is not an extremely difficult proposition.

**Buried Mitigation Systems** - A highly effective means of mitigating excessive AC pipeline potentials is the installation of gradient control wires or matting. These methods reduce both inductive and conductive interference. These gradient control wires consist of one or more bare conductors which are buried parallel and near to the pipeline and which are regularly connected to the pipeline. These wires provide grounding for the pipeline and thus lower the absolute value of the pipeline potential (i.e., the potential with respect to remote earth). They also raise earth potentials in the vicinity of the pipeline such that the difference in potential between the pipeline and local earth is reduced. As a result, touch voltages are significantly reduced.

### 1.3.3 Conductive Coupling

#### **Mechanism:**

When a single-phase-to-ground fault occurs at a power line structure, the structure injects a large magnitude current into the earth raising soil potentials in the vicinity of the structure. If a pipeline is located near such a faulted structure, then the earth around the pipeline will be at a relatively high potential with respect to the pipeline potential. The pipeline potential will typically remain relatively low, especially if the pipeline coating has a high resistance. The difference in potential between the pipeline metal and the earth surface above the pipeline is the touch voltage to which a person would be subjected when standing near the pipeline and touching an exposed metallic appurtenance of the pipeline.

If the pipeline is perpendicular to the power line, then no induction will occur and the conductive component described above will constitute the entirety of the touch voltages and coating stress voltages appearing on the pipeline. If the pipeline is not perpendicular to the power line, then an induced potential peak will appear in the pipeline near the fault location. Based on previous interference studies, the induced potential peak in the pipeline is typically on the order of one hundred and fifty-five degrees (155°) out of phase with the potential of the faulted structure and therefore

with the potentials of the soil energized by the structure. Thus, the pipeline steel potential due to induction is essentially opposite in sign to the soil potentials due to conduction. Therefore, inductive and conductive effects reinforce each other in terms of coating stress voltages and touch voltages.

### **Mitigation Measures:**

The magnitude of the conductive interference is primarily a function of the following factors:

- i) GPR of Transmission Line Structure. Soil potentials and touch voltages due to conductive coupling are directly proportional to the ground potential rise (GPR) of the transmission line structure. This GPR value is a property of the entire transmission line system.
- ii) Separation Distance. Although soil potentials and therefore touch voltages obviously decrease with increasing distance away from the faulted structure, the rate of decrease varies considerably from site to site, depending upon the soil structure, as described below.
- iii) Size of Structure Grounding System. Soil potentials decrease much more sharply with increasing distance away from a small grounding system than that from a large grounding system. Conductive interference can be minimized by limiting the use of counterpoise conductors and ground rods, by the power company, at sites where pipelines are in close proximity to the electric transmission system structures.
- iv) Soil Structure. When the soil in which the structure grounding system is buried has a significantly higher resistivity than the deeper soil layers (particularly if the lower resistivity layers are not far below the structure grounding system), earth surface potentials decay relatively sharply with increasing distance away from the structure. When the inverse is true, i.e., when the structure grounding system is in low resistivity soil, which is under laid by higher resistivity layers, earth surface potentials may decay very slowly.
- v) Pipeline Coating Resistance. When a pipeline has a low ground resistance (e.g., due to coating deterioration over time), the pipeline collects a significant amount of current from the surrounding soil and rises in potential. At the same time, earth surface potentials in the vicinity of the pipeline decrease due to the influence of the pipeline. As a result, the potential difference between the pipeline and the earth surface can be significantly reduced.

When a conductive interference problem is present, touch voltages can be reduced by: either reducing earth surface potentials in the vicinity of the pipeline, raising the pipeline potentials near the faulted structure, or a combination of these two (2) actions. The most effective mitigation systems perform both of these actions.

## 1.4 A BRIEF PERSPECTIVE ON AC CORROSION MECHANISMS

### 1.4.1 AC Corrosion Mechanism

AC corrosion is the metal loss that occurs from AC current leaving a metallic pipeline at a coating holiday. The mechanism of AC corrosion occurs when AC current leaves the pipeline through a small holiday in low resistance soil conditions.

### 1.4.2 Mitigation of AC Corrosion

The main factors that influence the AC corrosion phenomena are:

- Induced AC pipeline voltage
- DC polarization of the pipeline
- Size of coating faults (holidays)
- Local soil resistivity at pipe depth

The induced AC pipeline voltage is considered the most important parameter when evaluating the likelihood of AC corrosion on a buried pipeline section.

The likelihood of AC corrosion can be reduced through mitigation of the induced AC pipeline voltage. The European Standard CEN/TS 15280:2006 “Evaluation of AC Corrosion Likelihood of Buried Pipelines - Application to Cathodically Protected Pipelines” recommends that AC pipeline voltages should not exceed the following:

- Ten (10) Volts where the local soil resistivity is greater than 25 ohm-meters.
- Four (4) Volts where the local soil resistivity is less than 25 ohm-meters.

These AC pipeline voltage limits are derived in part by calculating AC density at pipeline coating holidays. Since the AC current is mainly discharged to earth through the exposed steel at pipeline coating holidays, the AC corrosion rate can vary proportionately with increasing AC density at a coating holiday.

European Standard CEN/TS 15280, offers the following guidelines:

The pipeline is considered protected from AC corrosion if the root mean square (RMS) AC density is lower than 30 A/m<sup>2</sup>. In practice, the evaluation of AC corrosion likelihood is done on a broader basis:

- Current density lower than 30 A/m<sup>2</sup>: no or low likelihood of AC Corrosion effects
- Current density between 30 and 100 A/m<sup>2</sup>: medium likelihood of AC Corrosion
- Current density higher than 100 A/m<sup>2</sup>: very high likelihood of AC Corrosion

If the soil resistivity and the pipeline AC voltage are known, the risk of AC corrosion can be determined using the following formula in Equation 1 to calculate the current density at a holiday location.

$$I = (8 * V_{ac}) / (\rho * \pi * d) \quad \text{(Equation 1)}$$

Where:

i = Current Density (A/m<sup>2</sup>)

V<sub>ac</sub> = Pipe-to-Soil Voltage (Volts)

ρ = Soil Resistivity (ohm-meters)

d = Holiday diameter (meters)

### 1.4.3 Determining Steady State Pipeline AC Voltage Limits

The primary factor in calculating AC density at coating holidays is induced AC voltage on the pipeline at these coating holidays. Since the local soil does not significantly change, lowering the induced AC pipeline voltage (by adding mitigation) also lowers the local AC density.

To analyze the possible AC corrosion effects on this pipeline section, calculations were completed to determine the AC current density exiting the pipeline, assuming a one (1) cm<sup>2</sup> circular coating holiday at each soil resistivity location.

## 1.5 Definitions

**AC Corrosion:** The corrosion reaction associated with an AC electric current leaving the metal pipeline surface, due to an induced AC voltage on the pipeline.

**AC Electrical Interference (Electromagnetic Interference):** A coupling of energy from an electrical source (such as an electrical power line) to a metallic conductor (such as a pipeline) which at low frequencies (in the range of power system frequencies) occurs in the form of three different mechanisms; capacitive, conductive and inductive coupling. Electrical interference can produce induced voltages and currents in the metallic conductors that may result in safety hazards and/or damage to equipment.

**Coating Stress Voltage:** This is the potential difference between the outer surface of a conductor (e.g., pipelines, cables, etc.) coating and the metal surface of the conductor, and results from inductive and conductive potentials.



**Capacitive Coupling:** Capacitive coupling occurs as a result of an energized electrical source (e.g., power line) that produces a power line voltage between a conductor (such as a pipeline) and earth where the conductor is electrically insulated from the earth. An electric field gradient from the electrical source induces a voltage onto the conductor insulated from earth, which varies primarily according to the distance between the source and the conductor, the voltage of the source and the length of parallelism.

**Conductive Coupling:** When a fault current flows from the power line conductor to ground, a potential rise is produced in the soil with regard to remote earth. A conductor, which is located in the influence area of the ground for the power line structure, is subject to a potential difference between the local earth and the conductor potential. Conductive coupling is a localized phenomenon that acts upon the earth in the vicinity of the flow of current to ground.

**Conductive Earth Potential:** This is the potential that is induced onto a conductor due to the energization of the surrounding earth by the current leaking from the power line structure.

**Dielectric Breakdown:** The potential gradient at which electric failure or breakdown occurs. In this case, it is pertinent to the coating of the pipeline and the potential at which damage to the coating will occur.

**Earth Surface Potential:** When a single-phase-to-ground fault occurs at a power line structure, the structure injects a large magnitude current into the earth and therefore raises soil potentials in the vicinity of the structure. These potentials are referred to as earth surface potentials.

**Fault Condition:** A fault condition is a physical condition that causes a device, a component, or an element to fail to perform such as a short circuit or a broken wire. As a result, an abnormally high current flows from one conductor to ground or to another conductor.

**Inductive Coupling:** Inductive coupling is an association of two (2) or more circuits with one another by means of inductance mutual to the circuits. The coupling results from alternating current in an energized conductor (e.g., power line) which is more or less parallel with a passive (non-energized) conductor. Inductive coupling acts upon the entire length of a conductor.

**Inductive Pipeline Potential:** The potential induced onto a pipeline during steady state or fault conditions that results from the mutual coupling between the energized conductor (power line) and the pipeline.

**Load Condition:** A load condition for a circuit is the amount of rated operating electrical power that is transmitted in that circuit under normal operating conditions for a specific period of time.

**Local Earth:** Local earth is the earth in the vicinity of a conductor, which is raised to a potential, typically, as a result of the flow of fault current to ground. In the case of a pipeline, which has a good coating and does not have grounding conductors connected to the pipeline where the earth potential rise occurs, the "local" earth will be the same as the "remote" earth.

**Permeability:** Permeability is a term used to express various relationships between magnetic induction and magnetizing force.

**Potential Difference:** The relative voltage at a point in an electric circuit or field with respect to a reference point in the same circuit or field.

**Remote Earth:** Remote earth is a location of the earth away from where the origin of the earth potential rise occurs that represents a potential of zero Volts.

**Steady State Condition:** A steady state condition for a power system is a normal operating condition where there is negligible change in the electrical power transmitted in a circuit over a long period of time.

**Step Voltage:** The difference in surface potential experienced by a person bridging a distance of 1 meter with his feet without contacting any other grounded conducting object.

**Touch Voltage:** The potential difference between the Ground Potential Rise and the surface potential at a point where a person is standing with his hand in contact with a grounded structure.

## 1.6 AC Mitigation System Design Objectives

An AC mitigation system designed to protect a pipeline subject to AC interference effects must achieve the following four (4) objectives:

- i) During worst-case steady state load conditions for each electric transmission circuit, reduce AC pipeline potentials with respect to local earth to acceptable levels for the safety of operating personnel and the public.
- ii) During fault conditions on the electric transmission circuits, ensure that pipeline coating stress voltages remain within acceptable limits in order to prevent damage to the coating or even to the pipeline steel.

Damage to the coating can result in accelerated corrosion of the pipeline itself. Coating damage can occur at voltages on the order of one thousand (1,000) to two thousand (2,000) Volts for bitumen coated pipelines, whereas damage to polyethylene or fusion bonded epoxy coated pipelines occurs at higher voltages, i.e., greater than five thousand (5,000) Volts.

- iii) During fault conditions on the electric transmission circuits, ensure the safety of the public and of operating personnel at exposed pipeline appurtenances. ANSI/IEEE Standard 80 specifies safety criteria for determining maximum acceptable touch and step voltages during fault conditions. Special precautions must be taken by maintenance personnel when excavating inaccessible portions of the pipeline to ensure safety in case of a fault condition.
- iv) During worst-case steady state load conditions for each electric transmission circuit, reduce AC current densities through coating holidays to prevent possible AC corrosion mechanisms on the pipeline.

Table 1-1 depicts the proposed 12" pipeline design criteria

**Table 1-1: Design Criteria for Personnel Safety, and Protection Against Damage to the Pipeline Coating**

Criteria	Steady State Maximum <sup>1</sup> (Volts)	Fault Maximum (Volts)
Exposed Pipeline Appurtenance Touch Voltage	15	-----
Exposed Pipeline Appurtenance Step Voltage	15	-----
Buried Pipeline Touch Voltage	30	-----
AC Current Density Through 1 cm <sup>2</sup> Coating Holiday	100 A/m <sup>2</sup> (Current)	
Coating Stress Voltage	-----	5,000

<sup>1</sup> With respect to "Local Earth"

## 2. PHYSICAL LAYOUT

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### 2.0 Physical Layout

The proposed 12" pipeline under study is approximately 41.2 miles in length. Eleven (11) electric transmission circuits will parallel or cross the proposed pipeline as described below:

- At pipeline station number 69+50, the pipeline will cross the VELCO 115 kV 'K22' electric transmission circuit.
- At pipeline station number 159+00, the pipeline will cross the VELCO 115 kV 'K21' electric transmission circuit.
- From pipeline station number 328+00 to 333+50, the pipeline will parallel and cross the 'GMP' electric transmission circuit.
- At pipeline station number 456+50, the pipeline will cross the VELCO 115 kV 'K24' electric transmission circuit.
- From pipeline station number 535+00 to 606+50, the pipeline will parallel the VELCO 115 kV 'K23' electric transmission circuit.
- At pipeline station number 606+50, the pipeline will pass in front of the VELCO 'Taft's Corner' electric substation.
- From pipeline station number 606+50 to 717+00, the pipeline will parallel and cross the VELCO 115 kV 'K27' electric transmission circuit.
- At pipeline station number 606+50, the pipeline will pass in front of the VELCO 'Williston' electric substation.
- At pipeline station number 717+50, the pipeline will pass the VELCO 115 kV 'K33' electric transmission circuit which ties into the VELCO 'Williston' electric substation.
- From pipeline station number 718+50 to 1854+50, the pipeline will parallel and cross the VELCO 115 kV 'K43' electric transmission circuit.
- From pipeline station number 1813+50 to 1854+50, the pipeline will parallel and cross the VELCO 115 kV 'K64' electric transmission circuit.

- At pipeline station number 1857+00, the pipeline will pass in front of the VELCO ‘New Haven’ electric substation.
- From pipeline station number 1859+00 to 2087+75, the pipeline will parallel and cross the VELCO 115 kV ‘K63’ electric transmission circuit.
- From pipeline station number 1859+50 to 2087+75, the pipeline will parallel and cross the VELCO 115 kV ‘K370’ electric transmission circuit.

The eleven (11) electric transmission circuits and the approximate pipeline station numbers are listed in Table 2-1.

**Table 2-1: Regions of Influence by Electric Circuits on the Proposed Pipeline**

Circuit Name	Power Company	Line Size (kV)	Pipeline Station Number Range
K22	VELCO	115	Crosses at 69+50
K21	VELCO	115	Crosses at 159+00
GMP	GMP	-	Parallel from 328+00 to 333+50
K24	VELCO	115	Crosses at 456+50
K23	VELCO	115	Parallel from 535+00 to 606+50
K27	VELCO	115	Parallel from 606+50 to 717+00
K33	VELCO	115	Passes at 717+50
K43	VELCO	115	Parallel from 718+50 to 1854+50
K64	VELCO	115	Parallel from 1813+50 to 1854+50
K63	VELCO	115	Parallel from 1859+00 to 2087+75
K370	VELCO	345	Parallel from 1859+50 to 2087+75

**Note:** All referenced pipeline station numbers are based on the pipeline alignment plans - Vermont Gas Proposed 12" Pipeline Addison Natural Gas Project - EPSC Plan issued 4/16/2013.

## 2.1 Pipeline Data

The effective coating resistance of a pipeline is a conservative value obtained from previous research on coating resistances for new coated pipelines.

- |                                       |                               |
|---------------------------------------|-------------------------------|
| 1) Coating Resistance of 12" pipeline | 1,000,000 ohm-ft <sup>2</sup> |
|---------------------------------------|-------------------------------|

The characteristics used for the proposed 12" pipeline, provided by Vermont Gas System, will be as follows:

- Relative resistivity: 10 (with respect to annealed copper)
- Relative permeability: 300 (with respect to free space)
- Pipeline diameter: 12.75" OD
- Pipeline depth: Minimum 3' Cover (top of pipe to natural grade)
- Pipeline wall thickness: 0.312"
- Coatings: Pritec 10/40 or Warrior 100

## 2.2 Soil Resistivity Measurements

This AC electrical interference analysis was based on soil resistivity measurements recorded at locations along the proposed pipeline route, using equipment and procedures developed especially for this type of interference study. ARK Engineering personnel conducted these soil resistivity measurements on May 1-6, 2013. Soil resistivity measurements for this analysis were recorded at forty (40) sites. This measurement data is outlined in Appendix A.

Soil resistivity measurements are used to calculate the ground resistance of electric transmission line structures, assess the gradient control performance of AC mitigation systems and gradient control mats, as well as to determine the conductive coupling of the pipeline through the earth from nearby faulted electric transmission circuit structures. The conductive coupling has an important effect on touch and step voltages at proximate valve sites and on pipeline coating-stress voltages.

Past experience has shown the need for a special measurement methodology for environments that are subject to electrical noise due to the presence of nearby high voltage electric transmission circuits. When conventional methods are used, the instrumentation can pick up noise from the nearby electric power circuits and indicate resistivity values much higher than reality at large electrode spacing, suggesting that deeper soil layers offer poorer grounding than they actually may. Resistance readings can be inflated by a factor of four (4) or more. This error can result in conservative mitigation designs.

### 2.2.1 Soil Resistivity Measurement Methodology

Measurements conducted by ARK Engineering personnel were based upon the industry recognized Wenner four-pin method, in accordance with IEEE Standard 81, "IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System", using the Miller 400D Digital Resistance Meter.

The electrode spacing varied from point one-five (0.15) meters to twenty-five (25) meters. Apparent resistivity values that correspond to the measured resistance values can be calculated using the expression:

$$\rho = 2\pi aR$$

Where:

$\rho$  = Apparent soil resistivity, in ohm-meters ( $\Omega$ -m)

$a$  = Electrode separation, in meters (m)

$R$  = Measured resistance, in ohms ( $\Omega$ )

In practice, four rods are placed in a straight line at intervals " $a$ ", driven to a depth that does not exceed one-tenth of " $a$ " ( $0.1*a$ ).

This results in the approximate average resistance of the soil to a depth of " $a$ " meters.

### 2.2.2 Soil Resistivity Data

Soil resistivity measurements were used to derive an equivalent soil structure model. This multilayer soil model is representative of the changing soil characteristics as a function of depth. The inductive coupling interference modeling uses the bottom-most soil resistivity layer from the multilayer model. The complete multi-layer soil characteristics are used to calculate the conductive and total AC interference effects. Touch voltage, coating stress voltage, and touch & step safety limits all use the complete multilayer soil model.

The bottom layer soil resistivity values were used for calculating electric transmission circuit parameters and inductive interference effects on the proposed pipeline.

**Table 2-2: Bottom Layer Soil Resistivity Values**

Soil Resistivity Location No.	Approx. Pipeline Station Number	Bottom Layer Resistivity ( $\Omega$ -m)
1	20+50	67.36
2	33+00	584.54
3	105+50	246.46
4	162+00	713.14
5	207+50	735.49
6	267+00	735.56
7	315+00	197.30
8	396+25	266.40
9	433+00	258.45
10	505+50	438.88
11	458+00	248.55
12	600+50	122.09
13	657+00	299.76
14	703+50	4,484.10
15	757+00	768.91
16	817+50	249.55
17	893+75	243.58
18	961+50	387.73
19	999+25	481.45
20	1046+00	456.23
21	1111+00	500.30
22	1157+00	231.01
23	1202+50	80.85
24	1264+00	321.77
25	1343+25	1,322.32
26	1397+00	997.16
27	1425+00	164.72
28	1492+50	885.79
29	1548+00	2,340.75
30	1587+50	583.50
31	1651+00	884.52
32	1731+00	2,846.73
33	1769+00	375.09



Soil Resistivity Location No.	Approx. Pipeline Station Number	Bottom Layer Resistivity ( $\Omega$ -m)
34	1841+50	995.52
35	1893+00	465.28
36	1955+00	620.99
37	2021+50	1,013.96
38	2103+50	1,606.38
39	2154+25	486.78
40	2179+88	1,182.73

**Note:** All referenced pipeline station numbers are based on the pipeline alignment plans - Vermont Gas Proposed 12" Pipeline Addison Natural Gas Project - EPSC Plan issued 4/16/2013.

### 3. STEADY STATE CONDITIONS

#### 3.0 Steady State Conditions

The emergency peak AC load currents, provided by VELCO or assumed by ARK Engineering, were used to compute the maximum steady state inductive AC interference effects on the proposed 12" pipeline.

Although these circuits may not be loaded to this level, the data provided by VELCO or assumed by ARK Engineering constitutes a realistic scenario if other critical circuits are out of service and the load must be redirected through these circuits. Therefore, under normal conditions, the steady state AC interference levels should be significantly less than those reported in this study.

Table 3-1 indicates the load currents for this interference analysis.

**Table 3-1: Transmission Circuit Peak Emergency Current Ratings**

Power Company	Circuit Name	Line Size (kV)	Emergency Peak Load Current (A)
VELCO	K21	115	1,250
VELCO	K22	115	1,250
VELCO	K24	115	1,100
VELCO	K23	115	1,500
VELCO	K27	115	1,500
VELCO	K33	115	1,250
VELCO	K43	115	1,250
VELCO	K63	115	1,250
VELCO	K64	115	1,500
VELCO	K370	345	1,350
GMP	GMP	-	1,000*

**Note:** GMP Circuit loading was assumed by ARK Engineering, based on industry experience.

### 3.1 Fault Conditions

To determine the maximum AC interference effects of a faulted circuit on the proposed 12" pipeline under study, the model included assumed single phase-to-ground fault branch currents on the VELCO and GMP electric transmission circuits.

Fault conditions were simulated on the electric transmission circuits in the areas of parallelism. Single phase-to-ground branch currents, provided by VELCO or assumed by ARK Engineering based on past industry experience, were used to calculate fault currents on grounded tower structures along each electric transmission circuit.

Reference Appendix C for all fault data used in this analysis.

### 3.2 Safety Criteria

The safety criteria established as part of this analysis is based upon the ANSI/IEEE Standard 80, "IEEE Guide for Safety in AC Substation Grounding" and the following assumptions:

- A surface layer of six inches (6") of gravel at all aboveground pipeline locations (1,000 Ohm-meter gravel unless otherwise noted)
- A 50 kg (110 lbs.) person having a body resistance ( $R_b$ ) of 1,000  $\Omega$
- A worst case breaker failure fault clearing times, provided by VELCO were used for all fault condition scenarios.

Reference Appendix C for worst case breaker failure fault clearing times, provided by VELCO.

### 3.3 Modeled Interference Levels

ARK Engineering performed this AC interference analysis using state of the art modeling software. The output file plots for the steady state and simulated fault conditions on the eleven (11) electric transmission circuits are included in Appendix B.

#### 3.3.1 Steady State Conditions

The induced AC pipeline potentials on the proposed pipeline were computed with the electric transmission circuits operating at emergency peak load conditions. The results are summarized in Appendix B.

The computed induced AC pipeline potentials were above the maximum allowable design limit of thirty (30) Volts at various locations along the proposed pipeline.

For the proposed pipeline, induced AC pipeline potentials reached a maximum of approximately one hundred and thirty-nine (139) Volts, with respect to remote earth. This peak occurs at pipeline station number 2087+16. At this location, the proposed pipeline leaves the shared right-of-way with two (2) VELCO electric transmission circuits.

Table 3-2 outlines the computed maximum induced AC pipeline potential at emergency peak load conditions on the electric transmission circuits.

**Table 3-2: Maximum Induced Potentials on the Proposed 12" Pipeline at Emergency Peak Load Conditions**

Pipeline		Pipeline Station Number	Maximum Induced Potential (V)	Design Limit (V)
12" Pipeline	Without AC Mitigation	2087+16	139	30
	With AC Mitigation	1951+53	25.78	30

All pipeline locations were reduced to less than the design limit.

Reference Appendix B for plots of the computed induced AC pipeline potentials on the proposed 12" pipeline.

### 3.3.2 Fault Conditions

As outlined in Chapter 1 of this report, when an electric transmission circuit fault occurs at a grounded structure (transmission tower) in proximity to a pipeline in a joint corridor, the induced AC pipeline potential is essentially out of phase with the earth potentials developed by conduction near the faulted structure. Therefore, inductive and conductive interference effects reinforce each other in terms of coating stress voltages and touch voltages.

**3.3.2.1 Inductive Interference** – Inductive interference effects to the proposed pipeline were computed and analyzed during simulated fault conditions on each of the eleven (11) electric transmission circuits. This was undertaken to determine the maximum induced AC pipeline potentials at all points along the proposed pipeline.

**3.3.2.2 Conductive Interference** – The configuration of the electric transmission circuit towers and their grounding systems was used to determine earth surface potentials in proximity to the structures and the pipeline during a simulated single phase-to-ground fault condition.

**3.3.2.3 Total Fault Current Interference** – The maximum total pipeline coating stress voltage was computed for each point along the pipeline. This is the sum of the inductive and conductive AC interference effects at each joint facility corridor area. The maximum pipeline coating stress voltage was calculated at four thousand six hundred and fourteen (4,614) Volts. This value was calculated at pipeline station number 1547+10. This occurred as a result of a simulated single phase-to-ground fault on the VELCO 115 kV 'K43' electric transmission circuit that will parallel the proposed pipeline from station numbers 1859+50 to 1854+50.

The maximum total coating stress voltage value is outlined below in Table 3-3.

**Table 3-3: Maximum Coating Stress Voltage on the Pipeline under Fault Conditions**

Pipeline	Transmission Circuit Faulted	Approximate Location (Station Number)	Maximum Coating Stress Voltage (V)
12" Proposed Pipeline	VELCO K43	1547+10	4,614

Appendix B includes plots of the coating stress voltage on the pipeline during simulated fault conditions on the electric transmission circuit structures.

**3.3.3 AC Touch and Step Voltage**

Six (6) aboveground pipeline appurtenances are proposed to be on or near the shared power line rights-of-way with this proposed pipeline. These sites were modeled with a simulated fault at the closest tower to determine the worst-case scenario for touch and step potentials. The following sites were modeled and analyzed:

- Williston M&R: MP 10.43
- MLV-2: MP 14.30
- MLV-3: MP 19.81
- MLV-4: MP 24.80
- MLV-5/ Plank Rd. M&R: MP 32.54
- MLV-6: MP 35.00

Reference Appendix B for plots of the AC Touch and Step Voltage at these locations.

**Williston M&R - Mile Post Number 10.43**

Single phase-to-ground fault conditions were simulated at the towers nearest to the site on the electric transmission circuits. Touch and step voltages were calculated around the site and the boundary fence. Table 3-4 outlines these results.

**Table 3-4: Williston M&R - Maximum Touch and Step Voltage Results**

	Calculated With No Mitigation	Calculated With Mitigation	IEEE Standard 80 Safety Limit
<b>Touch Voltage (Volts AC)</b>	347.46 V	58.98 V	187.30 V
<b>Step Voltage (Volts AC)</b>	1.48 V	17.19 V	498.10 V

Without an AC mitigation system installed, the computed AC touch voltage exceeds the IEEE Standard 80 design limit of 187.30 Volts.

With the recommended AC mitigation system installed at this station, the computed AC touch voltage is below the IEEE Standard 80 design limit.

**MLV-2 - Mile Post Number 14.30**

Single phase-to-ground fault conditions were simulated at the towers nearest to the site on the electric transmission circuits. Touch and step voltages were calculated around the site and the boundary fence. Table 3-5 outlines these results.

**Table 3-5: MLV-2 - Maximum Touch and Step Voltage Results**

	Calculated With No Mitigation	Calculated With Mitigation	IEEE Standard 80 Safety Limit
<b>Touch Voltage (Volts AC)</b>	1,870.85 V	148.34 V	228.20 V
<b>Step Voltage (Volts AC)</b>	9.30 V	69.07 V	606.10 V

Without an AC mitigation system installed, the computed AC touch voltage exceeds the IEEE Standard 80 design limit of 228.20 Volts.

With the recommended AC mitigation system installed at this station, the computed AC touch voltage is below the IEEE Standard 80 design limit.

**MLV-3 - Mile Post Number 19.81**

Single phase-to-ground fault conditions were simulated at the towers nearest to the site on the electric transmission circuits. Touch and step voltages were calculated around the site and the boundary fence. Table 3-6 outlines these results.

**Table 3-6: MLV-3 - Maximum Touch and Step Voltage Results**

	Calculated With No Mitigation	Calculated With Mitigation	IEEE Standard 80 Safety Limit
<b>Touch Voltage (Volts AC)</b>	1,855.42 V	186.70 V	227.60 V
<b>Step Voltage (Volts AC)</b>	11.43 V	71.39 V	603.4 V

Without an AC mitigation system installed, the computed AC touch voltage exceeds the IEEE Standard 80 design limit of 227.60 Volts.

With the recommended AC mitigation system installed at this station, the computed AC touch voltage is below the IEEE Standard 80 design limit.

**MLV-4 - Mile Post Number 24.80**

Single phase-to-ground fault conditions were simulated at the towers nearest to the site on the electric transmission circuits. Touch and step voltages were calculated around the site and the boundary fence. Table 3-7 outlines these results.

**Table 3-7: MLV-4 - Maximum Touch and Step Voltage Results**

	Calculated With No Mitigation	Calculated With Mitigation	IEEE Standard 80 Safety Limit
<b>Touch Voltage (Volts AC)</b>	1,290.12 V	252.64 V	432.80 V
<b>Step Voltage (Volts AC)</b>	59.51 V	102.23 V	1171.30 V

Without an AC mitigation system installed, the computed AC touch voltage exceeds the IEEE Standard 80 design limit of 432.80 Volts.

With the recommended AC mitigation system installed at this station, the computed AC touch voltage is below the IEEE Standard 80 design limit.

**MLV-5/Plank Rd. M&R - Mile Post Number 32.54**

Single phase-to-ground fault conditions were simulated at the towers nearest to the site on the electric transmission circuits. Touch and step voltages were calculated around the site and the boundary fence. Table 3-8 outlines these results.

**Table 3-8: MLV-5/Plank Rd. M&R - Maximum Touch and Step Voltage Results**

	Calculated With No Mitigation	Calculated With Mitigation	IEEE Standard 80 Safety Limit
<b>Touch Voltage (Volts AC)</b>	1,466 V	273.62 V	287.80 V
<b>Step Voltage (Volts AC)</b>	80.62 V	101.19 V	781.70 V

Without an AC mitigation system installed, the computed AC touch voltage exceeds the IEEE Standard 80 design limit of 287.80 Volts.

With the recommended AC mitigation system installed at this station, the computed AC touch voltage is below the IEEE Standard 80 design limit.

**MLV-6 - Mile Post Number 35.00**

Single phase-to-ground fault conditions were simulated at the towers nearest to the site on the electric transmission circuits. Touch and step voltages were calculated around the site and the boundary fence. Table 3-9 outlines these results.

**Table 3-9: MLV-6 - Maximum Touch and Step Voltage Results**

	Calculated With No Mitigation	Calculated With Mitigation	IEEE Standard 80 Safety Limit
<b>Touch Voltage (Volts AC)</b>	797.65 V	271.9 V	298.80 V
<b>Step Voltage (Volts AC)</b>	8.19 V	238.26 V	825.70 V

Without an AC mitigation system installed, the computed AC touch voltage exceeds the IEEE Standard 80 design limit of 298.80 Volts.

With the recommended AC mitigation system installed at this station, the computed AC touch voltage is below the IEEE Standard 80 design limit.



### 3.4 AC Mitigation System

The AC mitigation system designed and recommended by ARK Engineering for the proposed 12" pipeline reduces the AC interference effects to acceptable levels during emergency peak steady state and fault conditions on the eleven (11) electric transmission circuits that will parallel or cross the pipeline route.

The proposed AC mitigation system design includes the installation of gradient control wires (zinc ribbon anode or equivalent) in the areas of computed high pipeline AC potentials. This AC mitigation system will reduce the induced steady state AC voltage and AC current density on the pipeline system.

Also included in the AC mitigation system design are 2/0 bare copper ground loop systems at the following aboveground pipeline locations:

- Williston M&R: MP 10.43
- MLV-2: MP 14.30
- MLV-3: MP 19.81
- MLV-4: MP 24.80
- MLV-5/ Plank Rd. M&R: MP 32.54
- MLV-6: MP 35.00

This portion of the AC mitigation system will reduce AC touch potentials at these locations to acceptable levels.

### 3.5 AC Corrosion Analysis Results

To analyze the possible AC corrosion effects to this proposed pipeline, calculations were completed to determine the AC density based upon induced AC pipeline voltages, assuming a one (1) cm<sup>2</sup> circular coating holiday, along the proposed pipeline.

The computed induced pipeline voltages are shown in Appendix B.

For the proposed pipeline, a maximum computed AC density of one thousand thirty-one (1,031) A/m<sup>2</sup> may occur at pipeline station number 2179+88. At this location, the proposed pipeline will terminate at the Middlebury M&R valve station.

With the recommended AC mitigation system installed and connected to the proposed pipeline, the maximum computed AC density was reduced to two hundred and four (204) A/m<sup>2</sup>.

Table 3-10 outlines the computed maximum AC density at emergency load conditions on the VELCO and GMP electric transmission circuits.

**Table 3-10: Maximum Coating Holiday AC Current Density**

Pipeline		Pipeline Station Number	Maximum Current Density (A/m <sup>2</sup> )	Design Limit (A/m <sup>2</sup> )
12" Proposed Pipeline	Without AC Mitigation	2179+88	1,031.15	100
	With AC Mitigation	1517+91	204.93	100

Since the loading used on these electric transmission circuits are conservative resulting in AC density values above the design limit, ARK Engineering recommends installing coupon test stations and remote monitoring equipment at locations above 100 A/m<sup>2</sup> to monitor these locations.

Reference Appendix B for plots of the computed AC density on the proposed pipeline.

## 4. CONCLUSIONS

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### 4.0 Conclusions

The proposed 12" pipeline and the eleven (11) electric transmission circuits have been modeled and analyzed as described in this report.

Computer modeling and analysis, using emergency peak load currents on the electric transmission circuits, indicate the following:

- Steady state induced AC pipeline voltages will exceed the design limit of fifteen (15) Volts for aboveground sections at several locations along the proposed pipeline under these load conditions on the electric circuits.
- Steady state induced AC pipeline voltages will exceed the design limit of thirty (30) Volts for below ground sections at several locations along the proposed pipeline under these load conditions on the electric circuits.
- Pipeline coating stress voltages will not exceed the five thousand (5,000) Volt design limit for a single phase-to-ground fault on the electric circuits.
- Touch voltages at six (6) aboveground pipeline locations will exceed the IEEE Standard 80 design limits during single phase-to-ground simulations under breaker failure conditions.
- AC density across a 1cm<sup>2</sup> coating holiday will exceed the 100 A/m<sup>2</sup> design limit at several locations along the proposed pipeline.

AC mitigation systems were designed to effectively reduce the induced AC interference effects on the pipeline to less than the design limits. For locations where AC density is above the 100 A/m<sup>2</sup> design limit for maximum load conditions, ARK Engineering recommends the installation of coupon test stations and remote monitoring at these locations to monitor actual field conditions.

This analysis results in interference levels that are conservative. Under normal operating conditions, the AC interference levels on the pipeline should be less than reported in this study.

## 4.1 Assumptions

During the modeling and analysis of the AC interference effects on the proposed pipeline, various assumptions were required. These assumptions are outlined below in no particular order:

- a. Low voltage distribution taps were not included in this analysis.
- b. A coating resistance value of 1,000,000  $\Omega$ -ft<sup>2</sup> was used for the proposed pipeline. This is a conservative value used for new pipelines.
- c. GMP did not provide power data, upon request, therefore GMP power data was assumed by ARK Engineering using conservative values based on past industry experience.
- d. Simulated fault scenarios for GMP were computed using assumed fault data estimated by ARK Engineering.
- e. A six (6) inch layer of crushed rock was assumed to be installed at all above ground pipeline appurtenances.
- f. Ground grids for VELCO substations were not provided.
- g. A coating holiday size of 1 cm<sup>2</sup> was used in the calculation of AC current density.

## 5. RECOMMENDATIONS

### 5.0 Recommendations

As outlined in the previous chapter, induced AC pipeline potentials were calculated at values greater than the design limits detailed in Table 1-1, for the proposed pipeline, during conservative emergency peak steady state load conditions on the eleven (11) electric transmission circuits.

Pipeline AC voltage mitigation is accomplished by installation of gradient control wire (zinc ribbon anode or equivalent) along the pipeline in the areas of computed high AC pipeline potentials and AC current density values. This method also reduces AC coating stress voltages during fault conditions on the high voltage electric circuits. This gradient control wire will be connected to the pipeline at various locations through a Solid-State decoupling (SSD) device.

DC isolation is recommended between the pipeline and the grounding conductors through the use of SSD. These devices allow AC current to flow from the pipeline to the grounding system while blocking any DC cathodic protection current from flowing off the pipeline to the ground conductors.

### 5.1 Proposed Safety and Mitigation System Requirements

Having performed the modeling and analysis of the AC interference effects on the proposed 12" pipeline, ARK Engineering has designed an AC mitigation system to reduce the pipeline AC interference effects to safe levels for pipeline integrity and personnel safety.

ARK Engineering recommends that gradient control wire (zinc ribbon anode or equivalent) be installed in the following areas:

**Table 5-1: 12" Pipeline AC Mitigation System**

SECTION NO.	STATION NO. START	STATION NO. END	TOTAL LENGTH OF ZINC RIBBON (FT)
3	451+25	457+05	580
4	612+60	623+60	1,100
5	700+68	718+87	1,790
6	801+10	819+83	1,860
7	847+85	863+75	1,590
8	888+00	892+75	475
8A	893+75	906+82	1,425
9A	1040+90	1046+50	560
9B	1048+70	1063+10	1,440

SECTION NO.	STATION NO. START	STATION NO. END	TOTAL LENGTH OF ZINC RIBBON (FT)
10	1258+00	1267+25	925
11	1308+00	1320+40	1,240
12	1379+00	1390+10	1,110
13	1424+50	1437+00	1,250
14	1477+40	1490+73	770
15	1517+95	1551+35	3,340
17	1580+00	1588+00	800
18	1641+60	1656+70	1,510
19	1712+80	1718+00	520
20	1718+59	1724+01	580
21	1798+60	1846+00	4,740
22	1873+25	1881+00	775
22A	1882+75	1888+85	610
23	1918+11	1939+29	2,118
24	1976+29	1985+59	930
25	2080+10	2126+90	4,690
26	2129+05	2132+90	385
<b>Total</b>			<b>37,113 Feet</b>

**Note:** All referenced pipeline station numbers are based on the pipeline alignment plans - Vermont Gas Proposed 12" Pipeline Addison Natural Gas Project - EPSC Plan issued 4/16/13.

Reference - ARK Engineering design drawing package number: 12144-100, in Appendix D for zinc ribbon installation details.

12144-100 Vermont Gas 12" Pipeline Project  
 Rev. C AC Mitigation System Design  
 Zinc Ribbon Installation Drawings

**Williston M&R - Mile Post Number 10.43**

ARK Engineering recommends the installation of a 2/0 copper ground loop system at the Williston M&R. This 2/0 copper ground loop system is to be electrically connected to the perimeter fence and the pipeline through a Solid State Decoupler (SSD).

**MLV-2 - Mile Post Number 14.30**

ARK Engineering recommends the installation of a 2/0 copper ground loop system with 3/4" x 10' copper ground rods at each corner of the MLV-2 site. This 2/0 copper ground loop system is to be electrically connected to the perimeter fence and the pipeline through a Solid State Decoupler (SSD).

**MLV-3 - Mile Post Number 19.81**

Due to a pipeline reroute, the distance between MLV-3 and the VELCO 115kV 'K43' electric transmission circuit increased and therefore ARK Engineering recommends the installation of a 2/0 copper ground loop system at the MLV-4 site. This 2/0 copper ground loop system is to be electrically connected to the perimeter fence and the pipeline through a Solid State Decoupler (SSD). The use of copper ground rods and additional 2/0 copper cable connections is not necessary.

**MLV-4 - Mile Post Number 24.80**

ARK Engineering recommends the installation of a 2/0 copper ground loop system at the MLV-4 site. This 2/0 copper ground loop system is to be electrically connected to the perimeter fence and the pipeline through a Solid State Decoupler (SSD).

**MLV-5/Plank Rd. M&R - Mile Post Number 32.54**

ARK Engineering recommends the installation of a 2/0 copper ground loop system with 3/4" x 10' copper ground rods, spaced 15' along the outer ground loop at the MLV-5/Plank Rd. M&R site. Three (3) additional 2/0 copper cables are connected to this loop for additional AC mitigation. This 2/0 copper ground loop system is to be electrically connected to the perimeter fence and the pipeline through a Solid State Decoupler (SSD).

**MLV-6 - Mile Post Number 35.00**

ARK Engineering recommends the installation of a 2/0 copper ground loop system at the MLV-6 site. This 2/0 copper ground loop system is to be electrically connected to the proposed AC mitigation system and the perimeter fence and the pipeline through a Solid State Decoupler (SSD).

Reference - ARK Engineering design drawing package number: 12144-101, in Appendix D for copper ground loop installation details.

12144-101	Vermont Gas 12" Pipeline Project
Rev. B	Valves Sites:
	Williston M&R
	MLV-2
	MLV-3
	MLV-4
	MLV-5/Plank Rd. M&R,
	MLV-6
	Colchester Launcher
	Middlebury M&R

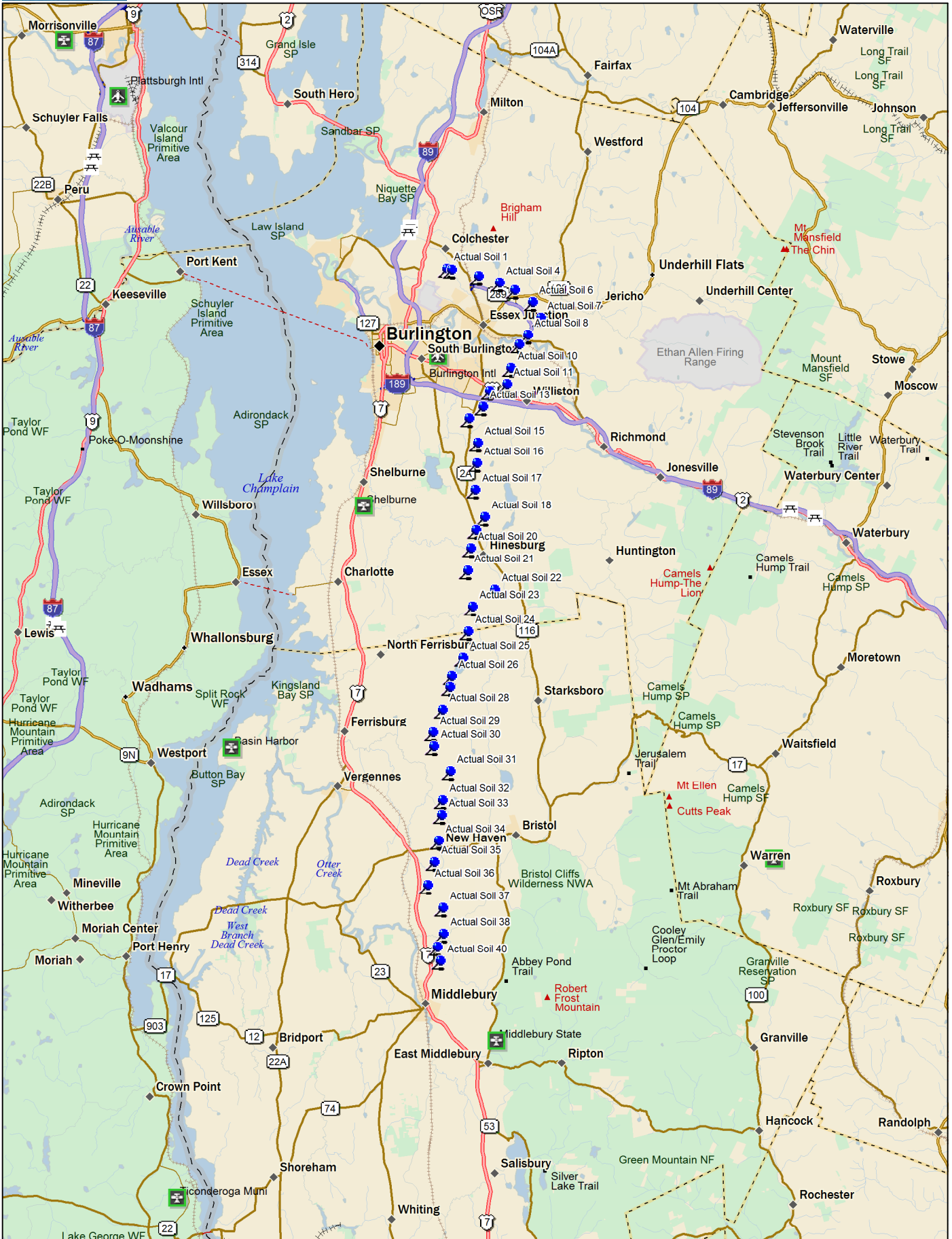
AC Mitigation System Design  
Valve Site Grounding Installation Drawings

Please call the author if you have questions or require additional information regarding this report.



APPENDIX A –  
SOIL RESISTIVITY DATA & GPS DATA

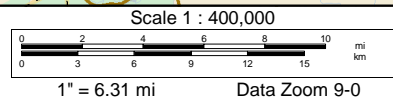
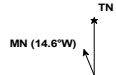
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TREES



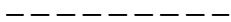
HOUSE



EXISTING PIPELINE



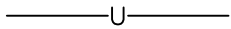
VALVE



NEW PIPELINE



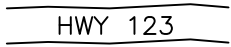
SUBSTATION



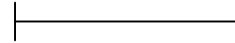
FOREIGN UTILITY



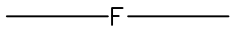
POWERPLANT



ROAD



TEST



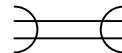
FENCE



NORTH



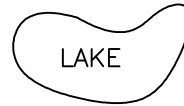
RAILROAD



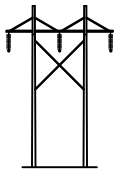
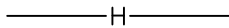
CULVERT



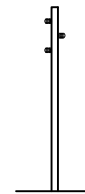
WETLANDS



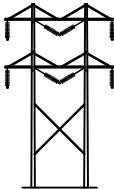
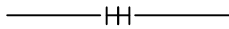
LAKE



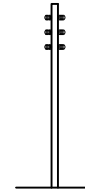
H FRAME  
SINGLE CIRCUIT  
(TWO LEGGED)



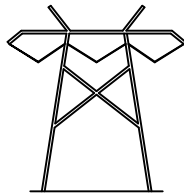
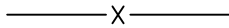
SINGLE POLE  
TRANSMISSION  
SINGLE CIRCUIT



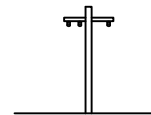
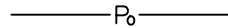
H FRAME  
DOUBLE CIRCUIT  
(TWO LEGGED)



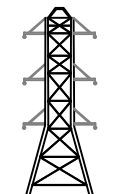
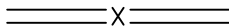
SINGLE POLE  
TRANSMISSION  
DOUBLE CIRCUIT



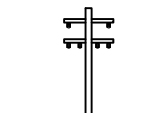
STEEL LATTICE  
SINGLE CIRCUIT  
(FOUR LEGGED)



SINGLE POLE  
SINGLE CIRCUIT  
DISTRIBUTION  
UNDERBUILD



STEEL LATTICE  
DOUBLE CIRCUIT  
(FOUR LEGGED)



SINGLE POLE  
DOUBLE CIRCUIT  
DISTRIBUTION  
UNDERBUILD



ENGINEERING &  
TECHNICAL SERVICES, INC.

DRAWING KEY

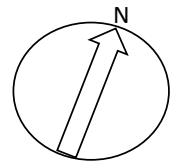
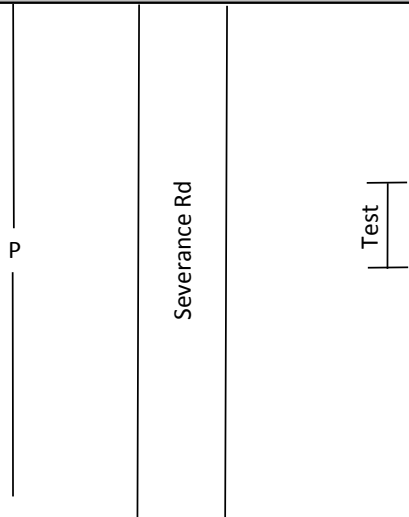
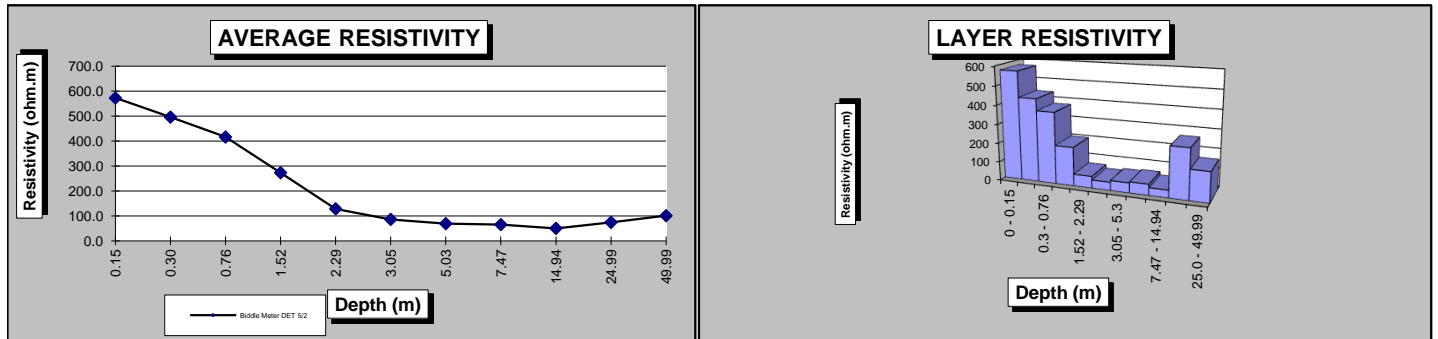
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-01  
**Date:** 5/3/2013  
**Location:** Rd sd off Severance Rd  
 44 31.4488N, 73 9.3344W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 61F/Clear  
**Soil Description:** Hard packed clay/Sand



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	598.000	1	572.6	0.00167	n/a	n/a	n/a	0 - 0.15	573
1.00	0.30	259.000	2	496.0	0.00386	0.00219	456.879	1	0.15 - 0.3	437
2.50	0.76	86.900	5	416.1	0.01151	0.00765	130.779	3	0.3 - 0.76	376
5.00	1.52	28.500	10	272.9	0.03509	0.02358	42.408	5	0.76 - 1.52	203
7.50	2.29	8.920	14	128.1	0.11211	0.07702	12.984	5	1.52 - 2.29	62
10.00	3.05	4.480	19	85.8	0.22321	0.11111	9.000	5	2.29 - 3.05	43
16.50	5.03	2.170	32	68.6	0.46083	0.23762	4.208	12	3.05 - 5.3	52
24.50	7.47	1.380	47	64.8	0.72464	0.26381	3.791	15	5.03 - 7.47	58
49.00	14.94	0.530	94	49.7	1.88679	1.16215	0.860	47	7.47 - 14.94	40
82.00	24.99	0.470	157	73.8	2.12766	0.24087	4.152	63	14.94 - 25.0	262
164.00	49.99	0.320	314	100.5	3.12500	0.99734	1.003	157	25.0 - 49.99	157

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



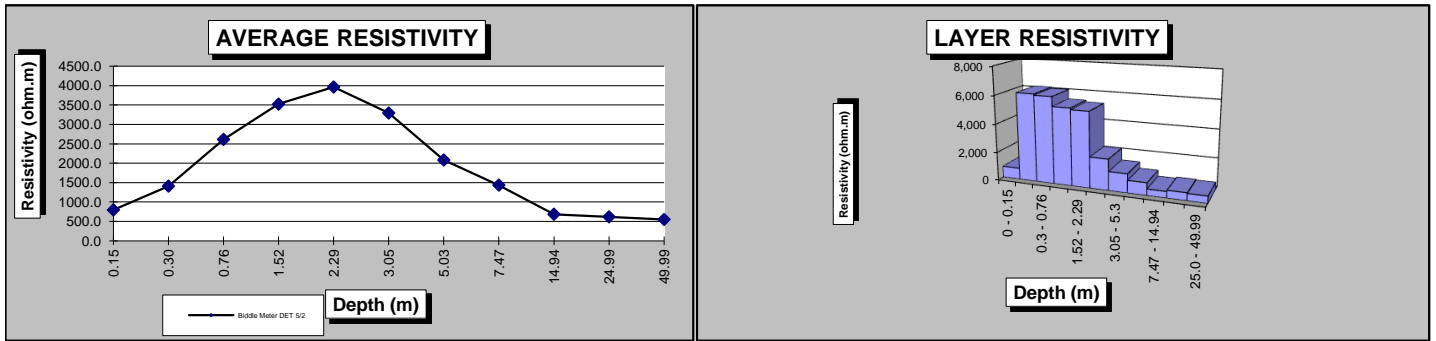
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-02  
**Date:** 5/3/2013  
**Location:** Open Field off Access Rd East of Severance Rd  
 44 31.4187N, 73 9.0318N  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 63F/Clear  
**Soil Description:** Hard packed clay/Sand

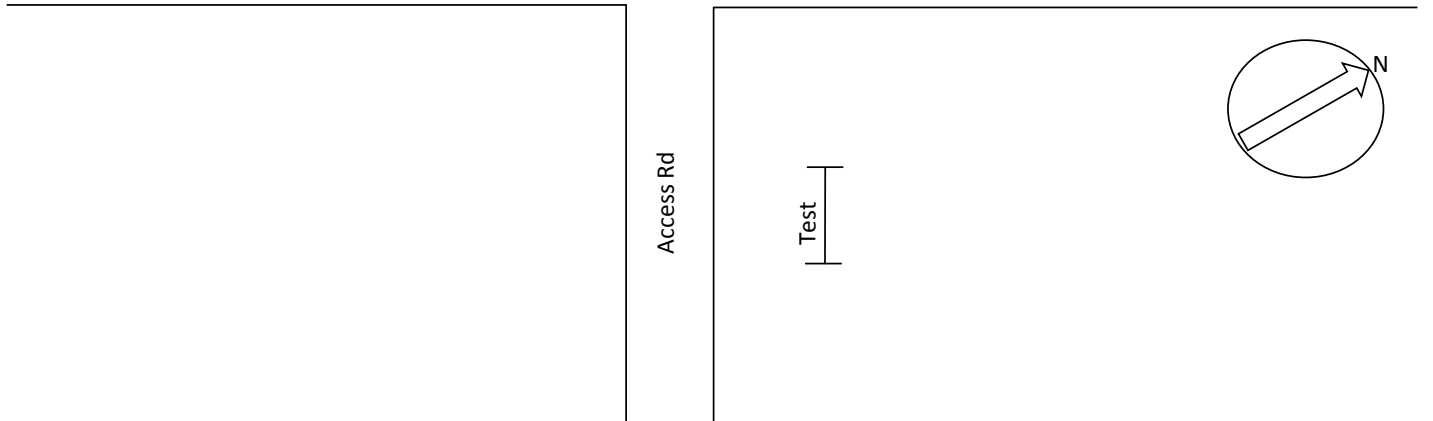


4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	831.000	1	795.7	0.00120	n/a	n/a	n/a	0 - 0.15	796
1.00	0.30	736.000	2	1409.5	0.00136	0.00016	6438.063	1	0.15 - 0.3	6,165
2.50	0.76	546.000	5	2614.1	0.00183	0.00047	2115.032	3	0.3 - 0.76	6,076
5.00	1.52	368.000	10	3523.8	0.00272	0.00089	1128.809	5	0.76 - 1.52	5,404
7.50	2.29	276.000	14	3964.3	0.00362	0.00091	1104.000	5	1.52 - 2.29	5,286
10.00	3.05	172.000	19	3294.0	0.00581	0.00219	456.462	5	2.29 - 3.05	2,185
16.50	5.03	65.900	32	2082.4	0.01517	0.00936	106.831	12	3.05 - 5.3	1,330
24.50	7.47	30.600	47	1435.8	0.03268	0.01751	57.126	15	5.03 - 7.47	875
49.00	14.94	7.300	94	685.0	0.13699	0.10431	9.587	47	7.47 - 14.94	450
82.00	24.99	3.930	157	617.2	0.25445	0.11747	8.513	63	14.94 - 25.0	538
164.00	49.99	1.750	314	549.6	0.57143	0.31698	3.155	157	25.0 - 49.99	495

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



Severance Rd



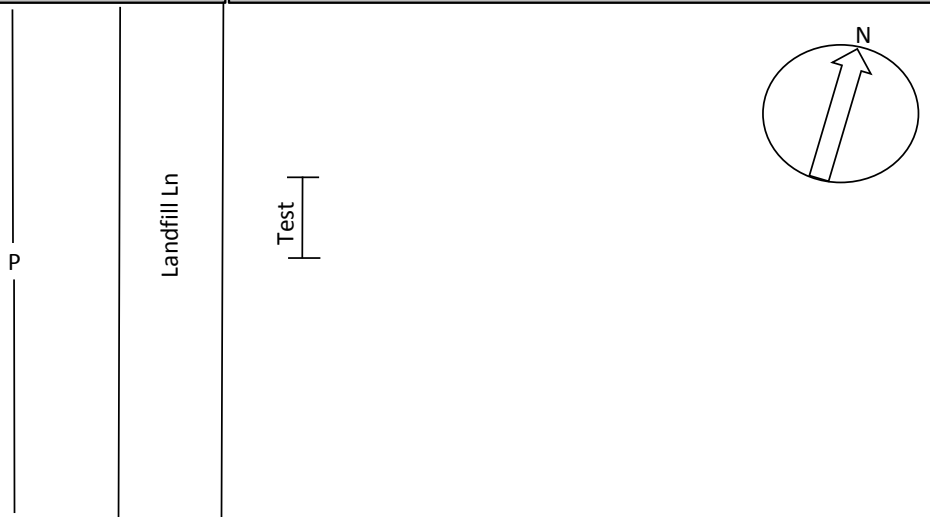
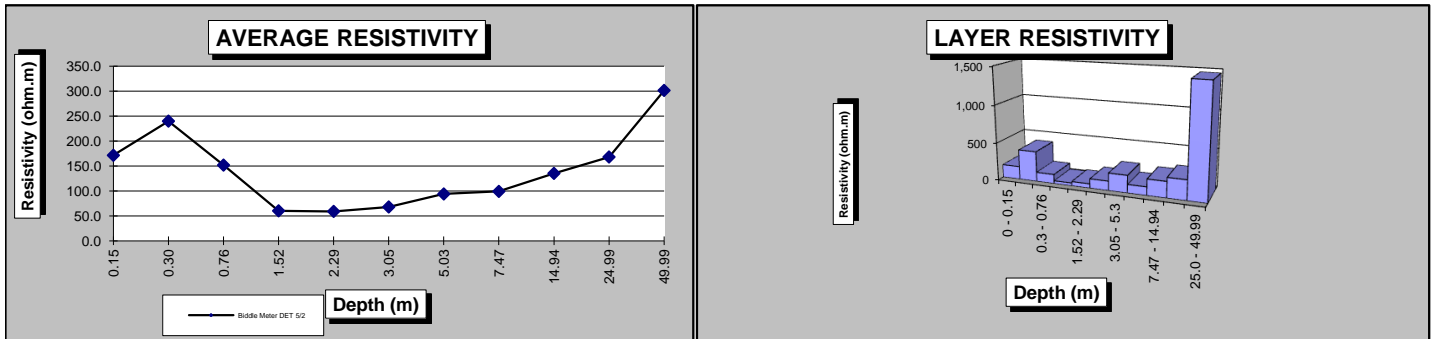
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-03  
**Date:** 5/3/2013  
**Location:** Rd Sd off Landfill Ln  
 44 31.1464N, 73 7.4733W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 58F/Clear  
**Soil Description:** Loose dry rocky soil



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	179.000	1	171.4	0.00559	n/a	n/a	n/a	0 - 0.15	171
1.00	0.30	125.300	2	240.0	0.00798	0.00239	417.667	1	0.15 - 0.3	400
2.50	0.76	31.700	5	151.8	0.03155	0.02356	42.436	3	0.3 - 0.76	122
5.00	1.52	6.270	10	60.0	0.15949	0.12794	7.816	5	0.76 - 1.52	37
7.50	2.29	4.100	14	58.9	0.24390	0.08441	11.847	5	1.52 - 2.29	57
10.00	3.05	3.540	19	67.8	0.28249	0.03858	25.918	5	2.29 - 3.05	124
16.50	5.03	2.970	32	93.9	0.33670	0.05421	18.445	12	3.05 - 5.3	230
24.50	7.47	2.110	47	99.0	0.47393	0.13723	7.287	15	5.03 - 7.47	112
49.00	14.94	1.440	94	135.1	0.69444	0.22051	4.535	47	7.47 - 14.94	213
82.00	24.99	1.070	157	168.0	0.93458	0.24013	4.164	63	14.94 - 25.0	263
164.00	49.99	0.960	314	301.5	1.04167	0.10709	9.338	157	25.0 - 49.99	1,466

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



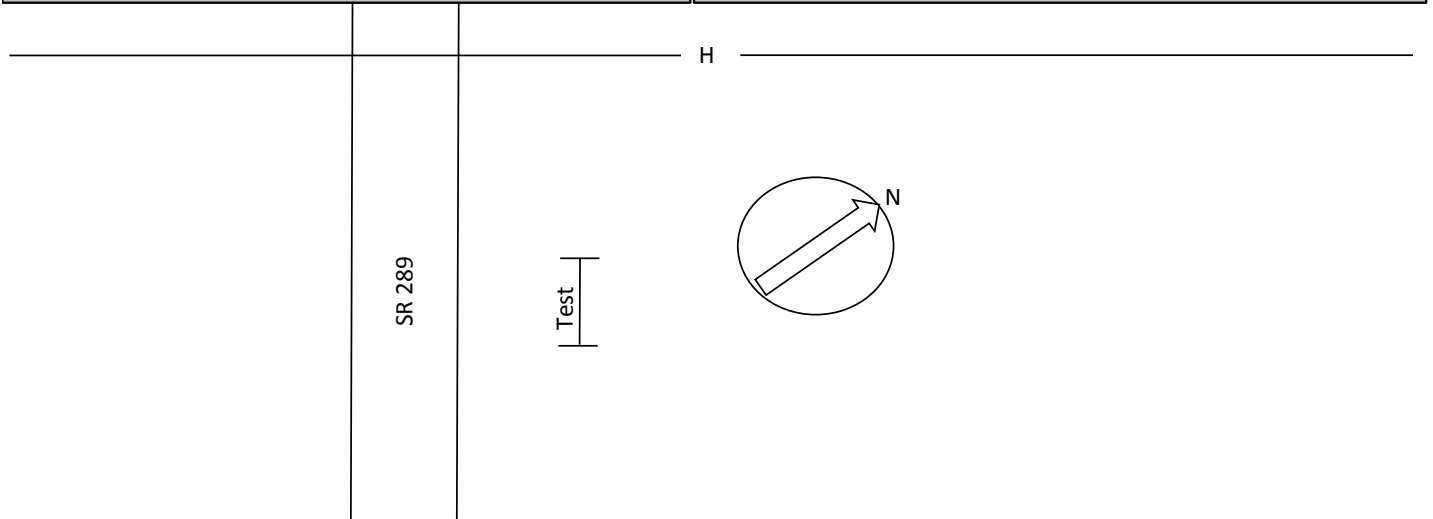
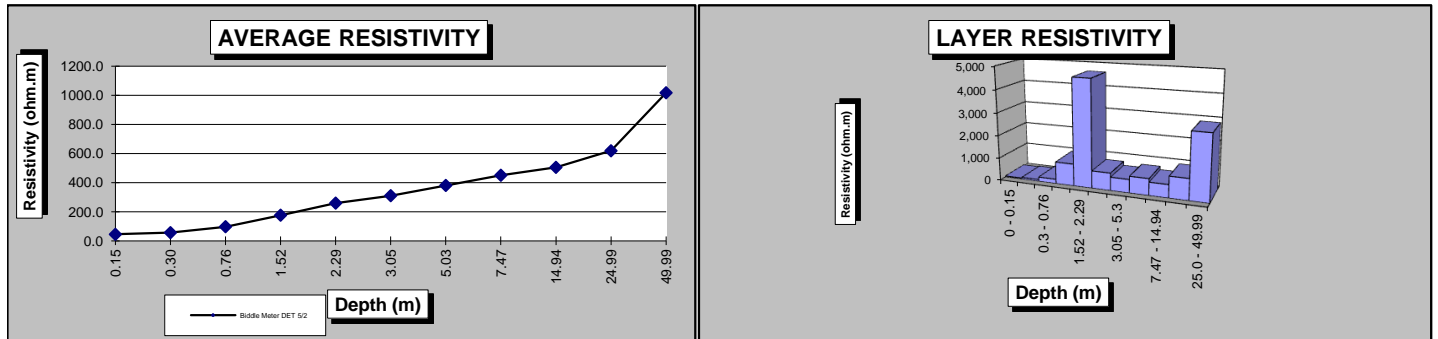
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-04  
**Date:** 5/3/2013  
**Location:** Rd Sd off SR 289  
 44 30.866N, 73 6.228W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 55F/Clear  
**Soil Description:** Dry rocky soil and vegetation



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	46.200	1	44.2	0.02165	n/a	n/a	n/a	0 - 0.15	44
1.00	0.30	29.100	2	55.7	0.03436	0.01272	78.621	1	0.15 - 0.3	75
2.50	0.76	20.200	5	96.7	0.04950	0.01514	66.047	3	0.3 - 0.76	190
5.00	1.52	18.360	10	175.8	0.05447	0.00496	201.561	5	0.76 - 1.52	965
7.50	2.29	18.020	14	258.8	0.05549	0.00103	973.080	5	1.52 - 2.29	4,659
10.00	3.05	16.190	19	310.1	0.06177	0.00627	159.423	5	2.29 - 3.05	763
16.50	5.03	12.040	32	380.5	0.08306	0.02129	46.971	12	3.05 - 5.3	585
24.50	7.47	9.600	47	450.4	0.10417	0.02111	47.370	15	5.03 - 7.47	726
49.00	14.94	5.380	94	504.9	0.18587	0.08171	12.239	47	7.47 - 14.94	574
82.00	24.99	3.940	157	618.7	0.25381	0.06793	14.720	63	14.94 - 25.0	930
164.00	49.99	3.240	314	1017.6	0.30864	0.05483	18.237	157	25.0 - 49.99	2,864

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



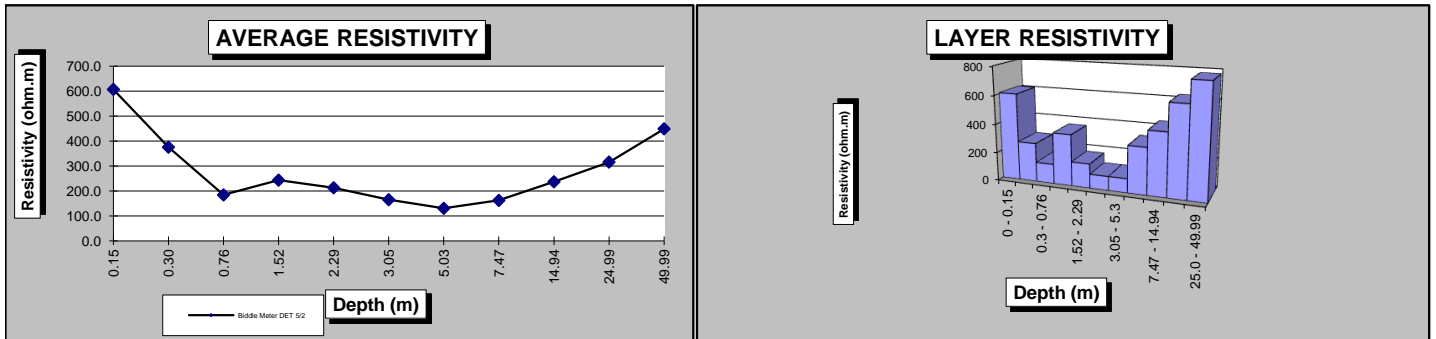
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-05  
**Date:** 5/3/2013  
**Location:** Open Lot off SR 289  
 44 30.5592N, 73 5.3331W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 52F/Clear  
**Soil Description:** Hard rocky soil

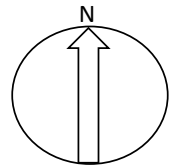


4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	634.000	1	607.1	0.00158	n/a	n/a	n/a	0 - 0.15	607
1.00	0.30	196.000	2	375.4	0.00510	0.00352	283.708	1	0.15 - 0.3	272
2.50	0.76	38.400	5	183.9	0.02604	0.02094	47.756	3	0.3 - 0.76	137
5.00	1.52	25.400	10	243.2	0.03937	0.01333	75.028	5	0.76 - 1.52	359
7.50	2.29	14.800	14	212.6	0.06757	0.02820	35.464	5	1.52 - 2.29	170
10.00	3.05	8.600	19	164.7	0.11628	0.04871	20.529	5	2.29 - 3.05	98
16.50	5.03	4.120	32	130.2	0.24272	0.12644	7.909	12	3.05 - 5.3	98
24.50	7.47	3.450	47	161.9	0.28986	0.04714	21.215	15	5.03 - 7.47	325
49.00	14.94	2.520	94	236.5	0.39683	0.10697	9.348	47	7.47 - 14.94	439
82.00	24.99	2.010	157	315.6	0.49751	0.10069	9.932	63	14.94 - 25.0	628
164.00	49.99	1.430	314	449.1	0.69930	0.20179	4.956	157	25.0 - 49.99	778

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



Test





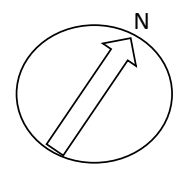
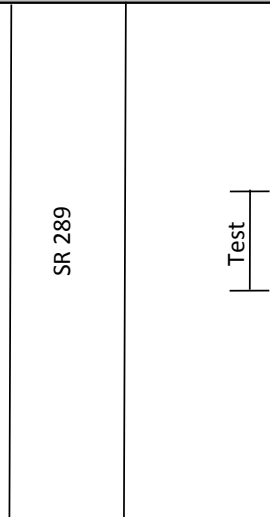
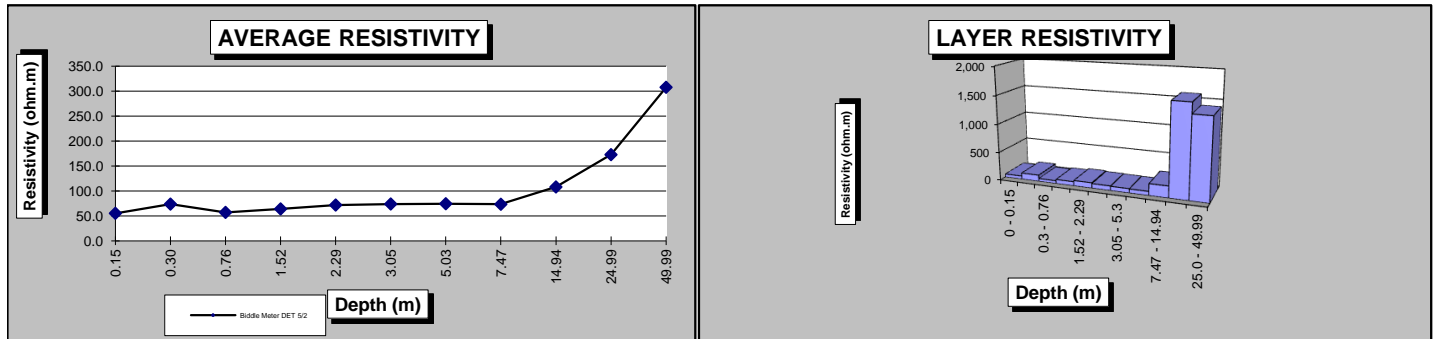
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-06  
**Date:** 5/2/2013  
**Location:** Rd Sd off SR 289  
 44 30.0397N, 73 4.2916W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 81F/Clear  
**Soil Description:** Dark moist soil



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	57.500	1	55.1	0.01739	n/a	n/a	n/a	0 - 0.15	55
1.00	0.30	38.400	2	73.5	0.02604	0.00865	115.602	1	0.15 - 0.3	111
2.50	0.76	11.880	5	56.9	0.08418	0.05813	17.202	3	0.3 - 0.76	49
5.00	1.52	6.670	10	63.9	0.14993	0.06575	15.209	5	0.76 - 1.52	73
7.50	2.29	4.990	14	71.7	0.20040	0.05048	19.811	5	1.52 - 2.29	95
10.00	3.05	3.850	19	73.7	0.25974	0.05934	16.852	5	2.29 - 3.05	81
16.50	5.03	2.350	32	74.3	0.42553	0.16579	6.032	12	3.05 - 5.3	75
24.50	7.47	1.560	47	73.2	0.64103	0.21549	4.641	15	5.03 - 7.47	71
49.00	14.94	1.150	94	107.9	0.86957	0.22854	4.376	47	7.47 - 14.94	205
82.00	24.99	1.100	157	172.7	0.90909	0.03953	25.300	63	14.94 - 25.0	1,599
120.00	49.99	0.980	314	307.8	1.02041	0.11132	8.983	157	25.0 - 49.99	1,411

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



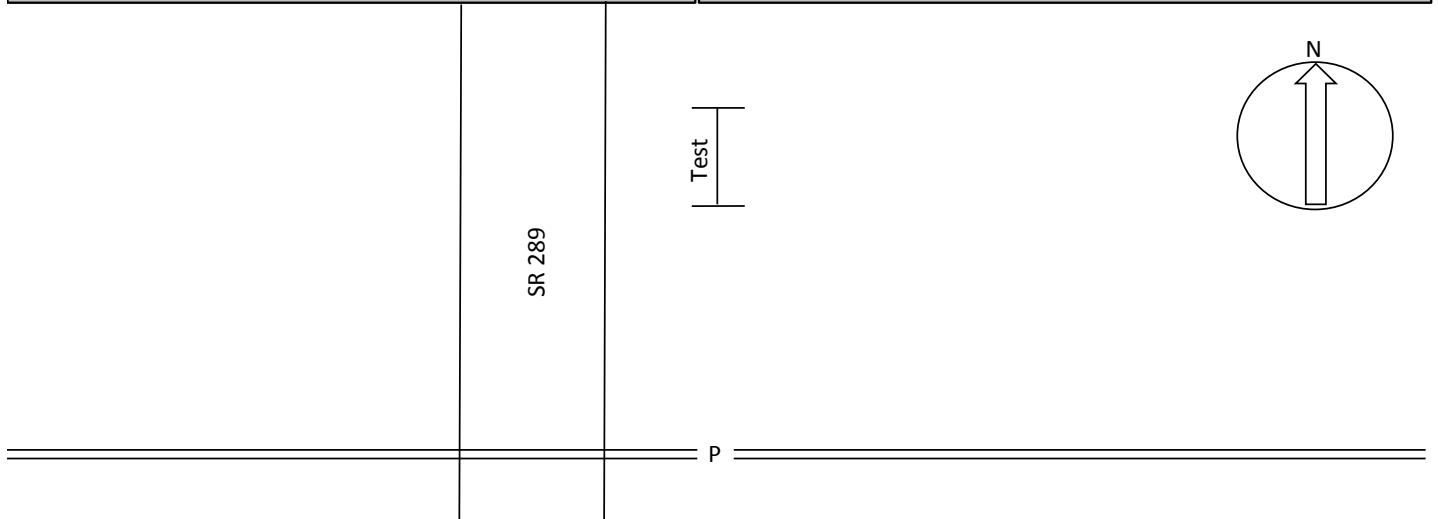
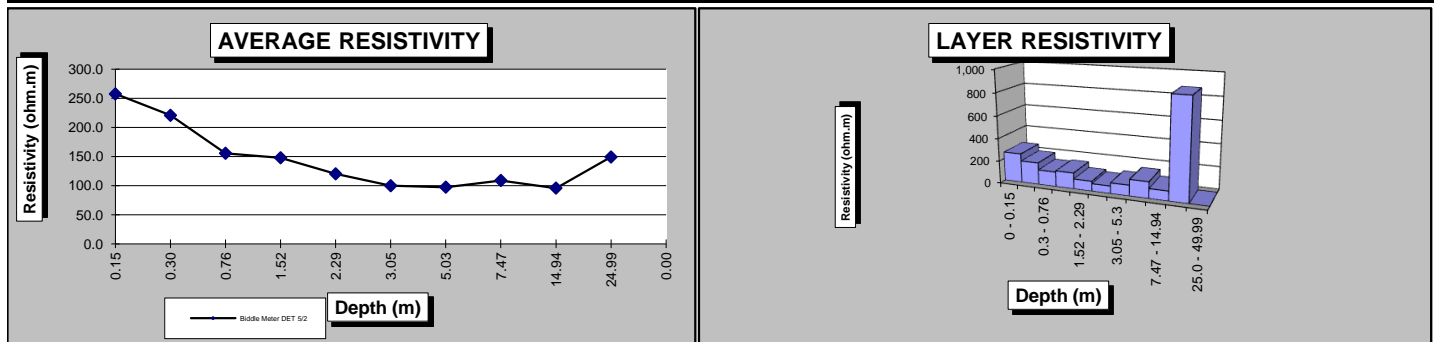
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-07  
**Date:** 5/2/2013  
**Location:** Rd Sd off SR 289  
 44 29.3821N, 73 3.8092W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 81F/Clear  
**Soil Description:** Moist dark soil and vegetation



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	269.000	1	257.6	0.00372	n/a	n/a	n/a	0 - 0.15	258
1.00	0.30	115.300	2	220.8	0.00867	0.00496	201.794	1	0.15 - 0.3	193
2.50	0.76	32.500	5	155.6	0.03077	0.02210	45.257	3	0.3 - 0.76	130
5.00	1.52	15.440	10	147.8	0.06477	0.03400	29.414	5	0.76 - 1.52	141
7.50	2.29	8.370	14	120.2	0.11947	0.05471	18.279	5	1.52 - 2.29	88
10.00	3.05	5.210	19	99.8	0.19194	0.07246	13.800	5	2.29 - 3.05	66
16.50	5.03	3.080	32	97.3	0.32468	0.13274	7.534	12	3.05 - 5.3	94
24.50	7.47	2.320	47	108.9	0.43103	0.10636	9.402	15	5.03 - 7.47	144
49.00	14.94	1.020	94	95.7	0.98039	0.54936	1.820	47	7.47 - 14.94	85
82.00	24.99	0.950	157	149.2	1.05263	0.07224	13.843	63	14.94 - 25.0	875
	0.00		0		#DIV/0!	#DIV/0!	#DIV/0!	-157	25.0 - 49.99	#DIV/0!

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



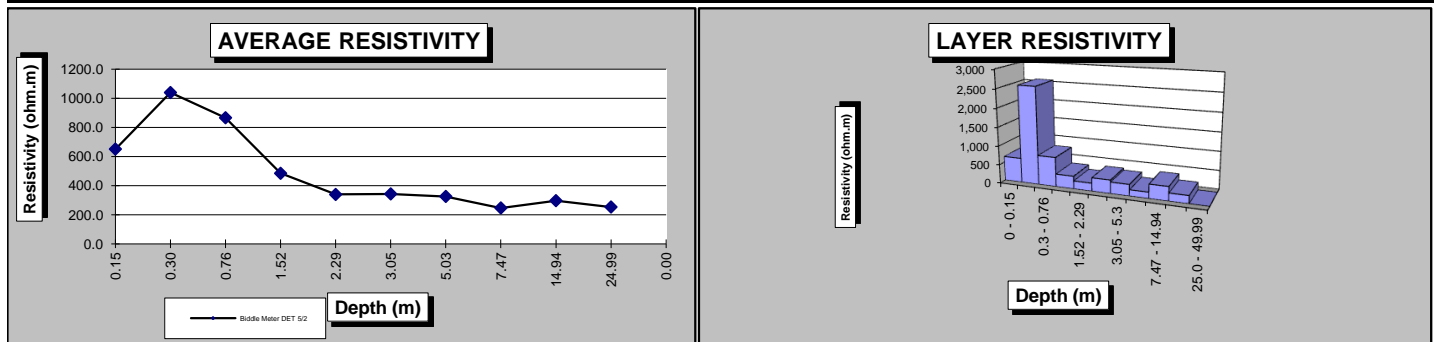
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-08  
**Date:** 5/2/2013  
**Location:** Rd Sd off Dump Access Rd  
 44 28.6848N, 73 4.5661W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET2/2  
**Weather:** 80F/Clear  
**Soil Description:** Dry sand and rock



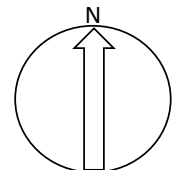
4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	680.000	1	651.1	0.00147	n/a	n/a	n/a	0 - 0.15	651
1.00	0.30	543.000	2	1039.9	0.00184	0.00037	2695.182	1	0.15 - 0.3	2,581
2.50	0.76	181.000	5	866.6	0.00552	0.00368	271.500	3	0.3 - 0.76	780
5.00	1.52	50.600	10	484.5	0.01976	0.01424	70.235	5	0.76 - 1.52	336
7.50	2.29	23.600	14	339.0	0.04237	0.02261	44.228	5	1.52 - 2.29	212
10.00	3.05	17.900	19	342.8	0.05587	0.01349	74.112	5	2.29 - 3.05	355
16.50	5.03	10.300	32	325.5	0.09709	0.04122	24.259	12	3.05 - 5.3	302
24.50	7.47	5.250	47	246.3	0.19048	0.09339	10.708	15	5.03 - 7.47	164
49.00	14.94	3.160	94	296.5	0.31646	0.12598	7.938	47	7.47 - 14.94	372
82.00	24.99	1.610	157	252.8	0.62112	0.30466	3.282	63	14.94 - 25.0	207
	0.00		0		#DIV/0!	#DIV/0!	#DIV/0!	-157	25.0 - 49.99	#DIV/0!

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



Test

Dump Access Rd



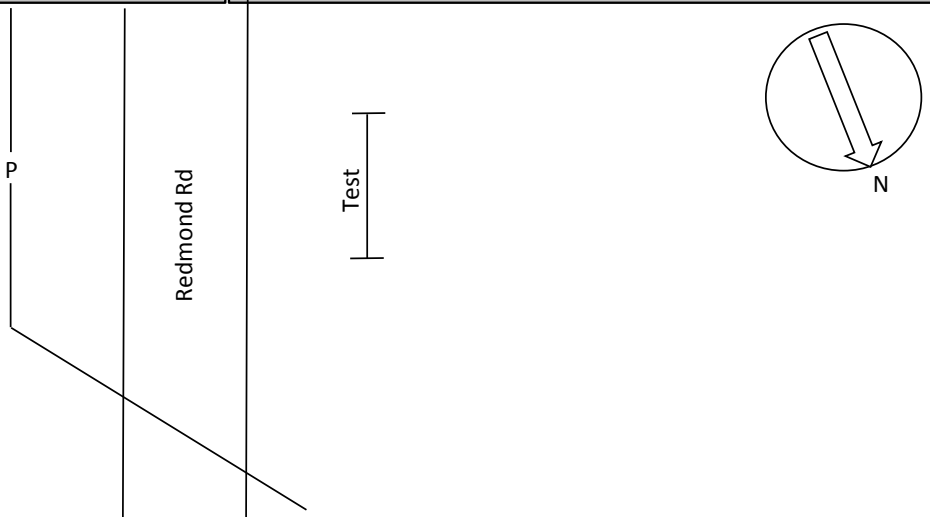
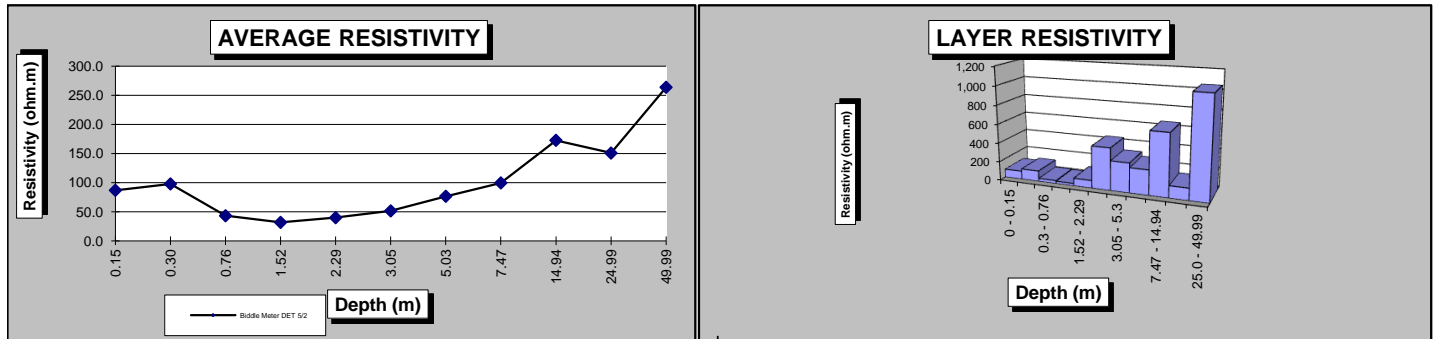
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-09  
**Date:** 5/2/2013  
**Location:** Rd Sd off Redmond Rd  
 44 28.277N, 73 5.082W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 80F/Clear  
**Soil Description:** Moist dark sodded



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	90.600	1	86.8	0.01104	n/a	n/a	n/a	0 - 0.15	87
1.00	0.30	51.000	2	97.7	0.01961	0.00857	116.682	1	0.15 - 0.3	112
2.50	0.76	8.970	5	42.9	0.11148	0.09187	10.884	3	0.3 - 0.76	31
5.00	1.52	3.300	10	31.6	0.30303	0.19155	5.221	5	0.76 - 1.52	25
7.50	2.29	2.760	14	39.6	0.36232	0.05929	16.867	5	1.52 - 2.29	81
10.00	3.05	2.680	19	51.3	0.37313	0.01082	92.460	5	2.29 - 3.05	443
16.50	5.03	2.420	32	76.5	0.41322	0.04009	24.945	12	3.05 - 5.3	311
24.50	7.47	2.120	47	99.5	0.47170	0.05847	17.101	15	5.03 - 7.47	262
49.00	14.94	1.840	94	172.7	0.54348	0.07178	13.931	47	7.47 - 14.94	654
82.00	24.99	0.960	157	150.8	1.04167	0.49819	2.007	63	14.94 - 25.0	127
164.00	49.99	0.840	314	263.8	1.19048	0.14881	6.720	157	25.0 - 49.99	1,055

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



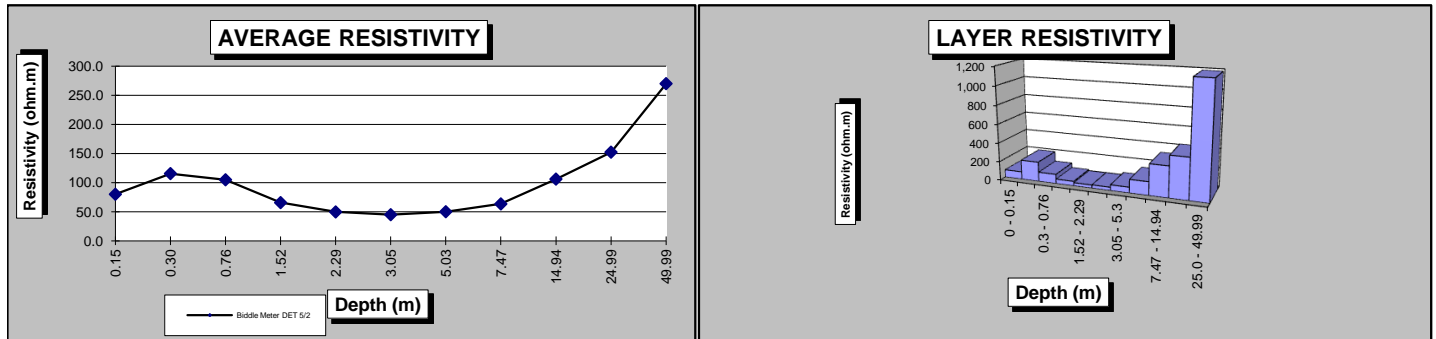
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-10  
**Date:** 5/2/2013  
**Location:** Overgrown lot off Brennan Woods Dr  
 44 27.286N, 73 5.568W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 75F/Clear  
**Soil Description:** Wet dark soil

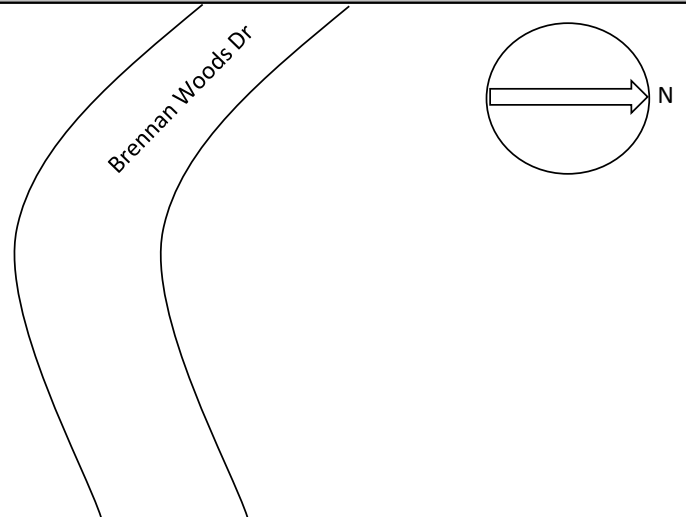


4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	83.500	1	80.0	0.01198	n/a	n/a	n/a	0 - 0.15	80
1.00	0.30	60.300	2	115.5	0.01658	0.00461	217.028	1	0.15 - 0.3	208
2.50	0.76	21.900	5	104.9	0.04566	0.02908	34.390	3	0.3 - 0.76	99
5.00	1.52	6.850	10	65.6	0.14599	0.10032	9.968	5	0.76 - 1.52	48
7.50	2.29	3.450	14	49.6	0.28986	0.14387	6.951	5	1.52 - 2.29	33
10.00	3.05	2.340	19	44.8	0.42735	0.13750	7.273	5	2.29 - 3.05	35
16.50	5.03	1.580	32	49.9	0.63291	0.20556	4.865	12	3.05 - 5.3	61
24.50	7.47	1.350	47	63.3	0.74074	0.10783	9.274	15	5.03 - 7.47	142
49.00	14.94	1.130	94	106.0	0.88496	0.14422	6.934	47	7.47 - 14.94	325
82.00	24.99	0.970	157	152.3	1.03093	0.14597	6.851	63	14.94 - 25.0	433
164.00	49.99	0.860	314	270.1	1.16279	0.13186	7.584	157	25.0 - 49.99	1,191

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



| Test |



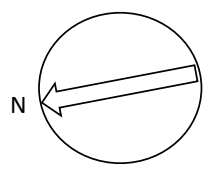
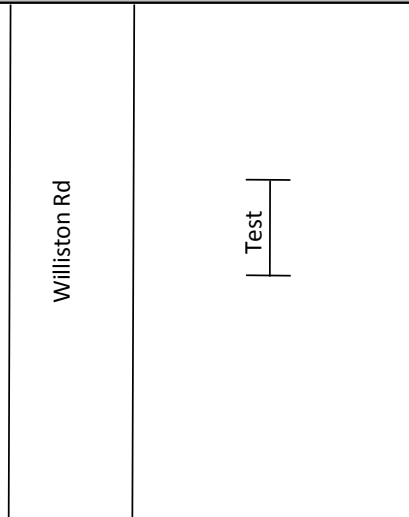
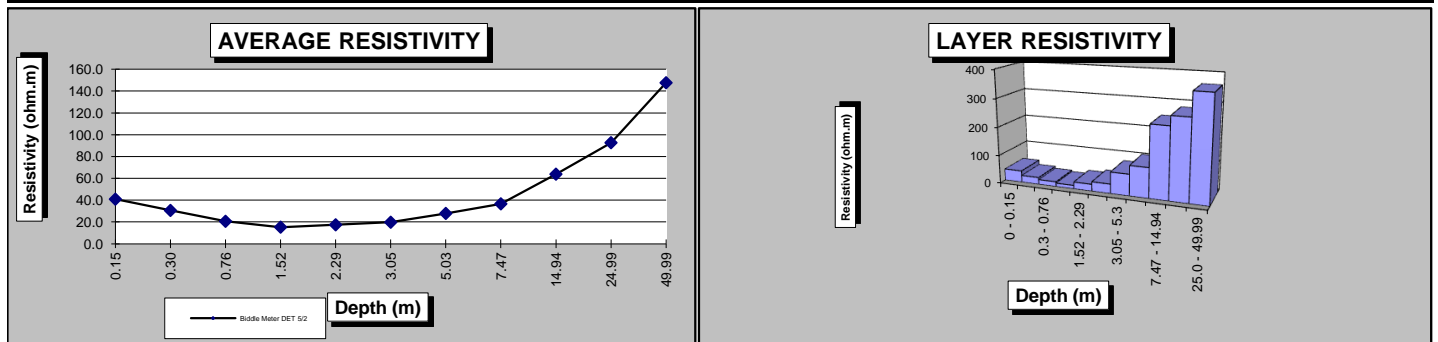
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-11  
**Date:** 5/2/2013  
**Location:** Rd Sd off Williston Rd  
 44 26.6096N, 73 5.7963W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 74F/Clear  
**Soil Description:** Sandy, Rocky soil



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	42.700	1	40.9	0.02342	n/a	n/a	n/a	0 - 0.15	41
1.00	0.30	15.950	2	30.5	0.06270	0.03928	25.460	1	0.15 - 0.3	24
2.50	0.76	4.300	5	20.6	0.23256	0.16986	5.887	3	0.3 - 0.76	17
5.00	1.52	1.590	10	15.2	0.62893	0.39637	2.523	5	0.76 - 1.52	12
7.50	2.29	1.210	14	17.4	0.82645	0.19752	5.063	5	1.52 - 2.29	24
10.00	3.05	1.030	19	19.7	0.97087	0.14443	6.924	5	2.29 - 3.05	33
16.50	5.03	0.880	32	27.8	1.13636	0.16549	6.043	12	3.05 - 5.3	75
24.50	7.47	0.780	47	36.6	1.28205	0.14569	6.864	15	5.03 - 7.47	105
49.00	14.94	0.680	94	63.8	1.47059	0.18854	5.304	47	7.47 - 14.94	249
82.00	24.99	0.590	157	92.7	1.69492	0.22433	4.458	63	14.94 - 25.0	282
164.00	49.99	0.470	314	147.6	2.12766	0.43274	2.311	157	25.0 - 49.99	363

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



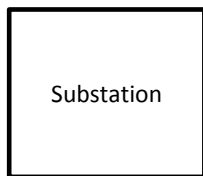
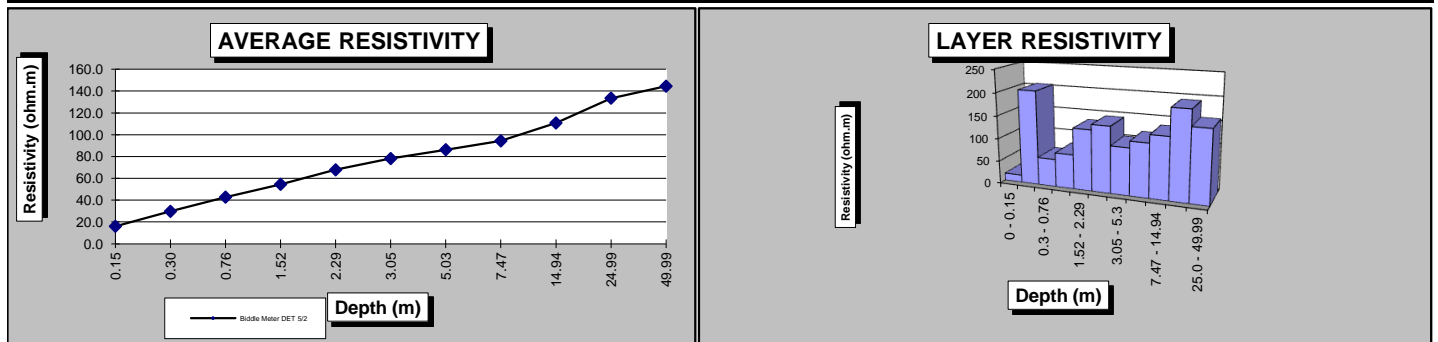
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-12  
**Date:** 5/2/2013  
**Location:** Rd Sd off entry ramp to I-89  
 44 26.3197N, 73 6.8117W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 73F/Clear  
**Soil Description:** Wet, dark, and rocky soil



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	16.720	1	16.0	0.05981	n/a	n/a	n/a	0 - 0.15	16
1.00	0.30	15.510	2	29.7	0.06447	0.00467	214.320	1	0.15 - 0.3	205
2.50	0.76	8.930	5	42.8	0.11198	0.04751	21.049	3	0.3 - 0.76	60
5.00	1.52	5.690	10	54.5	0.17575	0.06376	15.683	5	0.76 - 1.52	75
7.50	2.29	4.720	14	67.8	0.21186	0.03612	27.687	5	1.52 - 2.29	133
10.00	3.05	4.080	19	78.1	0.24510	0.03323	30.090	5	2.29 - 3.05	144
16.50	5.03	2.730	32	86.3	0.36630	0.12120	8.251	12	3.05 - 5.3	103
24.50	7.47	2.010	47	94.3	0.49751	0.13121	7.621	15	5.03 - 7.47	117
49.00	14.94	1.180	94	110.7	0.84746	0.34995	2.858	47	7.47 - 14.94	134
82.00	24.99	0.850	157	133.5	1.17647	0.32901	3.039	63	14.94 - 25.0	192
164.00	49.99	0.460	314	144.5	2.17391	0.99744	1.003	157	25.0 - 49.99	157

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth

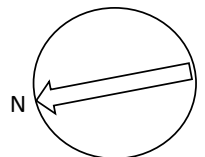


Ramp to I-89

Test

H

H



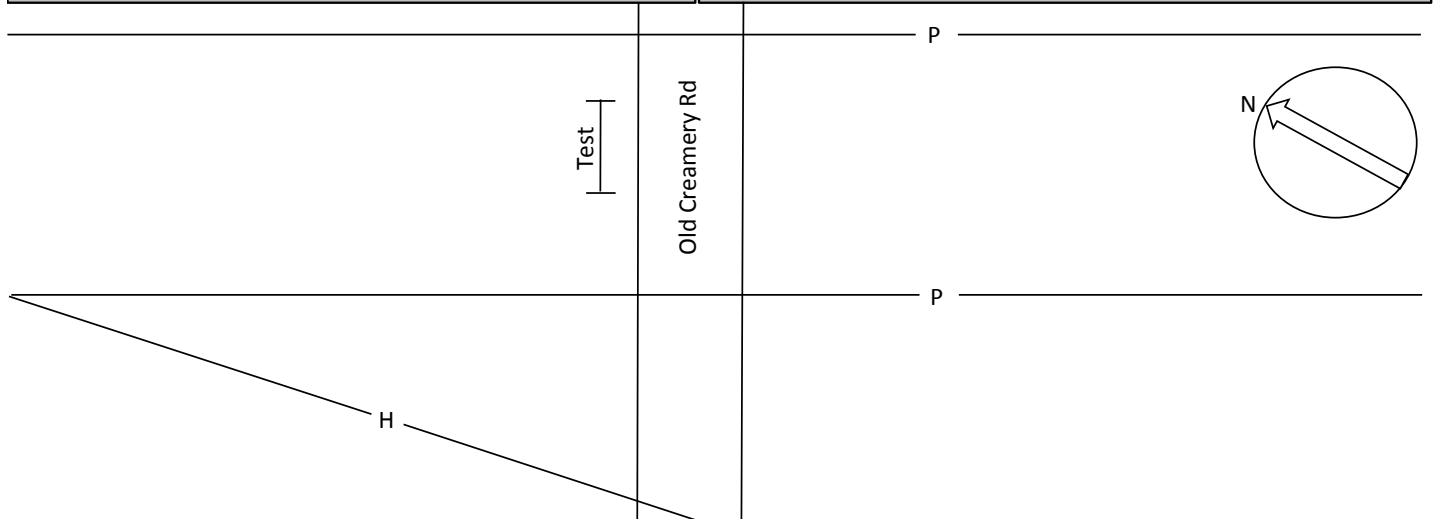
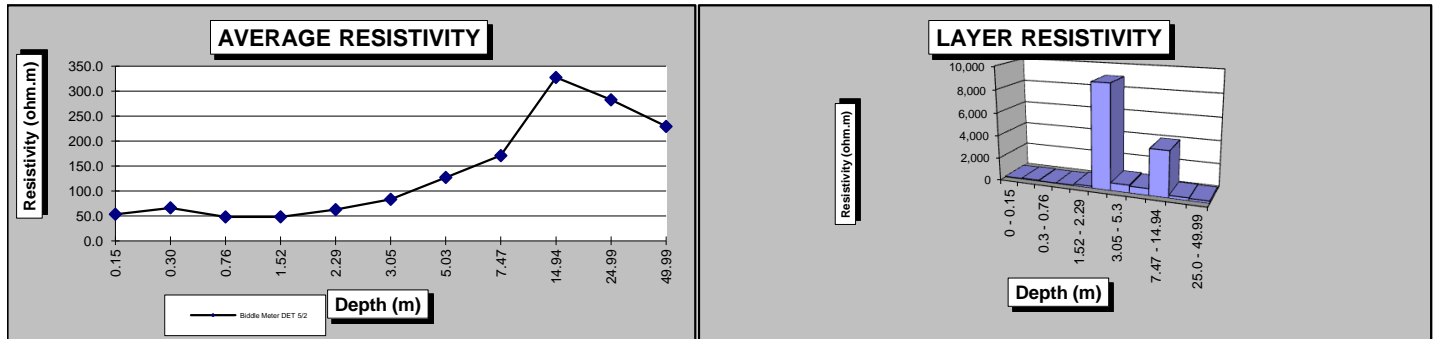
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-13  
**Date:** 5/2/2013  
**Location:** Rd Sd off Old Creamery Rd  
 44 25.6578N, 73 7.205W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 64F/Clear  
**Soil Description:** Wet, dark, and rocky soil



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	55.600	1	53.2	0.01799	n/a	n/a	n/a	0 - 0.15	53
1.00	0.30	34.500	2	66.1	0.02899	0.01100	90.910	1	0.15 - 0.3	87
2.50	0.76	9.980	5	47.8	0.10020	0.07121	14.042	3	0.3 - 0.76	40
5.00	1.52	5.010	10	48.0	0.19960	0.09940	10.060	5	0.76 - 1.52	48
7.50	2.29	4.350	14	62.5	0.22989	0.03028	33.020	5	1.52 - 2.29	158
10.00	3.05	4.340	19	83.1	0.23041	0.00053	1887.900	5	2.29 - 3.05	9,039
16.50	5.03	4.020	32	127.0	0.24876	0.01834	54.521	12	3.05 - 5.3	679
24.50	7.47	3.640	47	170.8	0.27473	0.02597	38.507	15	5.03 - 7.47	590
49.00	14.94	3.490	94	327.5	0.28653	0.01181	84.691	47	7.47 - 14.94	3,974
82.00	24.99	1.800	157	282.7	0.55556	0.26902	3.717	63	14.94 - 25.0	235
164.00	49.99	0.730	314	229.3	1.36986	0.81431	1.228	157	25.0 - 49.99	193

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth





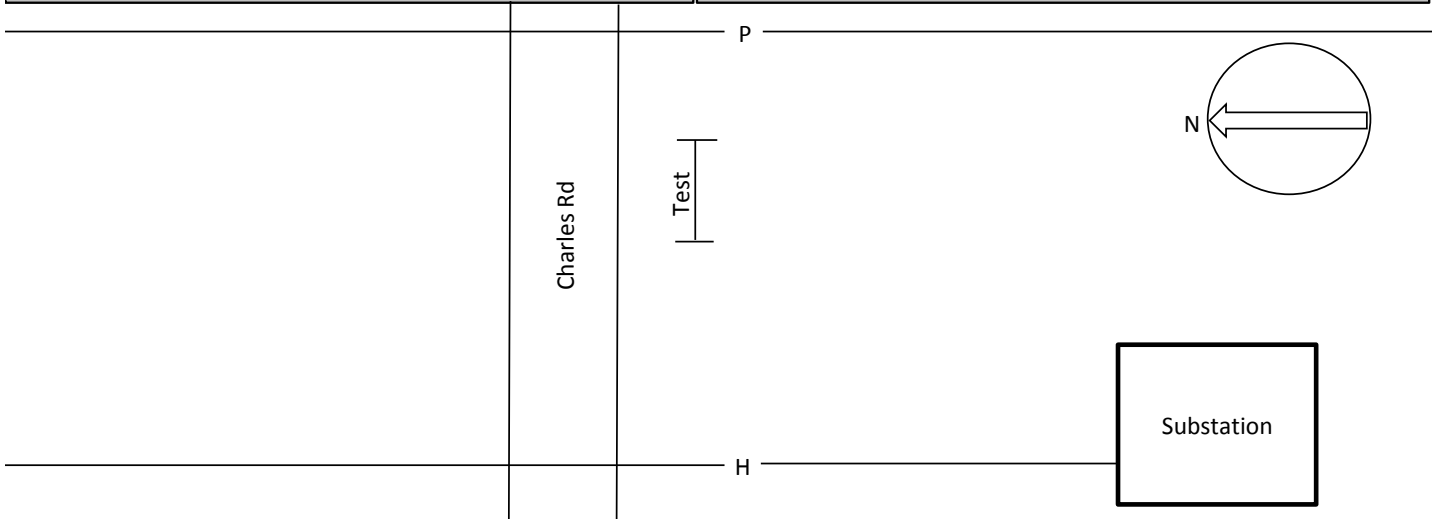
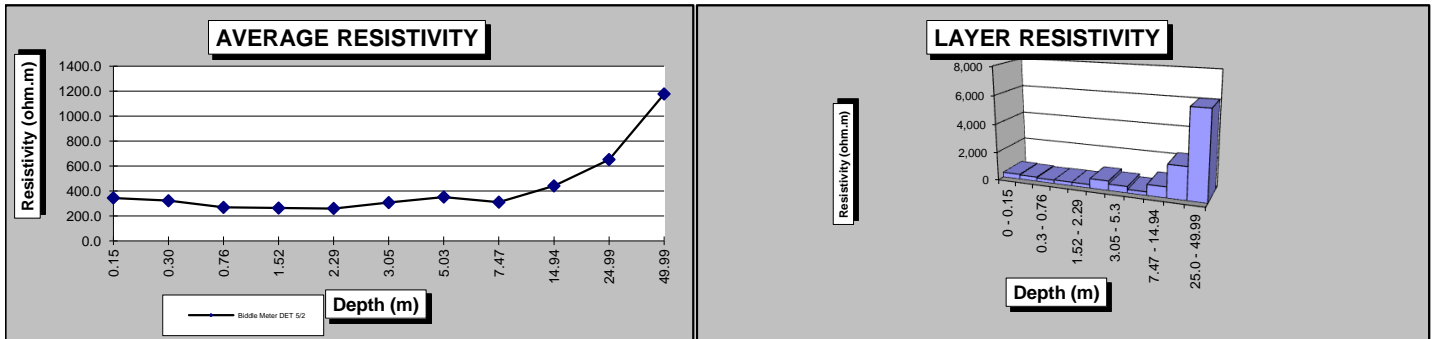
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-14  
**Date:** 5/2/2013  
**Location:** Rd Sd off Charles Rd  
 44 25.1789N, 73 8.0221W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 64F/Clear  
**Soil Description:** Dark, moist, and rocky soil



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	359.000	1	343.8	0.00279	n/a	n/a	n/a	0 - 0.15	344
1.00	0.30	167.600	2	321.0	0.00597	0.00318	314.359	1	0.15 - 0.3	301
2.50	0.76	55.900	5	267.6	0.01789	0.01192	83.875	3	0.3 - 0.76	241
5.00	1.52	27.400	10	262.4	0.03650	0.01861	53.742	5	0.76 - 1.52	257
7.50	2.29	18.050	14	259.3	0.05540	0.01891	52.895	5	1.52 - 2.29	253
10.00	3.05	15.990	19	306.2	0.06254	0.00714	140.107	5	2.29 - 3.05	671
16.50	5.03	11.100	32	350.8	0.09009	0.02755	36.296	12	3.05 - 5.3	452
24.50	7.47	6.600	47	309.7	0.15152	0.06143	16.280	15	5.03 - 7.47	249
49.00	14.94	4.690	94	440.1	0.21322	0.06170	16.206	47	7.47 - 14.94	760
82.00	24.99	4.150	157	651.7	0.24096	0.02774	36.044	63	14.94 - 25.0	2,278
164.00	49.99	3.750	314	1177.8	0.26667	0.02570	38.906	157	25.0 - 49.99	6,110

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



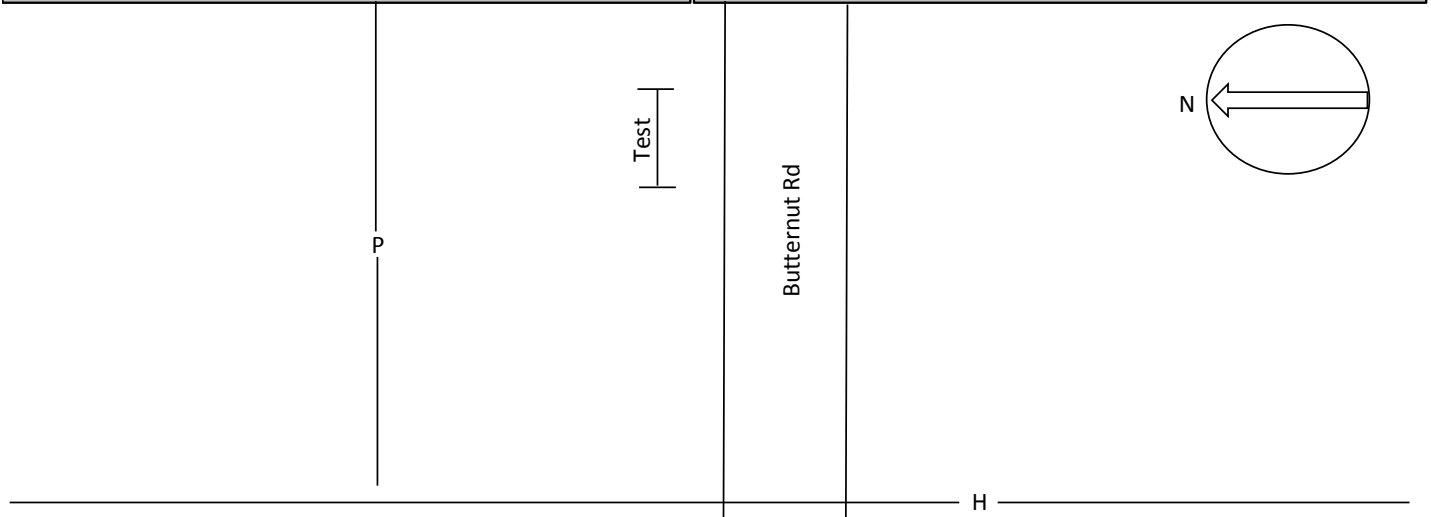
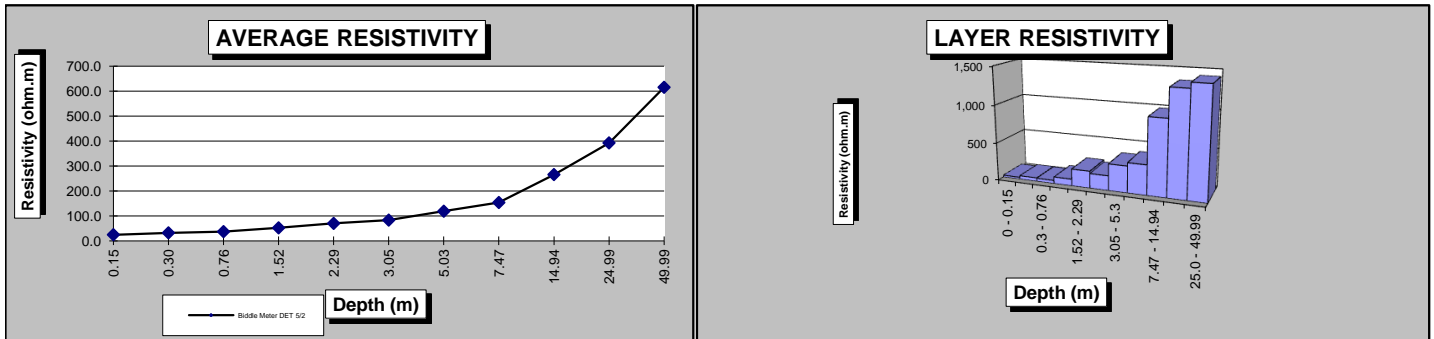
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-15  
**Date:** 5/2/2013  
**Location:** Rd Sd off Butternut Rd  
 44 24.1525N, 73 7.5014W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 61F/Clear  
**Soil Description:** Moist, dark, and rocky soil



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	25.400	1	24.3	0.03937	n/a	n/a	n/a	0 - 0.15	24
1.00	0.30	16.570	2	31.7	0.06035	0.02098	47.665	1	0.15 - 0.3	46
2.50	0.76	7.650	5	36.6	0.13072	0.07037	14.211	3	0.3 - 0.76	41
5.00	1.52	5.410	10	51.8	0.18484	0.05412	18.476	5	0.76 - 1.52	88
7.50	2.29	4.850	14	69.7	0.20619	0.02134	46.854	5	1.52 - 2.29	224
10.00	3.05	4.330	19	82.9	0.23095	0.02476	40.386	5	2.29 - 3.05	193
16.50	5.03	3.750	32	118.5	0.26667	0.03572	27.996	12	3.05 - 5.3	348
24.50	7.47	3.270	47	153.4	0.30581	0.03914	25.547	15	5.03 - 7.47	391
49.00	14.94	2.830	94	265.6	0.35336	0.04755	21.032	47	7.47 - 14.94	987
82.00	24.99	2.500	157	392.6	0.40000	0.04664	21.439	63	14.94 - 25.0	1,355
164.00	49.99	1.960	314	615.6	0.51020	0.11020	9.074	157	25.0 - 49.99	1,425

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



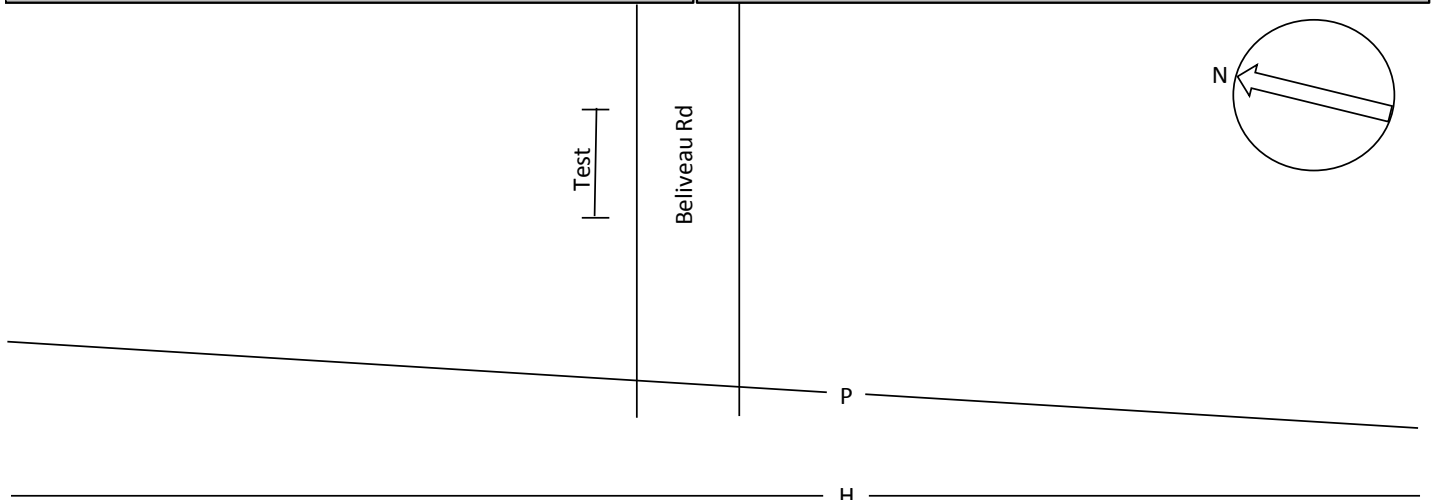
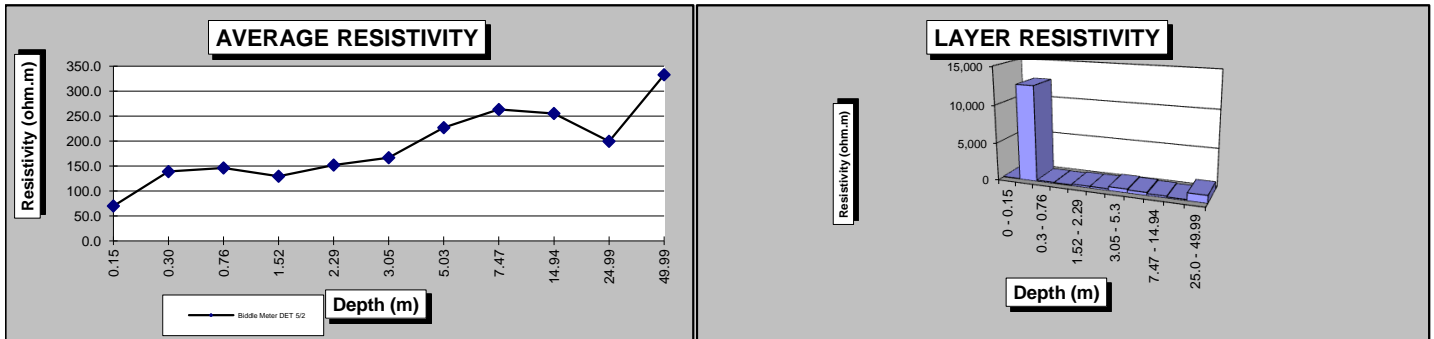
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-16  
**Date:** 5/2/2013  
**Location:** Rd Sd off Beliveau Rd  
 44 23.2839N, 73 7.5540W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 62F/Clear  
**Soil Description:** Dry, rocky soil



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	72.800	1	69.7	0.01374	n/a	n/a	n/a	0 - 0.15	70
1.00	0.30	72.400	2	138.7	0.01381	0.00008	13176.800	1	0.15 - 0.3	12,618
2.50	0.76	30.500	5	146.0	0.03279	0.01897	52.702	3	0.3 - 0.76	151
5.00	1.52	13.510	10	129.4	0.07402	0.04123	24.253	5	0.76 - 1.52	116
7.50	2.29	10.570	14	151.8	0.09461	0.02059	48.572	5	1.52 - 2.29	233
10.00	3.05	8.700	19	166.6	0.11494	0.02034	49.176	5	2.29 - 3.05	235
16.50	5.03	7.180	32	226.9	0.13928	0.02433	41.096	12	3.05 - 5.3	512
24.50	7.47	5.610	47	263.2	0.17825	0.03898	25.656	15	5.03 - 7.47	393
49.00	14.94	2.720	94	255.2	0.36765	0.18939	5.280	47	7.47 - 14.94	248
82.00	24.99	1.270	157	199.4	0.78740	0.41975	2.382	63	14.94 - 25.0	151
164.00	49.99	1.060	314	332.9	0.94340	0.15599	6.410	157	25.0 - 49.99	1,007

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



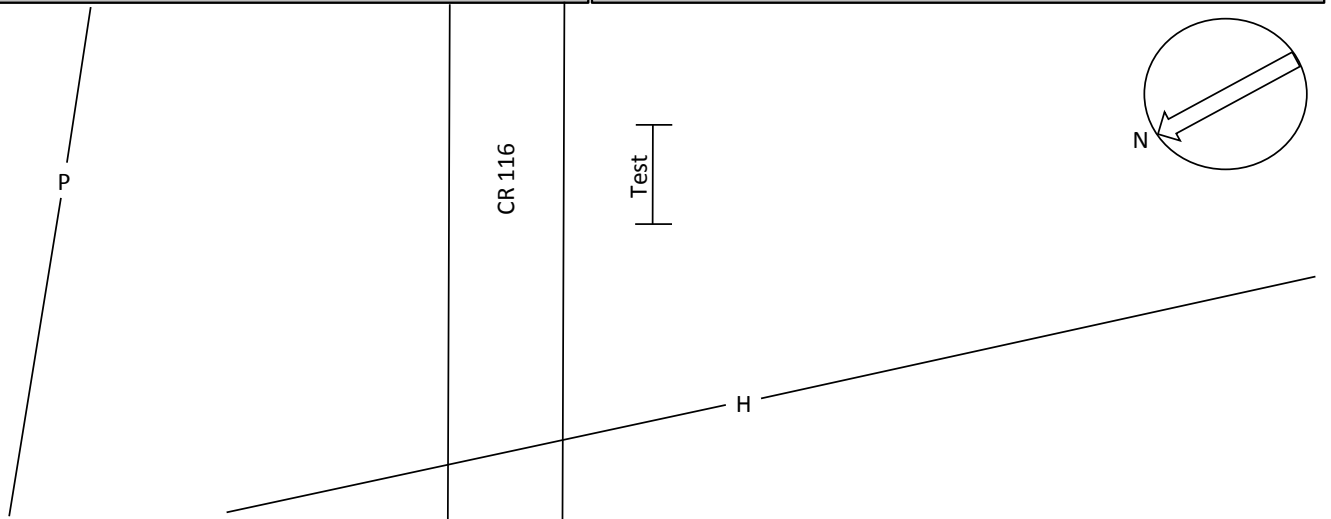
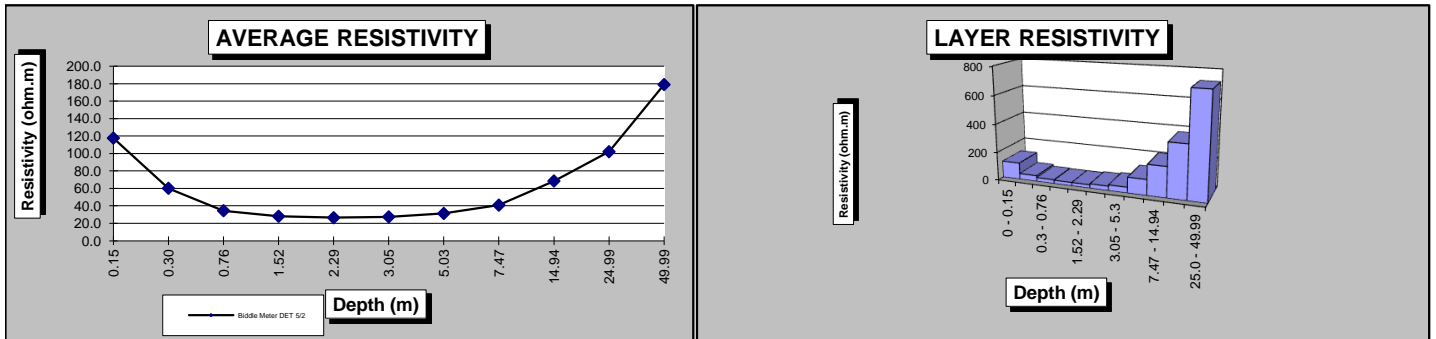
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-17  
**Date:** 5/1/2013  
**Location:** Rd Sd North of CR116  
 44 22.1536N, 73 7.6751W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 76F/Clear  
**Soil Description:** Dark, moist, sodded



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	122.900	1	117.7	0.00814	n/a	n/a	n/a	0 - 0.15	118
1.00	0.30	31.400	2	60.1	0.03185	0.02371	42.176	1	0.15 - 0.3	40
2.50	0.76	7.200	5	34.5	0.13889	0.10704	9.342	3	0.3 - 0.76	27
5.00	1.52	2.930	10	28.1	0.34130	0.20241	4.941	5	0.76 - 1.52	24
7.50	2.29	1.840	14	26.4	0.54348	0.20218	4.946	5	1.52 - 2.29	24
10.00	3.05	1.430	19	27.4	0.69930	0.15582	6.418	5	2.29 - 3.05	31
16.50	5.03	0.990	32	31.3	1.01010	0.31080	3.218	12	3.05 - 5.3	40
24.50	7.47	0.870	47	40.8	1.14943	0.13932	7.178	15	5.03 - 7.47	110
49.00	14.94	0.730	94	68.5	1.36986	0.22044	4.536	47	7.47 - 14.94	213
82.00	24.99	0.650	157	102.1	1.53846	0.16860	5.931	63	14.94 - 25.0	375
164.00	49.99	0.570	314	179.0	1.75439	0.21592	4.631	157	25.0 - 49.99	727

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



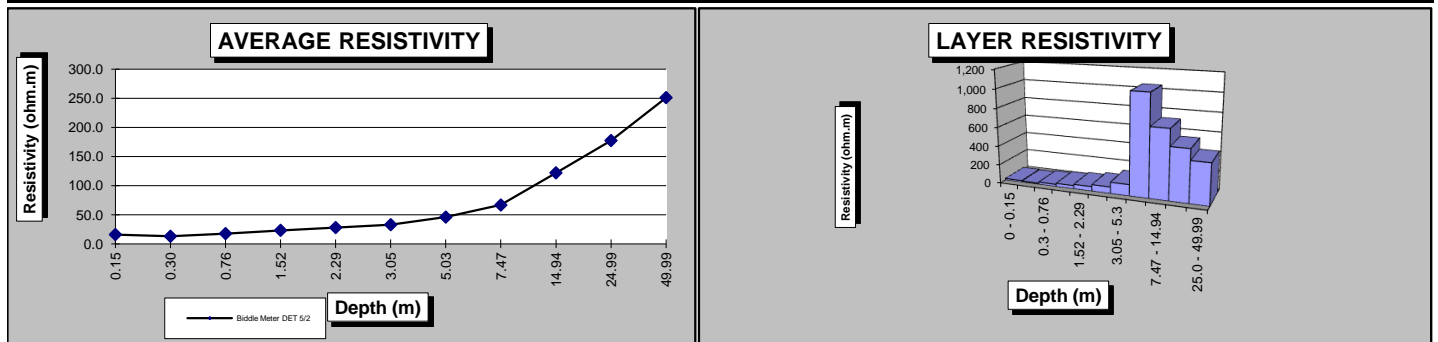
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-18  
**Date:** 5/1/2013  
**Location:** Mowed pasture West of CR116  
 44 21.010N, 73 7.096W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 75F/Clear  
**Soil Description:** Wet, dark soil

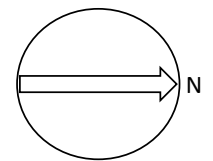


4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	16.540	1	15.8	0.06046	n/a	n/a	n/a	0 - 0.15	16
1.00	0.30	6.740	2	12.9	0.14837	0.08791	11.375	1	0.15 - 0.3	11
2.50	0.76	3.650	5	17.5	0.27397	0.12560	7.961	3	0.3 - 0.76	23
5.00	1.52	2.410	10	23.1	0.41494	0.14097	7.094	5	0.76 - 1.52	34
7.50	2.29	1.940	14	27.9	0.51546	0.10053	9.948	5	1.52 - 2.29	48
10.00	3.05	1.710	19	32.7	0.58480	0.06933	14.423	5	2.29 - 3.05	69
16.50	5.03	1.450	32	45.8	0.68966	0.10486	9.537	12	3.05 - 5.3	119
24.50	7.47	1.420	47	66.6	0.70423	0.01457	68.633	15	5.03 - 7.47	1,052
49.00	14.94	1.300	94	122.0	0.76923	0.06501	15.383	47	7.47 - 14.94	722
82.00	24.99	1.130	157	177.5	0.88496	0.11572	8.641	63	14.94 - 25.0	546
164.00	49.99	0.800	314	251.3	1.25000	0.36504	2.739	157	25.0 - 49.99	430

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



H



| Test |

CR 116

P

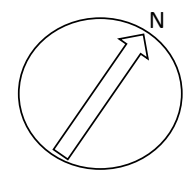
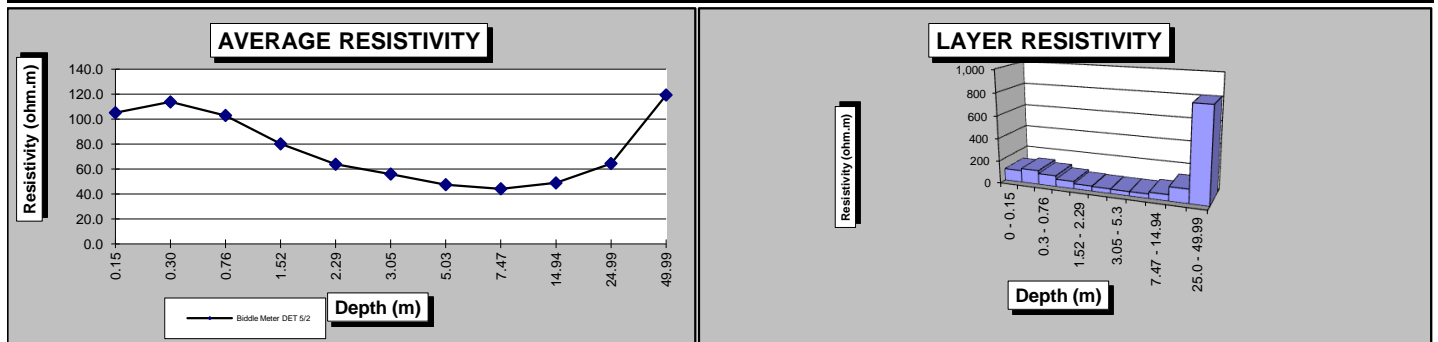
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-19  
**Date:** 5/1/2013  
**Location:** Mowed field off Shelburne Falls Rd  
 44 20.454N, 73 7.615W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 75F/Clear  
**Soil Description:** Dark and moist



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	109.800	1	105.1	0.00911	n/a	n/a	n/a	0 - 0.15	105
1.00	0.30	59.400	2	113.8	0.01684	0.00773	129.407	1	0.15 - 0.3	124
2.50	0.76	21.500	5	102.9	0.04651	0.02968	33.697	3	0.3 - 0.76	97
5.00	1.52	8.370	10	80.1	0.11947	0.07296	13.706	5	0.76 - 1.52	66
7.50	2.29	4.440	14	63.8	0.22523	0.10575	9.456	5	1.52 - 2.29	45
10.00	3.05	2.920	19	55.9	0.34247	0.11724	8.529	5	2.29 - 3.05	41
16.50	5.03	1.500	32	47.4	0.66667	0.32420	3.085	12	3.05 - 5.3	38
24.50	7.47	0.940	47	44.1	1.06383	0.39716	2.518	15	5.03 - 7.47	39
49.00	14.94	0.520	94	48.8	1.92308	0.85925	1.164	47	7.47 - 14.94	55
82.00	24.99	0.410	157	64.4	2.43902	0.51595	1.938	63	14.94 - 25.0	122
164.00	49.99	0.380	314	119.3	2.63158	0.19255	5.193	157	25.0 - 49.99	816

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



| Test |

H

Shelburne Falls Rd

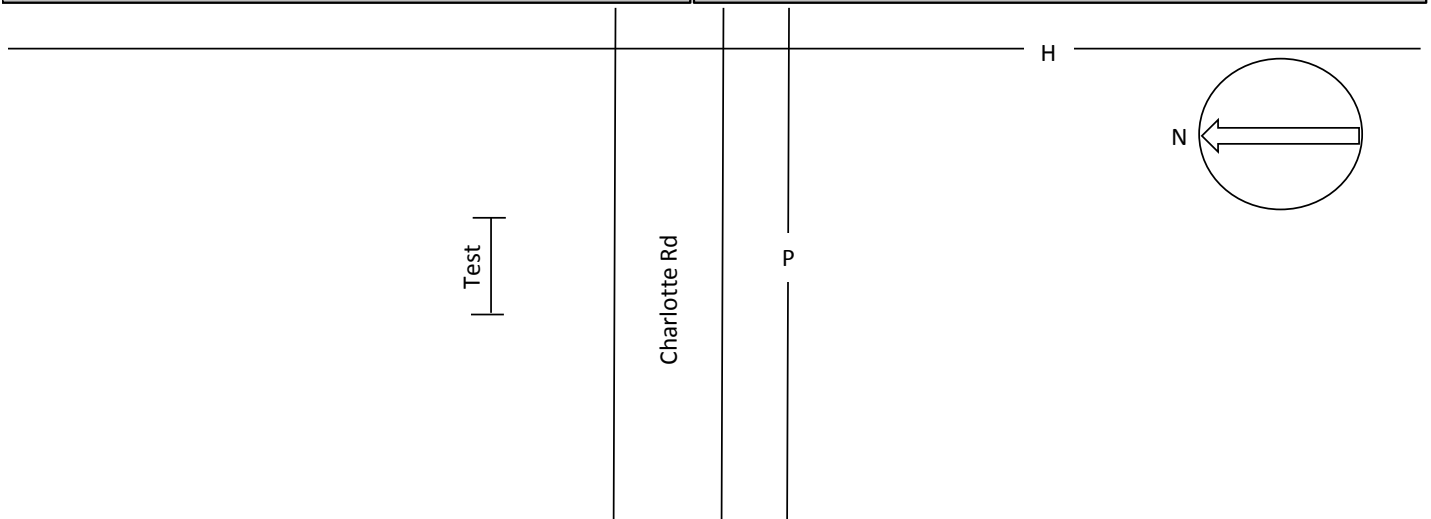
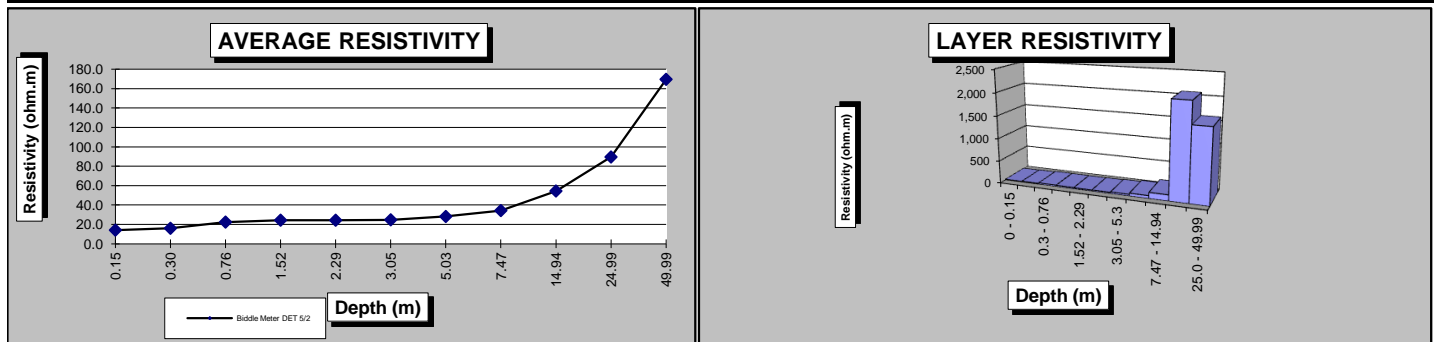
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-20  
**Date:** 5/1/2013  
**Location:** Mowed field off Charlotte Rd  
 44 19.6814N, 73 7.9244W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 73F/Clear  
**Soil Description:** Moist, Dark



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	14.710	1	14.1	0.06798	n/a	n/a	n/a	0 - 0.15	14
1.00	0.30	8.330	2	16.0	0.12005	0.05207	19.206	1	0.15 - 0.3	18
2.50	0.76	4.670	5	22.4	0.21413	0.09408	10.629	3	0.3 - 0.76	31
5.00	1.52	2.540	10	24.3	0.39370	0.17957	5.569	5	0.76 - 1.52	27
7.50	2.29	1.690	14	24.3	0.59172	0.19802	5.050	5	1.52 - 2.29	24
10.00	3.05	1.290	19	24.7	0.77519	0.18348	5.450	5	2.29 - 3.05	26
16.50	5.03	0.890	32	28.1	1.12360	0.34840	2.870	12	3.05 - 5.3	36
24.50	7.47	0.730	47	34.3	1.36986	0.24627	4.061	15	5.03 - 7.47	62
49.00	14.94	0.580	94	54.4	1.72414	0.35427	2.823	47	7.47 - 14.94	132
82.00	24.99	0.570	157	89.5	1.75439	0.03025	33.060	63	14.94 - 25.0	2,089
164.00	49.99	0.540	314	169.6	1.85185	0.09747	10.260	157	25.0 - 49.99	1,611

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



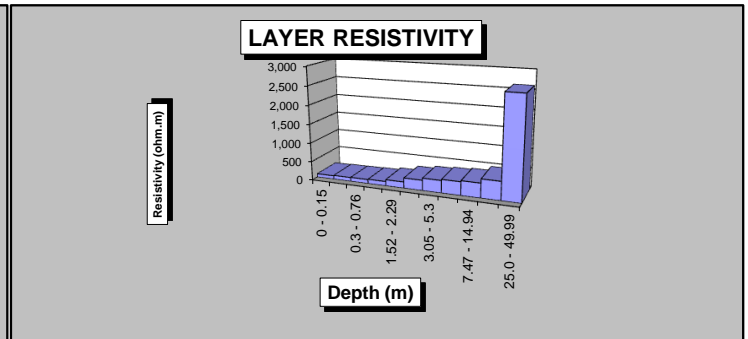
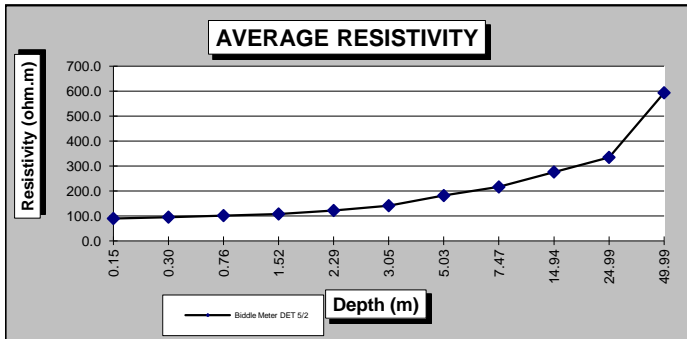
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-21  
**Date:** 5/1/2013  
**Location:** Rd Sd off Burritt Rd  
 44 18.7647N, 73 8.1066W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 66F/Clear  
**Soil Description:** Dry sand and rock



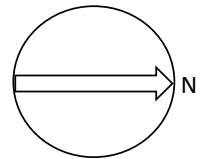
4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	93.300	1	89.3	0.01072	n/a	n/a	n/a	0 - 0.15	89
1.00	0.30	49.500	2	94.8	0.02020	0.00948	105.442	1	0.15 - 0.3	101
2.50	0.76	21.100	5	101.0	0.04739	0.02719	36.776	3	0.3 - 0.76	106
5.00	1.52	11.220	10	107.4	0.08913	0.04173	23.962	5	0.76 - 1.52	115
7.50	2.29	8.450	14	121.4	0.11834	0.02922	34.227	5	1.52 - 2.29	164
10.00	3.05	7.350	19	140.8	0.13605	0.01771	56.461	5	2.29 - 3.05	270
16.50	5.03	5.740	32	181.4	0.17422	0.03816	26.204	12	3.05 - 5.3	326
24.50	7.47	4.600	47	215.8	0.21739	0.04318	23.161	15	5.03 - 7.47	355
49.00	14.94	2.940	94	275.9	0.34014	0.12274	8.147	47	7.47 - 14.94	382
82.00	24.99	2.130	157	334.5	0.46948	0.12935	7.731	63	14.94 - 25.0	489
164.00	49.99	1.890	314	593.6	0.52910	0.05962	16.774	157	25.0 - 49.99	2,634

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



Burritt Rd

Test



Baldwin Rd

H



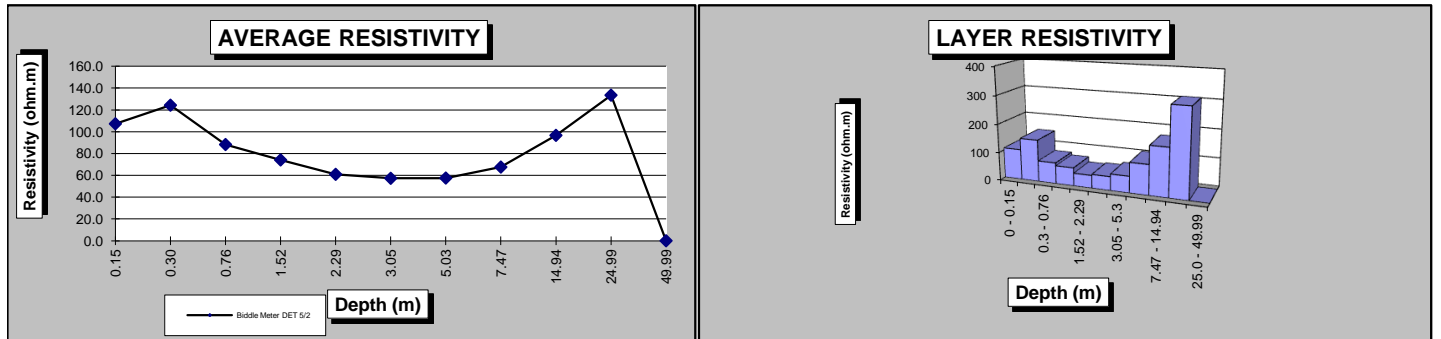
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-22  
**Date:** 5/6/2013  
**Location:** Rd Sd off Meade Farm Rd  
 44 17.956N, 73 6.513W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 70F/Clear  
**Soil Description:** Dark, moist and vegetation

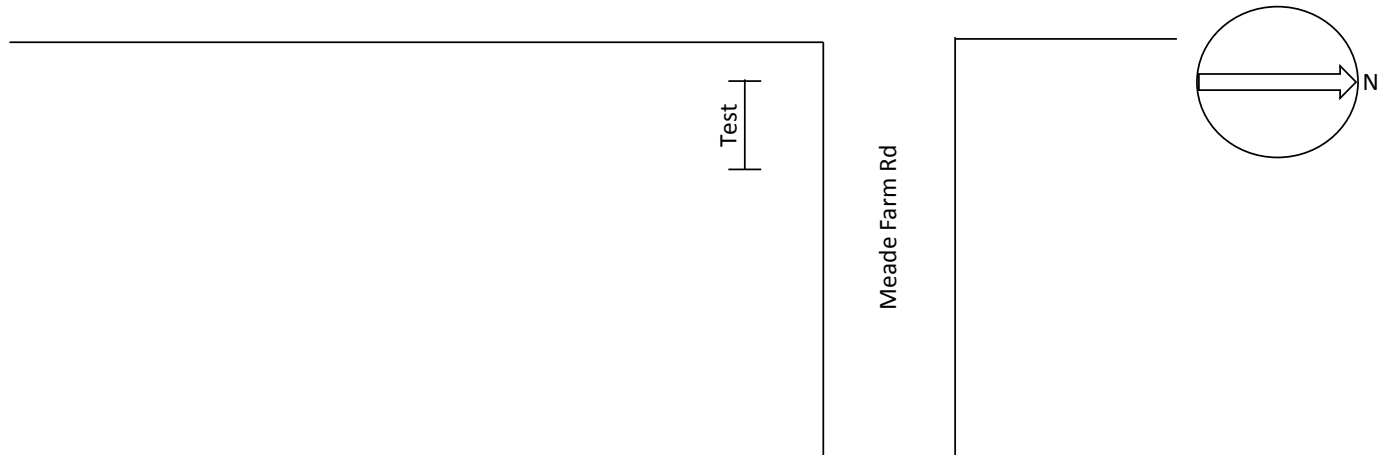


4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	112.000	1	107.2	0.00893	n/a	n/a	n/a	0 - 0.15	107
1.00	0.30	64.900	2	124.3	0.01541	0.00648	154.327	1	0.15 - 0.3	148
2.50	0.76	18.430	5	88.2	0.05426	0.03885	25.739	3	0.3 - 0.76	74
5.00	1.52	7.740	10	74.1	0.12920	0.07494	13.344	5	0.76 - 1.52	64
7.50	2.29	4.240	14	60.9	0.23585	0.10665	9.376	5	1.52 - 2.29	45
10.00	3.05	2.990	19	57.3	0.33445	0.09860	10.142	5	2.29 - 3.05	49
16.50	5.03	1.820	32	57.5	0.54945	0.21500	4.651	12	3.05 - 5.3	58
24.50	7.47	1.440	47	67.6	0.69444	0.14499	6.897	15	5.03 - 7.47	106
49.00	14.94	1.030	94	96.7	0.97087	0.27643	3.618	47	7.47 - 14.94	170
82.00	24.99	0.850	157	133.5	1.17647	0.20560	4.864	63	14.94 - 25.0	307
164.00	49.99	Short Test	314	#VALUE!	#####	#VALUE!	#VALUE!	157	25.0 - 49.99	#VALUE!

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



P



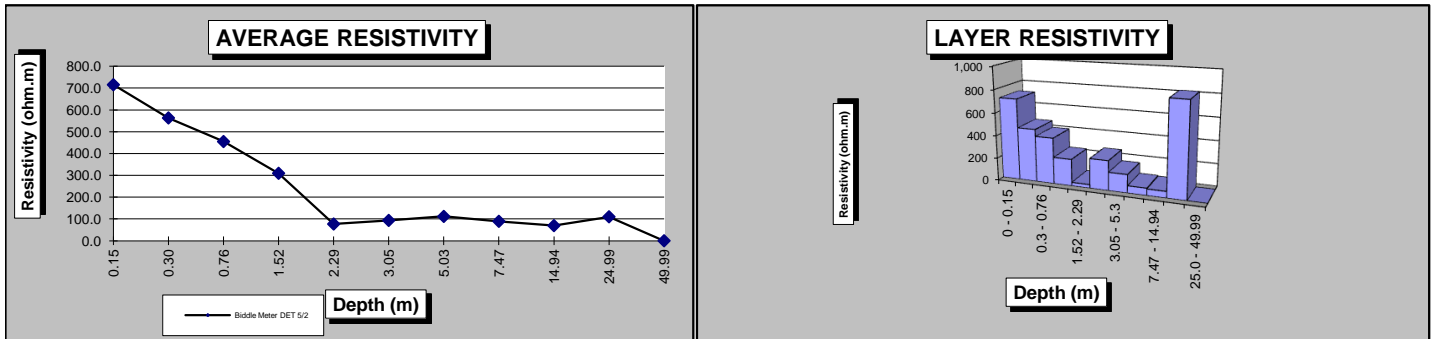
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-23  
**Date:** 5/6/2013  
**Location:** Rd Sd off Deer Run Ln  
 44 17.238N, 73 7.823W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 60F/Clear  
**Soil Description:** Dark, moist, and vegetation

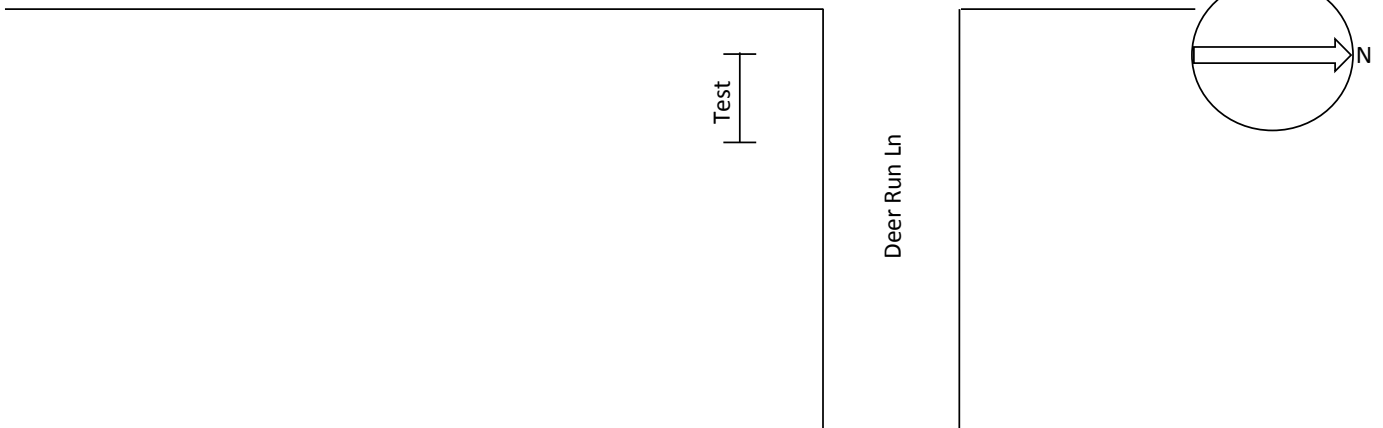


4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	747.000	1	715.3	0.00134	n/a	n/a	n/a	0 - 0.15	715
1.00	0.30	294.000	2	563.0	0.00340	0.00206	484.808	1	0.15 - 0.3	464
2.50	0.76	95.000	5	454.8	0.01053	0.00712	140.352	3	0.3 - 0.76	403
5.00	1.52	32.300	10	309.3	0.03096	0.02043	48.939	5	0.76 - 1.52	234
7.50	2.29	5.350	14	76.8	0.18692	0.15596	6.412	5	1.52 - 2.29	31
10.00	3.05	4.870	19	93.3	0.20534	0.01842	54.280	5	2.29 - 3.05	260
16.50	5.03	3.530	32	111.5	0.28329	0.07795	12.829	12	3.05 - 5.3	160
24.50	7.47	1.900	47	89.1	0.52632	0.24303	4.115	15	5.03 - 7.47	63
49.00	14.94	0.740	94	69.4	1.35135	0.82504	1.212	47	7.47 - 14.94	57
82.00	24.99	0.700	157	109.9	1.42857	0.07722	12.950	63	14.94 - 25.0	818
164.00	49.99	Short Test	314	#VALUE!	#####	#VALUE!	#VALUE!	157	25.0 - 49.99	#VALUE!

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



Baldwin Rd



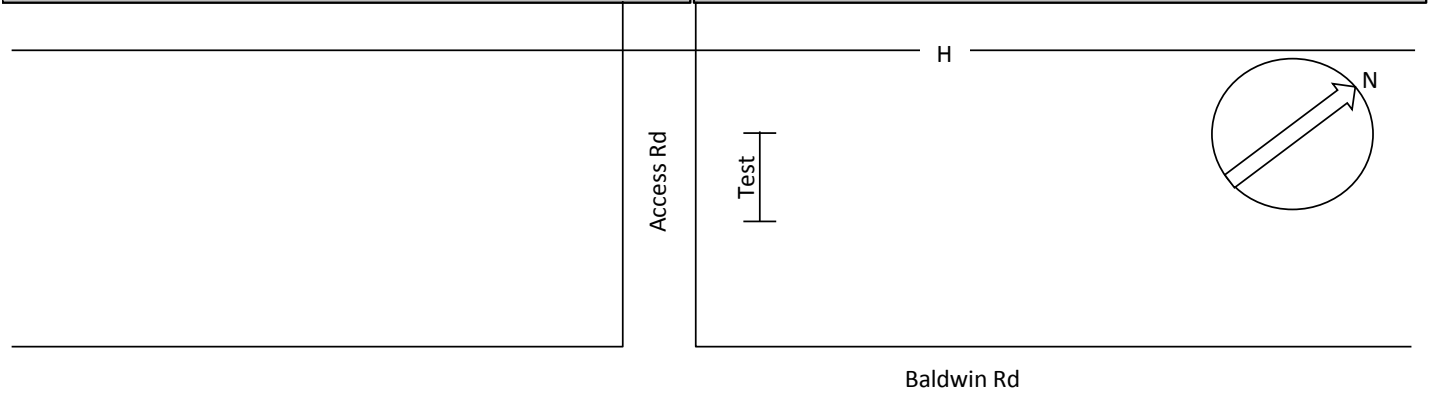
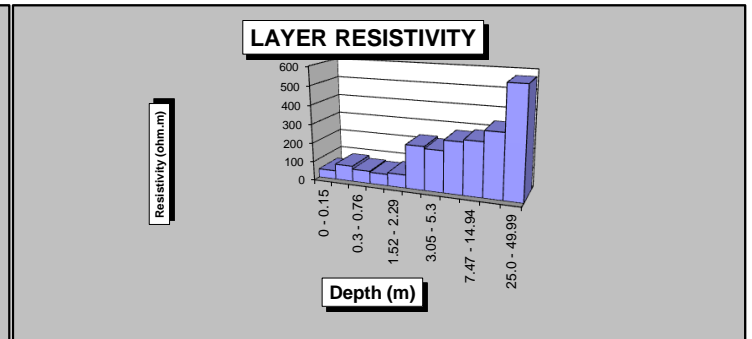
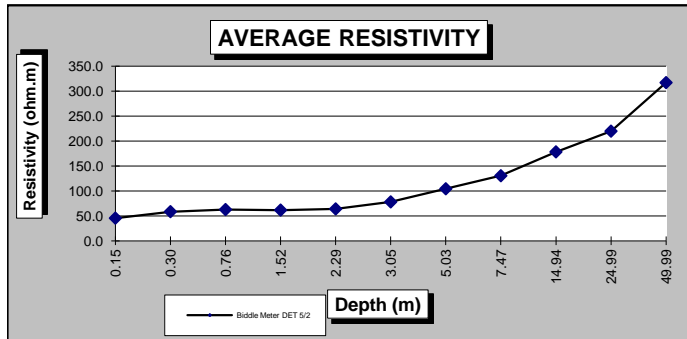
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-24  
**Date:** 5/3/2013  
**Location:** Rd Sd off Access Rd West of Baldwin Rd  
 44 16.205N, 73 8.074W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 68F/Clear  
**Soil Description:** Dry sand and rock



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	47.400	1	45.4	0.02110	n/a	n/a	n/a	0 - 0.15	45
1.00	0.30	30.500	2	58.4	0.03279	0.01169	85.544	1	0.15 - 0.3	82
2.50	0.76	13.080	5	62.6	0.07645	0.04367	22.901	3	0.3 - 0.76	66
5.00	1.52	6.430	10	61.6	0.15552	0.07907	12.647	5	0.76 - 1.52	61
7.50	2.29	4.450	14	63.9	0.22472	0.06920	14.451	5	1.52 - 2.29	69
10.00	3.05	4.070	19	77.9	0.24570	0.02098	47.662	5	2.29 - 3.05	228
16.50	5.03	3.300	32	104.3	0.30303	0.05733	17.443	12	3.05 - 5.3	217
24.50	7.47	2.780	47	130.4	0.35971	0.05668	17.642	15	5.03 - 7.47	270
49.00	14.94	1.900	94	178.3	0.52632	0.16660	6.002	47	7.47 - 14.94	282
82.00	24.99	1.400	157	219.9	0.71429	0.18797	5.320	63	14.94 - 25.0	336
164.00	49.99	1.010	314	317.2	0.99010	0.27581	3.626	157	25.0 - 49.99	569

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



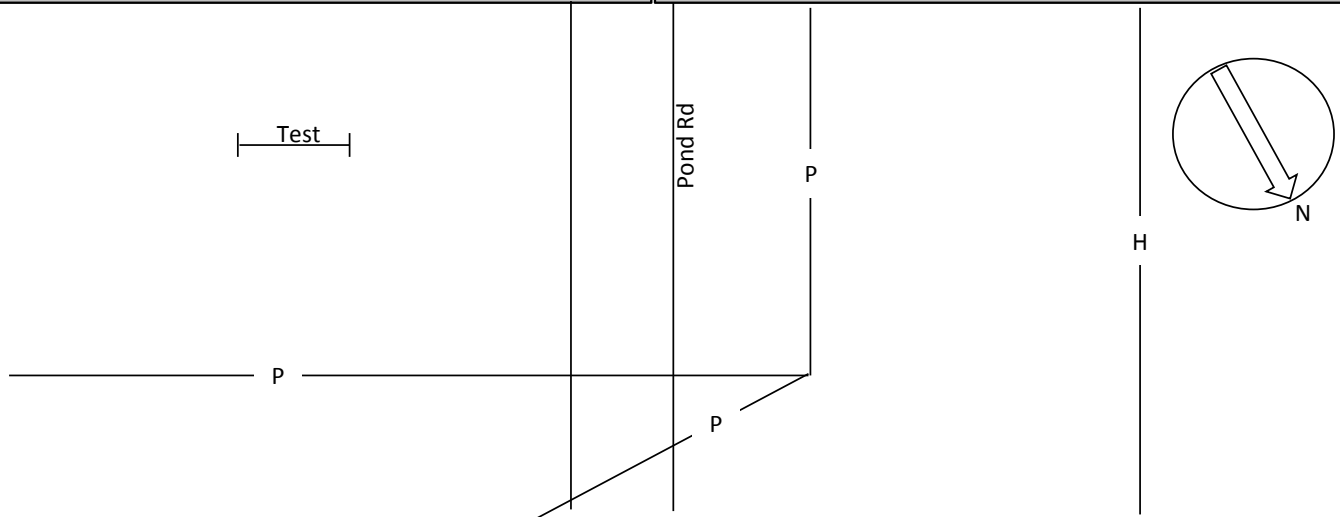
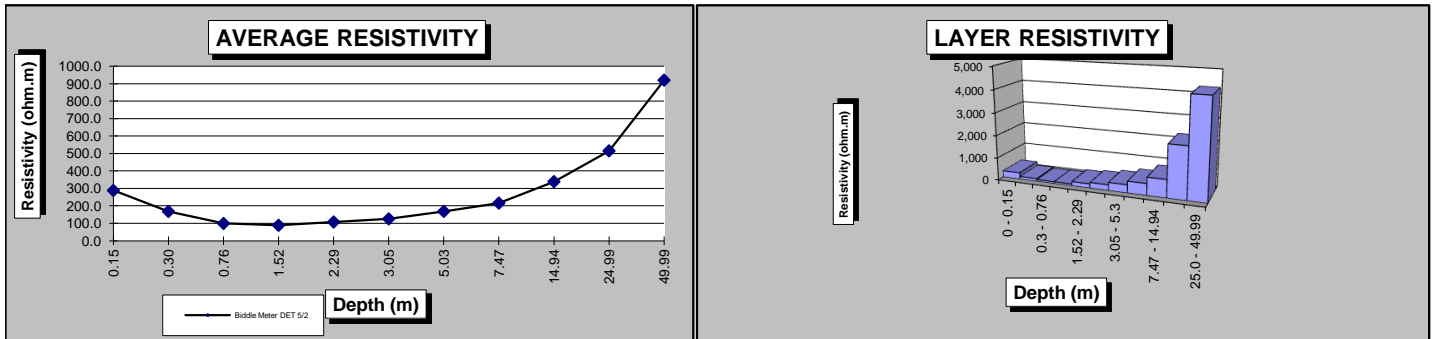
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-25  
**Date:** 5/3/2013  
**Location:** Rd Sd off Pond Rd  
 44 15.096N, 73 8.382W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 69F/Clear  
**Soil Description:** Dry sand and rock



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	301.000	1	288.2	0.00332	n/a	n/a	n/a	0 - 0.15	288
1.00	0.30	87.700	2	168.0	0.01140	0.00808	123.759	1	0.15 - 0.3	119
2.50	0.76	20.700	5	99.1	0.04831	0.03691	27.095	3	0.3 - 0.76	78
5.00	1.52	9.250	10	88.6	0.10811	0.05980	16.723	5	0.76 - 1.52	80
7.50	2.29	7.490	14	107.6	0.13351	0.02540	39.365	5	1.52 - 2.29	188
10.00	3.05	6.550	19	125.4	0.15267	0.01916	52.191	5	2.29 - 3.05	250
16.50	5.03	5.330	32	168.4	0.18762	0.03495	28.616	12	3.05 - 5.3	356
24.50	7.47	4.600	47	215.8	0.21739	0.02977	33.586	15	5.03 - 7.47	515
49.00	14.94	3.610	94	338.8	0.27701	0.05962	16.774	47	7.47 - 14.94	787
82.00	24.99	3.280	157	515.1	0.30488	0.02787	35.881	63	14.94 - 25.0	2,268
164.00	49.99	2.930	314	920.3	0.34130	0.03642	27.458	157	25.0 - 49.99	4,312

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



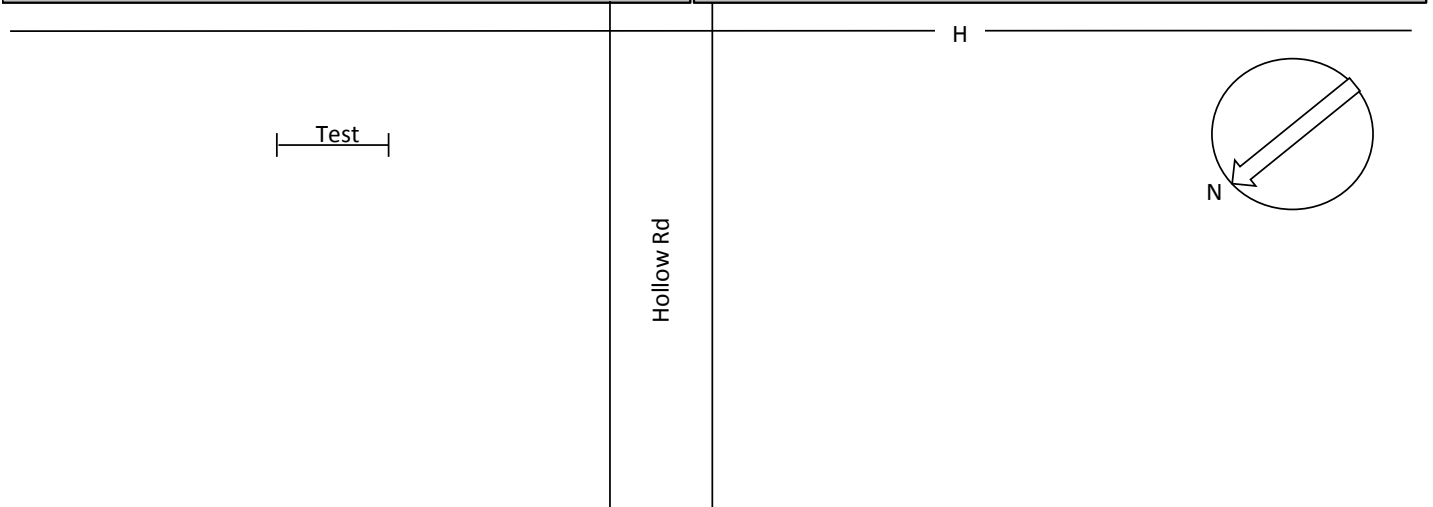
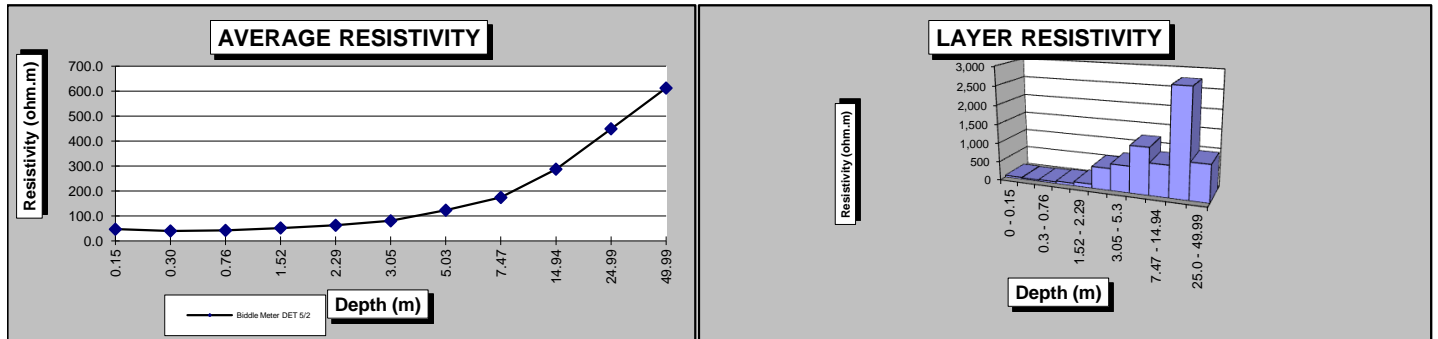
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-26  
**Date:** 5/4/2013  
**Location:** Rd Sd off Hollow Rd  
 44 14.318N, 73 9.036W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 55F/Clear  
**Soil Description:** Moist, dark soil



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	48.300	1	46.3	0.02070	n/a	n/a	n/a	0 - 0.15	46
1.00	0.30	20.500	2	39.3	0.04878	0.02808	35.617	1	0.15 - 0.3	34
2.50	0.76	8.690	5	41.6	0.11507	0.06629	15.084	3	0.3 - 0.76	43
5.00	1.52	5.360	10	51.3	0.18657	0.07149	13.988	5	0.76 - 1.52	67
7.50	2.29	4.320	14	62.0	0.23148	0.04491	22.265	5	1.52 - 2.29	107
10.00	3.05	4.170	19	79.9	0.23981	0.00833	120.096	5	2.29 - 3.05	575
16.50	5.03	3.880	32	122.6	0.25773	0.01792	55.792	12	3.05 - 5.3	695
24.50	7.47	3.700	47	173.6	0.27027	0.01254	79.756	15	5.03 - 7.47	1,222
49.00	14.94	3.060	94	287.2	0.32680	0.05653	17.691	47	7.47 - 14.94	830
82.00	24.99	2.860	157	449.1	0.34965	0.02285	43.758	63	14.94 - 25.0	2,765
164.00	49.99	1.950	314	612.5	0.51282	0.16317	6.129	157	25.0 - 49.99	962

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



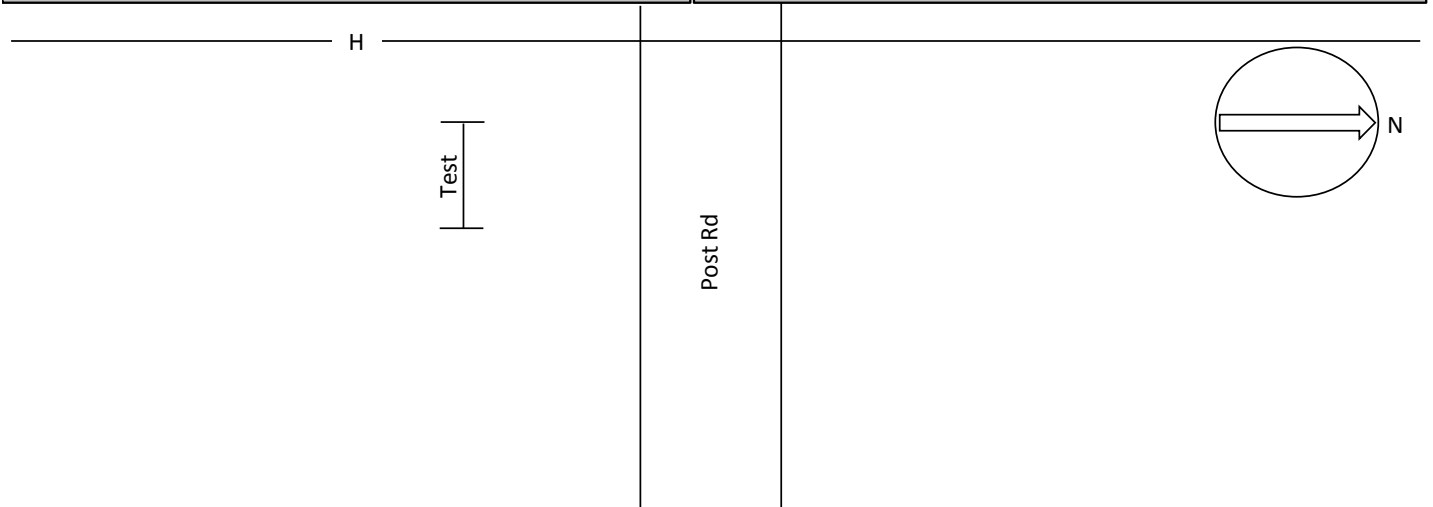
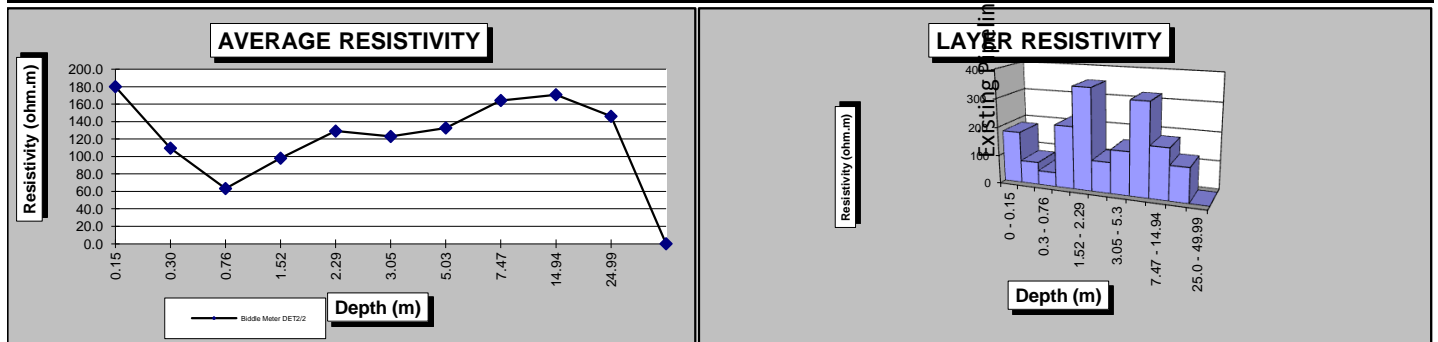
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-27  
**Date:** 5/6/2013  
**Location:** Rd Sd off Post Rd  
 44 13.8614N, 73 9.1396W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 56F/Clear  
**Soil Description:** Sand and rock



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	188.000	1	180.0	0.00532	n/a	n/a	n/a	0 - 0.15	180
1.00	0.30	57.200	2	109.5	0.01748	0.01216	82.214	1	0.15 - 0.3	79
2.50	0.76	13.220	5	63.3	0.07564	0.05816	17.194	3	0.3 - 0.76	49
5.00	1.52	10.240	10	98.1	0.09766	0.02201	45.427	5	0.76 - 1.52	217
7.50	2.29	8.990	14	129.1	0.11123	0.01358	73.646	5	1.52 - 2.29	353
10.00	3.05	6.420	19	123.0	0.15576	0.04453	22.458	5	2.29 - 3.05	108
16.50	5.03	4.200	32	132.7	0.23810	0.08233	12.146	12	3.05 - 5.3	151
24.50	7.47	3.500	47	164.2	0.28571	0.04762	21.000	15	5.03 - 7.47	322
49.00	14.94	1.820	94	170.8	0.54945	0.26374	3.792	47	7.47 - 14.94	178
82.00	24.99	0.930	157	146.0	1.07527	0.52582	1.902	63	14.94 - 25.0	120
			0	0.0	#DIV/0!	#DIV/0!	#DIV/0!	-157	25.0 - 49.99	#DIV/0!

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



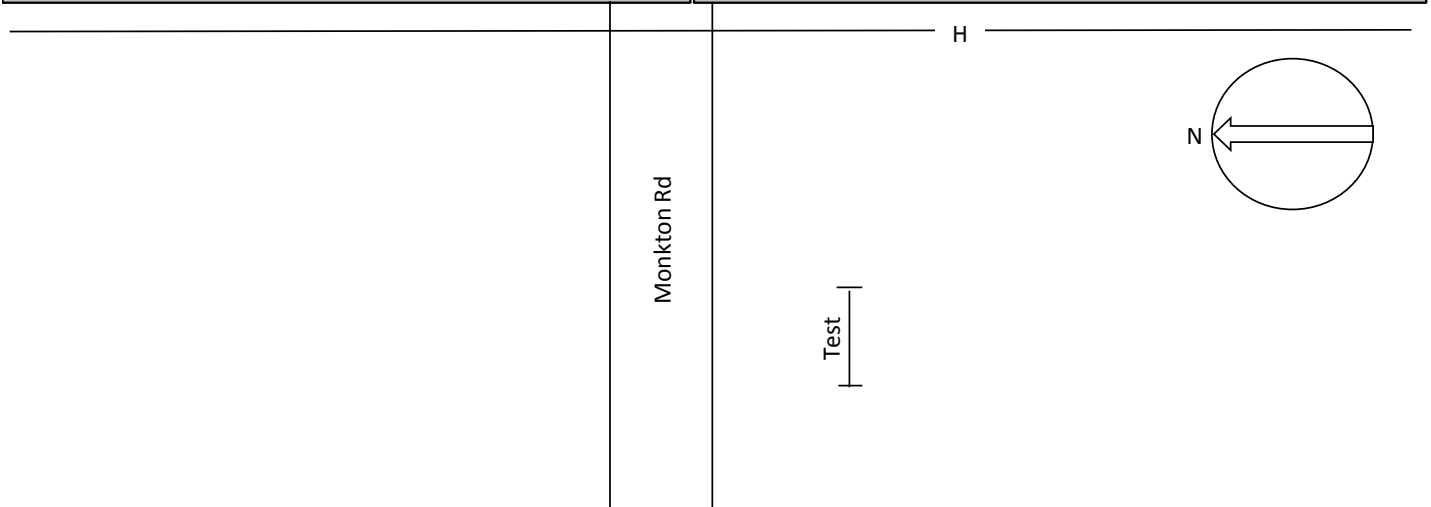
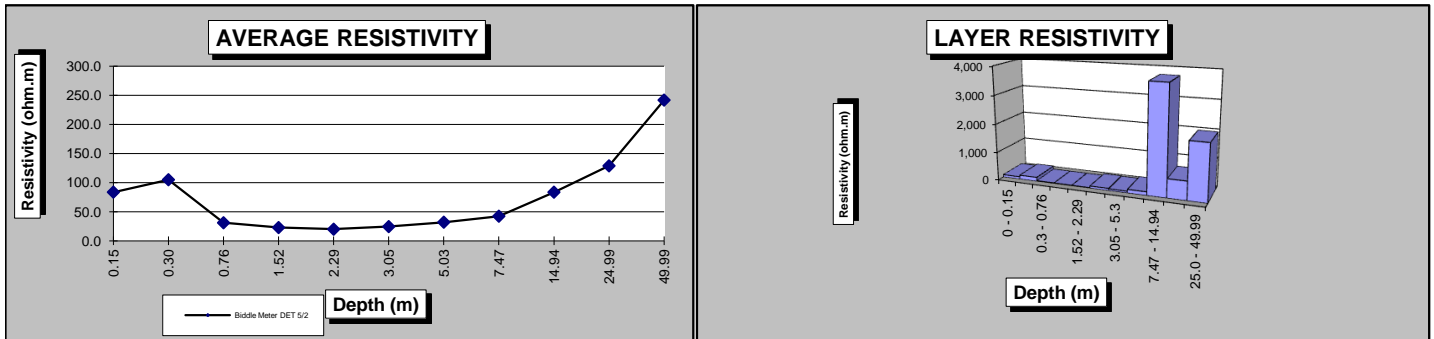
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-28  
**Date:** 5/3/2013  
**Location:** Rd Sd off Monkton Rd  
 44 12.9201N, 73 9.5695W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 59F/Clear  
**Soil Description:** Moist, dark soil and vegetation



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	87.300	1	83.6	0.01145	n/a	n/a	n/a	0 - 0.15	84
1.00	0.30	54.800	2	104.9	0.01825	0.00679	147.201	1	0.15 - 0.3	141
2.50	0.76	6.460	5	30.9	0.15480	0.13655	7.323	3	0.3 - 0.76	21
5.00	1.52	2.370	10	22.7	0.42194	0.26714	3.743	5	0.76 - 1.52	18
7.50	2.29	1.380	14	19.8	0.72464	0.30270	3.304	5	1.52 - 2.29	16
10.00	3.05	1.270	19	24.3	0.78740	0.06276	15.933	5	2.29 - 3.05	76
16.50	5.03	1.010	32	31.9	0.99010	0.20270	4.933	12	3.05 - 5.3	61
24.50	7.47	0.900	47	42.2	1.11111	0.12101	8.264	15	5.03 - 7.47	127
49.00	14.94	0.890	94	83.5	1.12360	0.01248	80.100	47	7.47 - 14.94	3,758
82.00	24.99	0.820	157	128.8	1.21951	0.09592	10.426	63	14.94 - 25.0	659
164.00	49.99	0.770	314	241.8	1.29870	0.07919	12.628	157	25.0 - 49.99	1,983

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



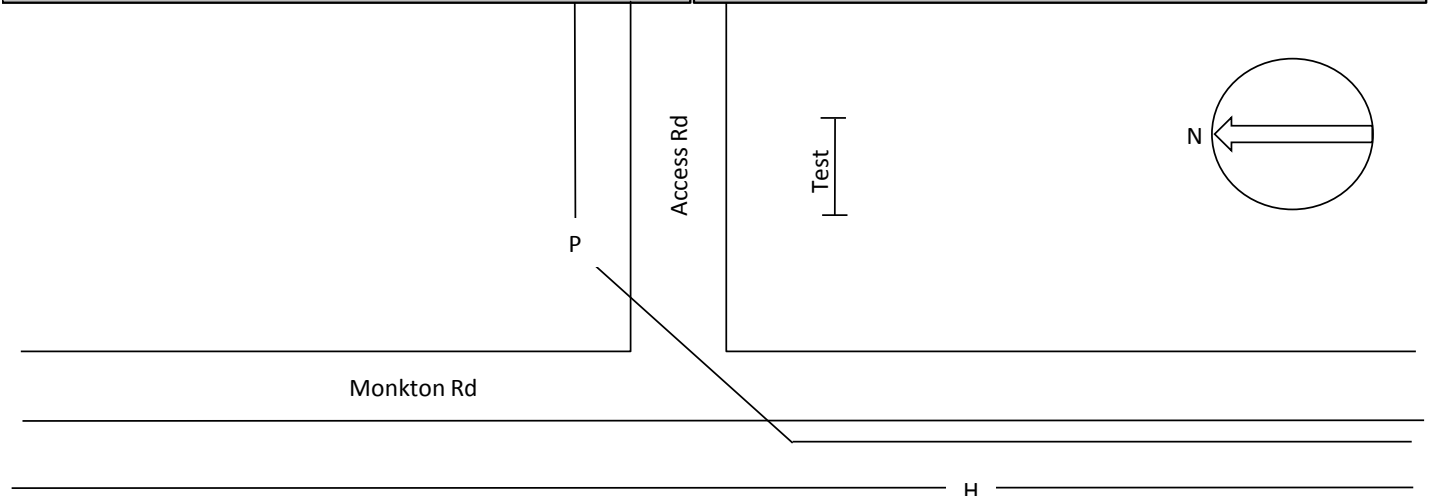
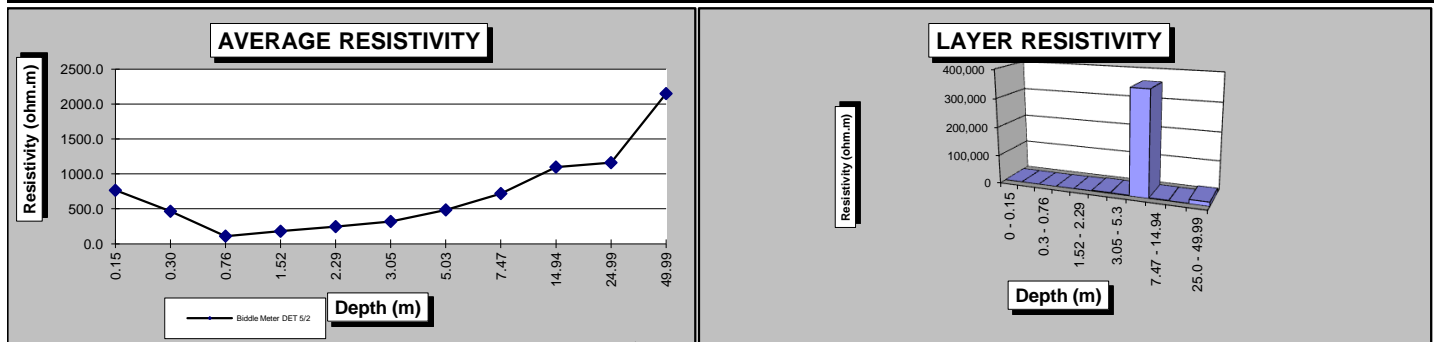
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-29  
**Date:** 5/4/2013  
**Location:** Access Rd off Monkton Rd  
 44 11.9620N, 73 10.1339W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 60F/Clear  
**Soil Description:** Dry, rocky soil



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	800.000	1	766.0	0.00125	n/a	n/a	n/a	0 - 0.15	766
1.00	0.30	243.000	2	465.4	0.00412	0.00287	349.013	1	0.15 - 0.3	334
2.50	0.76	22.900	5	109.6	0.04367	0.03955	25.283	3	0.3 - 0.76	73
5.00	1.52	18.700	10	179.1	0.05348	0.00981	101.960	5	0.76 - 1.52	488
7.50	2.29	17.120	14	245.9	0.05841	0.00494	202.623	5	1.52 - 2.29	970
10.00	3.05	16.690	19	319.6	0.05992	0.00150	664.495	5	2.29 - 3.05	3,181
16.50	5.03	15.350	32	485.1	0.06515	0.00523	191.188	12	3.05 - 5.3	2,380
24.50	7.47	15.340	47	719.8	0.06519	0.00004	23546.900	15	5.03 - 7.47	360,760
49.00	14.94	11.710	94	1098.9	0.08540	0.02021	49.485	47	7.47 - 14.94	2,322
82.00	24.99	7.400	157	1162.1	0.13514	0.04974	20.105	63	14.94 - 25.0	1,271
164.00	49.99	6.850	314	2151.4	0.14599	0.01085	92.164	157	25.0 - 49.99	14,473

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth





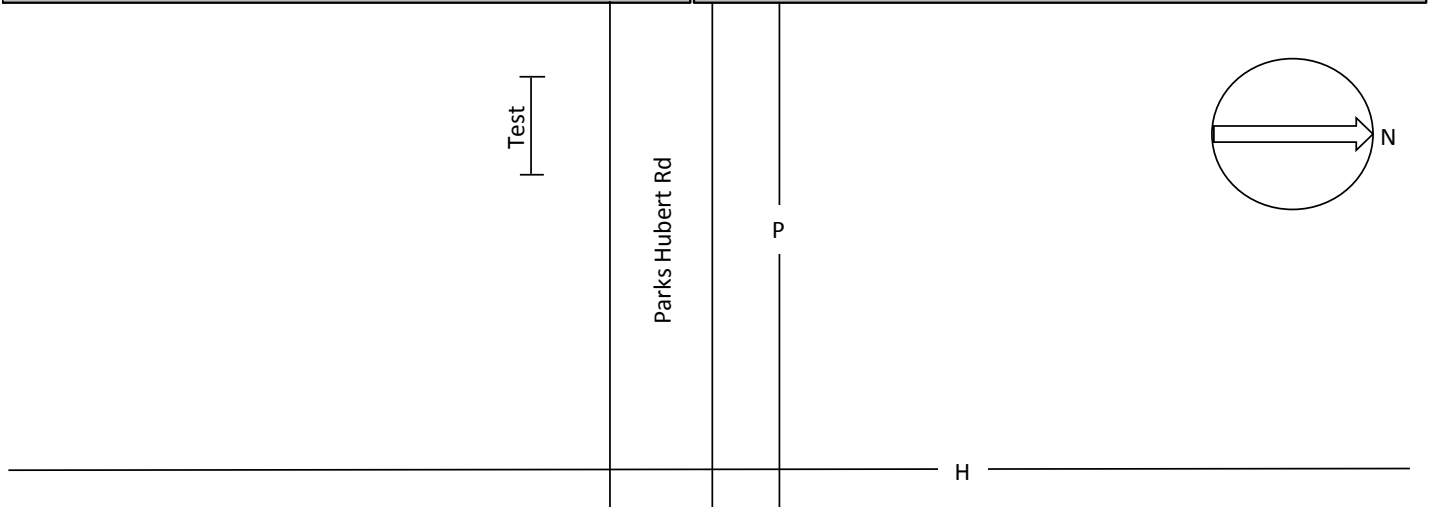
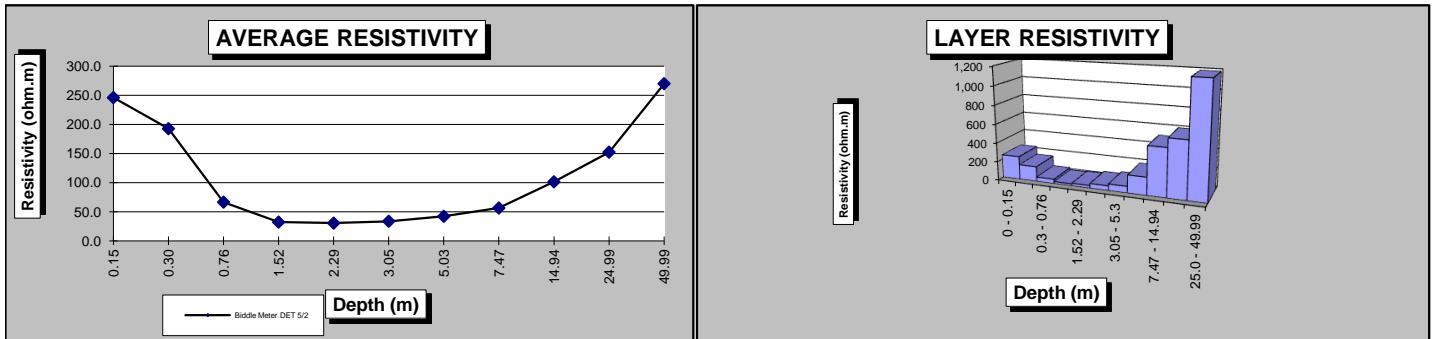
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-30  
**Date:** 5/4/2013  
**Location:** Rd Sd off Parks Hubert Rd  
 44 11.3774N, 73 10.1006W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 63F/Clear  
**Soil Description:** Dry sand and rock



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	257.000	1	246.1	0.00389	n/a	n/a	n/a	0 - 0.15	246
1.00	0.30	100.600	2	192.7	0.00994	0.00605	165.308	1	0.15 - 0.3	158
2.50	0.76	13.870	5	66.4	0.07210	0.06216	16.088	3	0.3 - 0.76	46
5.00	1.52	3.350	10	32.1	0.29851	0.22641	4.417	5	0.76 - 1.52	21
7.50	2.29	2.110	14	30.3	0.47393	0.17543	5.700	5	1.52 - 2.29	27
10.00	3.05	1.750	19	33.5	0.57143	0.09749	10.257	5	2.29 - 3.05	49
16.50	5.03	1.330	32	42.0	0.75188	0.18045	5.542	12	3.05 - 5.3	69
24.50	7.47	1.200	47	56.3	0.83333	0.08145	12.277	15	5.03 - 7.47	188
49.00	14.94	1.080	94	101.3	0.92593	0.09259	10.800	47	7.47 - 14.94	507
82.00	24.99	0.970	157	152.3	1.03093	0.10500	9.524	63	14.94 - 25.0	602
164.00	49.99	0.860	314	270.1	1.16279	0.13186	7.584	157	25.0 - 49.99	1,191

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



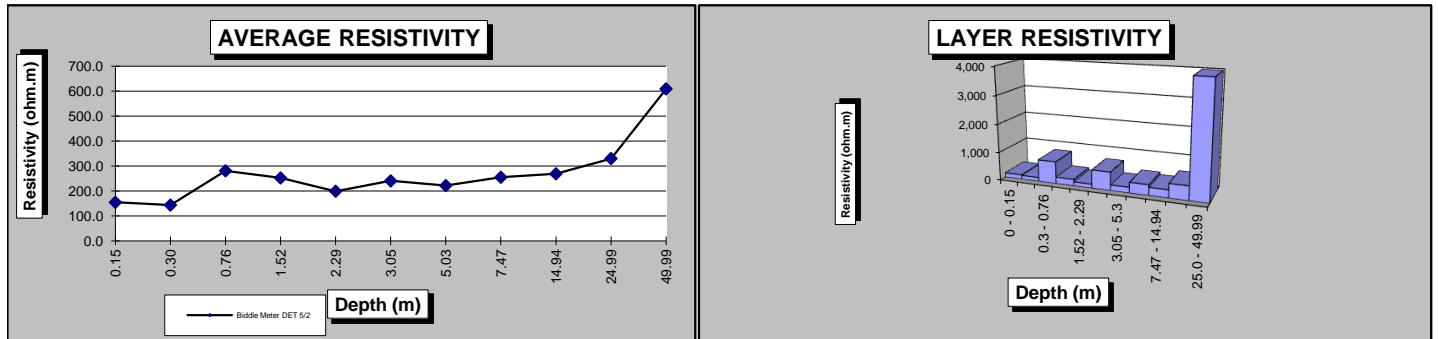
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-31  
**Date:** 5/4/2013  
**Location:** Rd Sd off NorthSt  
 44 10.3319N, 73 9.1138W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 64F/Clear  
**Soil Description:** Moist and rocky



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	161.000	1	154.2	0.00621	n/a	n/a	n/a	0 - 0.15	154
1.00	0.30	74.800	2	143.3	0.01337	0.00716	139.708	1	0.15 - 0.3	134
2.50	0.76	58.600	5	280.6	0.01706	0.00370	270.573	3	0.3 - 0.76	777
5.00	1.52	26.300	10	251.8	0.03802	0.02096	47.715	5	0.76 - 1.52	228
7.50	2.29	13.830	14	198.6	0.07231	0.03428	29.168	5	1.52 - 2.29	140
10.00	3.05	12.540	19	240.2	0.07974	0.00744	134.440	5	2.29 - 3.05	644
16.50	5.03	7.000	32	221.2	0.14286	0.06311	15.845	12	3.05 - 5.3	197
24.50	7.47	5.430	47	254.8	0.18416	0.04130	24.210	15	5.03 - 7.47	371
49.00	14.94	2.860	94	268.4	0.34965	0.16549	6.043	47	7.47 - 14.94	284
82.00	24.99	2.100	157	329.8	0.47619	0.12654	7.903	63	14.94 - 25.0	499
164.00	49.99	1.940	314	609.3	0.51546	0.03927	25.462	157	25.0 - 49.99	3,999

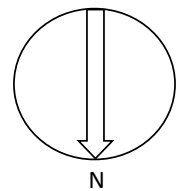
\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



Test

North St

H



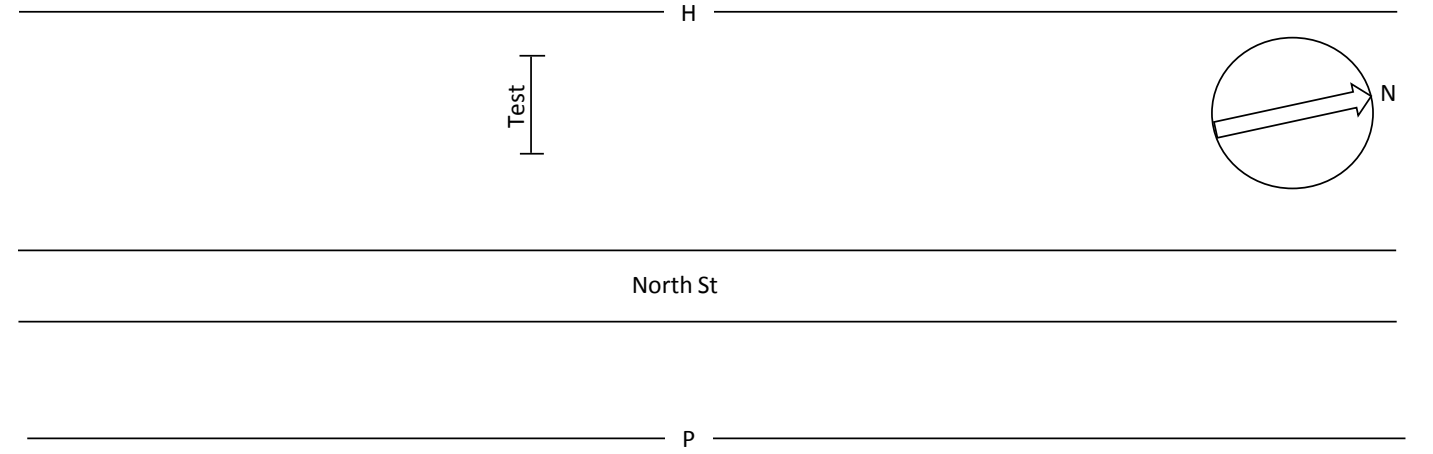
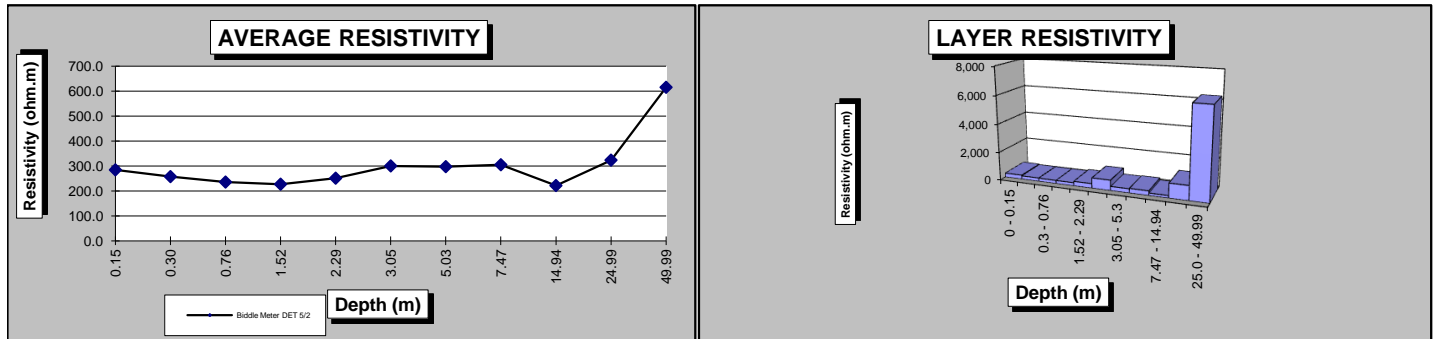
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-32  
**Date:** 5/4/2013  
**Location:** Planted Field off North St  
 44 9.1029N, 73 9.5749W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 64F/Clear  
**Soil Description:** Dry, rocky soil



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	297.000	1	284.4	0.00337	n/a	n/a	n/a	0 - 0.15	284
1.00	0.30	134.400	2	257.4	0.00744	0.00407	245.491	1	0.15 - 0.3	235
2.50	0.76	49.200	5	235.6	0.02033	0.01288	77.611	3	0.3 - 0.76	223
5.00	1.52	23.700	10	226.9	0.04219	0.02187	45.727	5	0.76 - 1.52	219
7.50	2.29	17.480	14	251.1	0.05721	0.01501	66.604	5	1.52 - 2.29	319
10.00	3.05	15.680	19	300.3	0.06378	0.00657	152.270	5	2.29 - 3.05	729
16.50	5.03	9.410	32	297.4	0.10627	0.04249	23.533	12	3.05 - 5.3	293
24.50	7.47	6.500	47	305.0	0.15385	0.04758	21.019	15	5.03 - 7.47	322
49.00	14.94	2.360	94	221.5	0.42373	0.26988	3.705	47	7.47 - 14.94	174
82.00	24.99	2.060	157	323.5	0.48544	0.06171	16.205	63	14.94 - 25.0	1,024
164.00	49.99	1.960	314	615.6	0.51020	0.02477	40.376	157	25.0 - 49.99	6,341

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



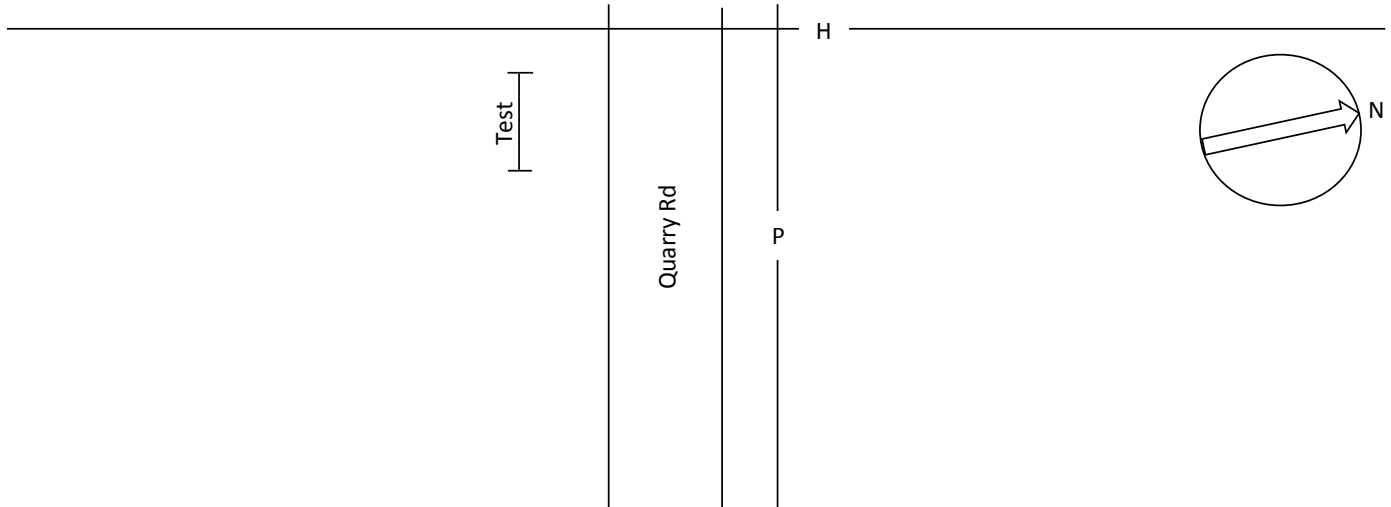
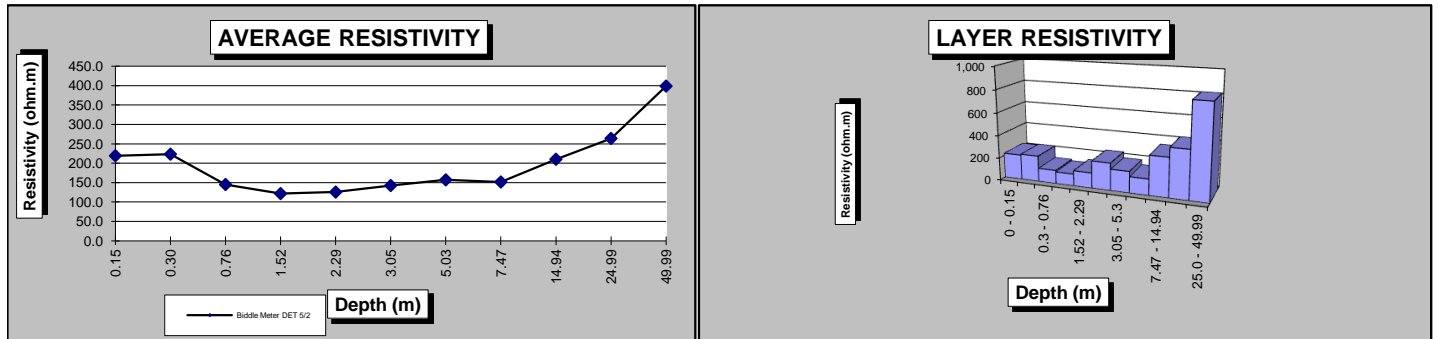
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-33  
**Date:** 5/4/2013  
**Location:** Rd Sd off Quarry Rd  
 44 8.4956N, 73 9.6391W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 62F/Clear  
**Soil Description:** Dry sand, rock and vegetation



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	229.000	1	219.3	0.00437	n/a	n/a	n/a	0 - 0.15	219
1.00	0.30	116.600	2	223.3	0.00858	0.00421	237.557	1	0.15 - 0.3	227
2.50	0.76	30.300	5	145.1	0.03300	0.02443	40.938	3	0.3 - 0.76	118
5.00	1.52	12.700	10	121.6	0.07874	0.04574	21.864	5	0.76 - 1.52	105
7.50	2.29	8.740	14	125.5	0.11442	0.03568	28.030	5	1.52 - 2.29	134
10.00	3.05	7.440	19	142.5	0.13441	0.01999	50.020	5	2.29 - 3.05	239
16.50	5.03	4.970	32	157.0	0.20121	0.06680	14.970	12	3.05 - 5.3	186
24.50	7.47	3.230	47	151.6	0.30960	0.10839	9.226	15	5.03 - 7.47	141
49.00	14.94	2.240	94	210.2	0.44643	0.13683	7.308	47	7.47 - 14.94	343
82.00	24.99	1.680	157	263.8	0.59524	0.14881	6.720	63	14.94 - 25.0	425
164.00	49.99	1.270	314	398.9	0.78740	0.19216	5.204	157	25.0 - 49.99	817

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



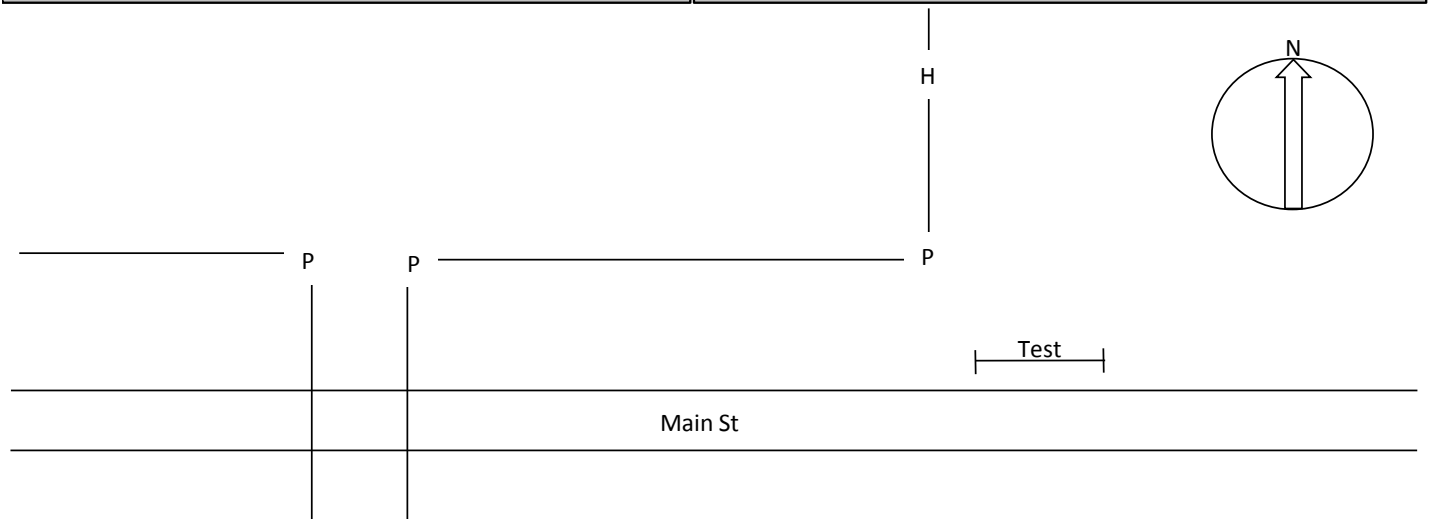
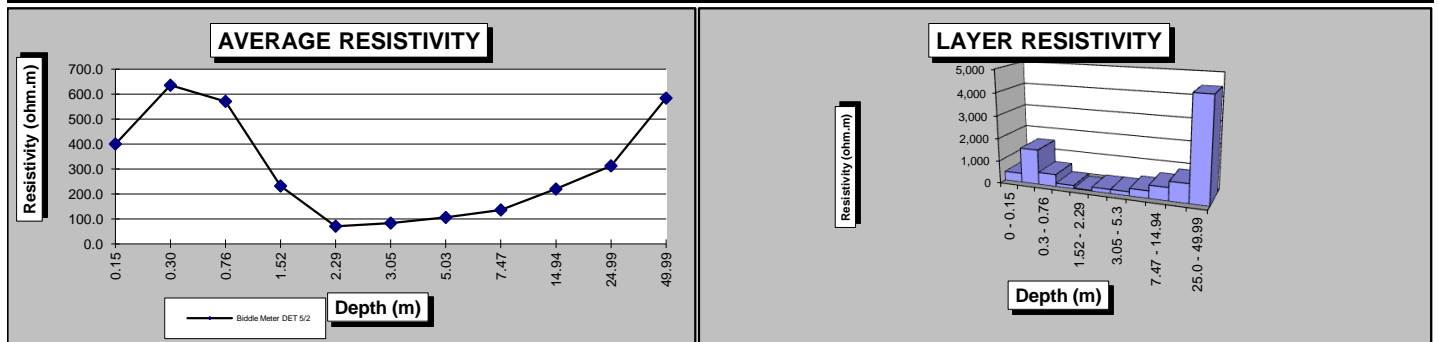
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-34  
**Date:** 5/4/2013  
**Location:** Rd Sd off Main St  
 44 7.4123N, 73 9.8050W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 72F/Clear  
**Soil Description:** Dry sand, rock and vegetation



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	418.000	1	400.3	0.00239	n/a	n/a	n/a	0 - 0.15	400
1.00	0.30	332.000	2	635.8	0.00301	0.00062	1613.674	1	0.15 - 0.3	1,545
2.50	0.76	119.300	5	571.2	0.00838	0.00537	186.213	3	0.3 - 0.76	535
5.00	1.52	24.200	10	231.7	0.04132	0.03294	30.358	5	0.76 - 1.52	145
7.50	2.29	4.900	14	70.4	0.20408	0.16276	6.144	5	1.52 - 2.29	29
10.00	3.05	4.330	19	82.9	0.23095	0.02687	37.223	5	2.29 - 3.05	178
16.50	5.03	3.340	32	105.5	0.29940	0.06845	14.608	12	3.05 - 5.3	182
24.50	7.47	2.890	47	135.6	0.34602	0.04662	21.450	15	5.03 - 7.47	329
49.00	14.94	2.340	94	219.6	0.42735	0.08133	12.296	47	7.47 - 14.94	577
82.00	24.99	1.990	157	312.5	0.50251	0.07516	13.305	63	14.94 - 25.0	841
164.00	49.99	1.860	314	584.2	0.53763	0.03512	28.472	157	25.0 - 49.99	4,471

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



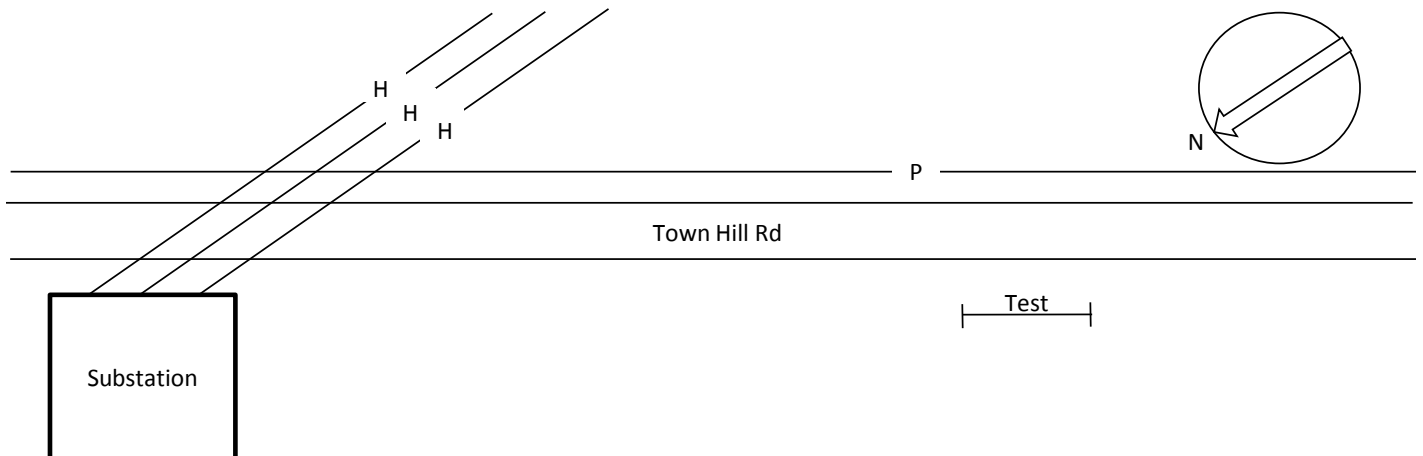
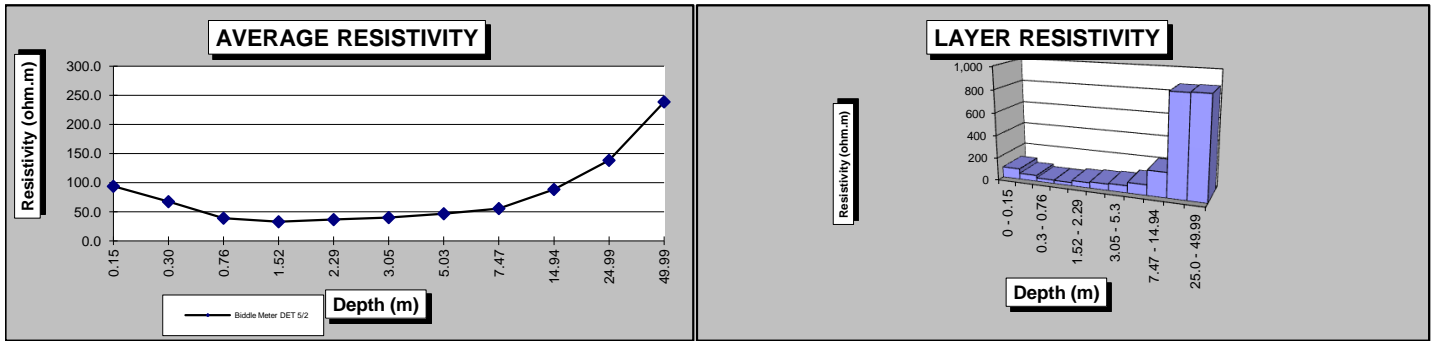
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-35  
**Date:** 5/5/2013  
**Location:** Rd Sd off Town Hill Rd  
 44 6.5084N, 73 10.0670W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 56F/Clear  
**Soil Description:** Hard dry and vegetation



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	97.700	1	93.6	0.01024	n/a	n/a	n/a	0 - 0.15	94
1.00	0.30	35.100	2	67.2	0.02849	0.01825	54.781	1	0.15 - 0.3	52
2.50	0.76	8.100	5	38.8	0.12346	0.09497	10.530	3	0.3 - 0.76	30
5.00	1.52	3.410	10	32.7	0.29326	0.16980	5.889	5	0.76 - 1.52	28
7.50	2.29	2.530	14	36.3	0.39526	0.10200	9.804	5	1.52 - 2.29	47
10.00	3.05	2.080	19	39.8	0.48077	0.08551	11.694	5	2.29 - 3.05	56
16.50	5.03	1.470	32	46.5	0.68027	0.19950	5.012	12	3.05 - 5.3	62
24.50	7.47	1.180	47	55.4	0.84746	0.16719	5.981	15	5.03 - 7.47	92
49.00	14.94	0.940	94	88.2	1.06383	0.21637	4.622	47	7.47 - 14.94	217
82.00	24.99	0.880	157	138.2	1.13636	0.07253	13.787	63	14.94 - 25.0	871
164.00	49.99	0.760	314	238.7	1.31579	0.17943	5.573	157	25.0 - 49.99	875

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



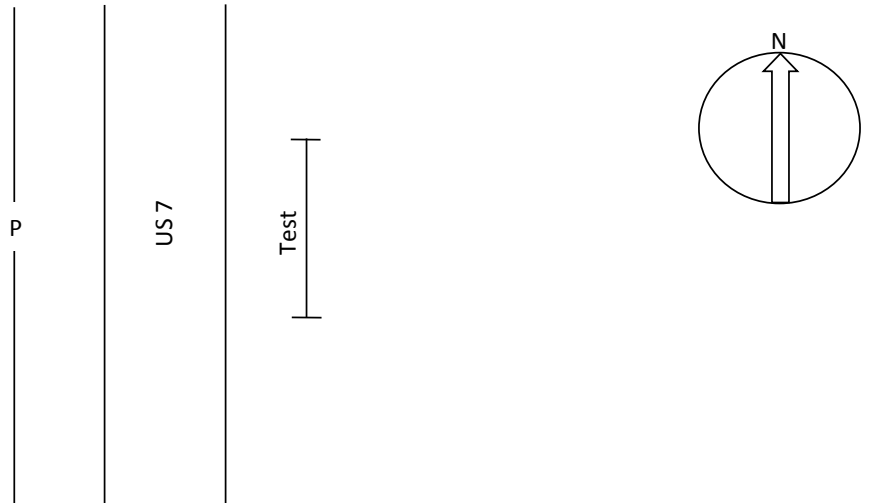
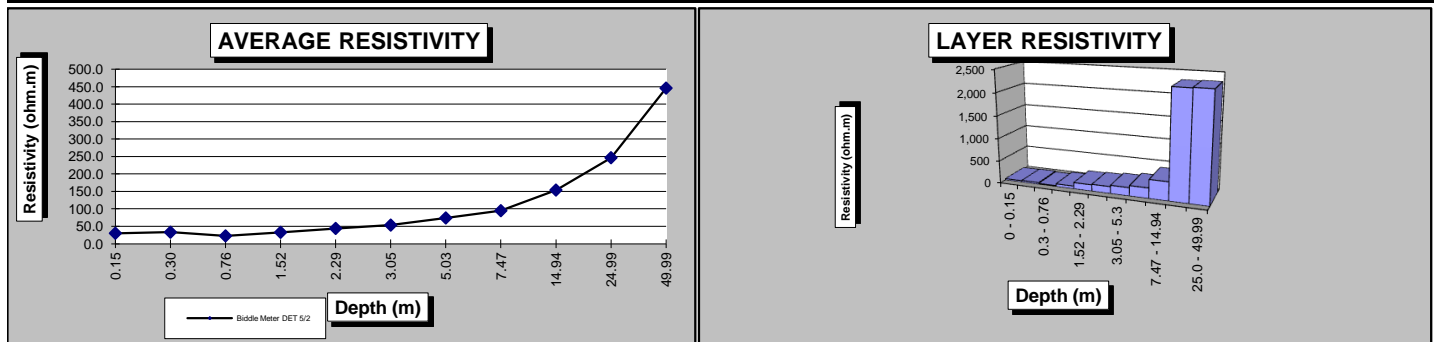
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-36  
**Date:** 5/5/2013  
**Location:** Rd Sd off Ethan Allen Hwy  
 44 5.5455N, 73 10.4509W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 56F/Clear  
**Soil Description:** Hard dry and vegetation



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	31.500	1	30.2	0.03175	n/a	n/a	n/a	0 - 0.15	30
1.00	0.30	17.270	2	33.1	0.05790	0.02616	38.229	1	0.15 - 0.3	37
2.50	0.76	4.700	5	22.5	0.21277	0.15486	6.457	3	0.3 - 0.76	19
5.00	1.52	3.420	10	32.7	0.29240	0.07963	12.558	5	0.76 - 1.52	60
7.50	2.29	3.060	14	44.0	0.32680	0.03440	29.070	5	1.52 - 2.29	139
10.00	3.05	2.790	19	53.4	0.35842	0.03163	31.620	5	2.29 - 3.05	151
16.50	5.03	2.340	32	73.9	0.42735	0.06893	14.508	12	3.05 - 5.3	181
24.50	7.47	2.020	47	94.8	0.49505	0.06770	14.771	15	5.03 - 7.47	226
49.00	14.94	1.640	94	153.9	0.60976	0.11471	8.718	47	7.47 - 14.94	409
82.00	24.99	1.570	157	246.6	0.63694	0.02719	36.783	63	14.94 - 25.0	2,325
164.00	49.99	1.420	314	446.0	0.70423	0.06728	14.863	157	25.0 - 49.99	2,334

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



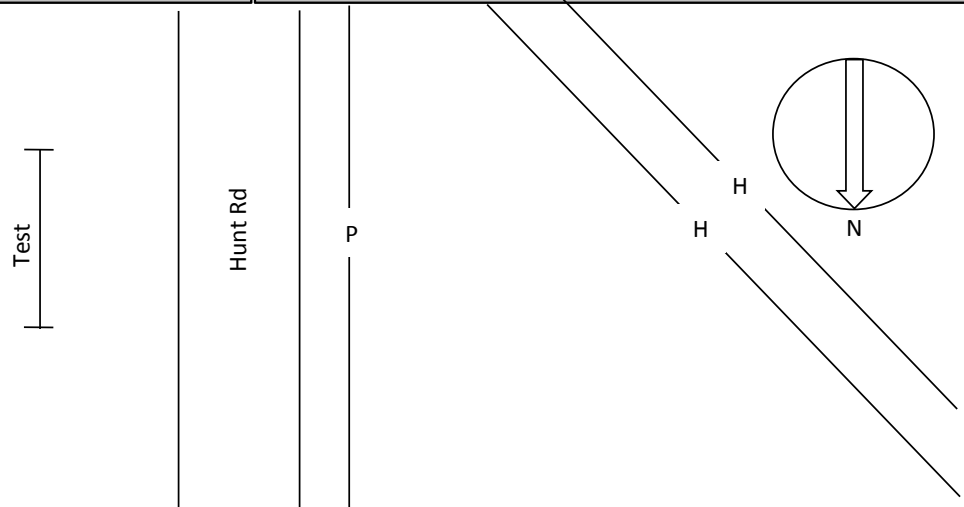
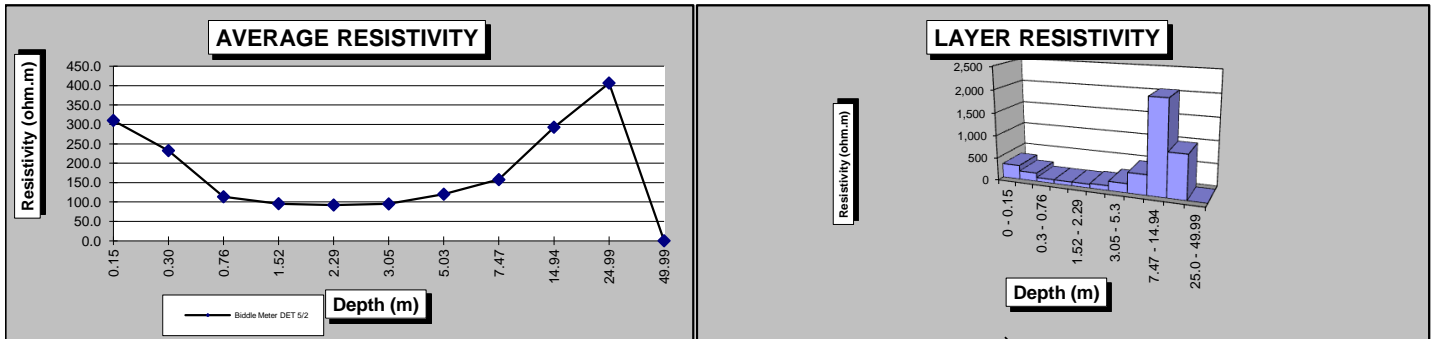
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-37  
**Date:** 5/5/2013  
**Location:** Rd Sd off Hunt Rd  
 44 4.5951N, 73 9.5652W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 57F/Clear  
**Soil Description:** Hard packed dark soil



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	324.000	1	310.2	0.00309	n/a	n/a	n/a	0 - 0.15	310
1.00	0.30	121.400	2	232.5	0.00824	0.00515	194.144	1	0.15 - 0.3	186
2.50	0.76	23.700	5	113.5	0.04219	0.03396	29.449	3	0.3 - 0.76	85
5.00	1.52	9.990	10	95.7	0.10010	0.05791	17.269	5	0.76 - 1.52	83
7.50	2.29	6.420	14	92.2	0.15576	0.05566	17.965	5	1.52 - 2.29	86
10.00	3.05	4.960	19	95.0	0.20161	0.04585	21.810	5	2.29 - 3.05	104
16.50	5.03	3.800	32	120.1	0.26316	0.06154	16.248	12	3.05 - 5.3	202
24.50	7.47	3.360	47	157.7	0.29762	0.03446	29.018	15	5.03 - 7.47	445
49.00	14.94	3.120	94	292.8	0.32051	0.02289	43.680	47	7.47 - 14.94	2,049
82.00	24.99	2.590	157	406.7	0.38610	0.06559	15.247	63	14.94 - 25.0	964
164.00	49.99	Short Test	314	#VALUE!	#####	#VALUE!	#VALUE!	157	25.0 - 49.99	#VALUE!

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth





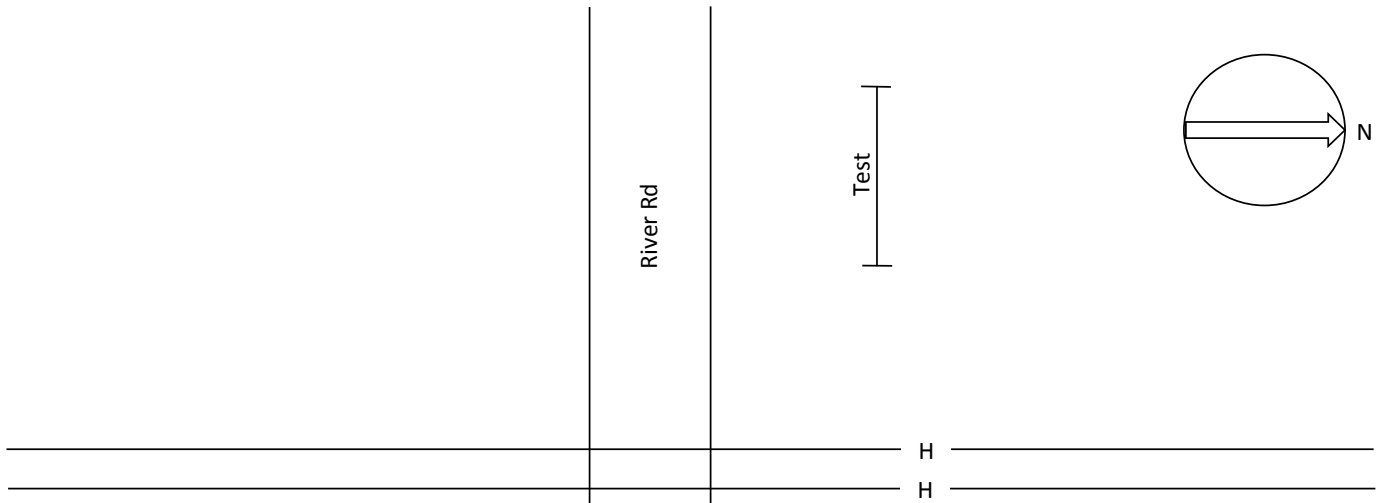
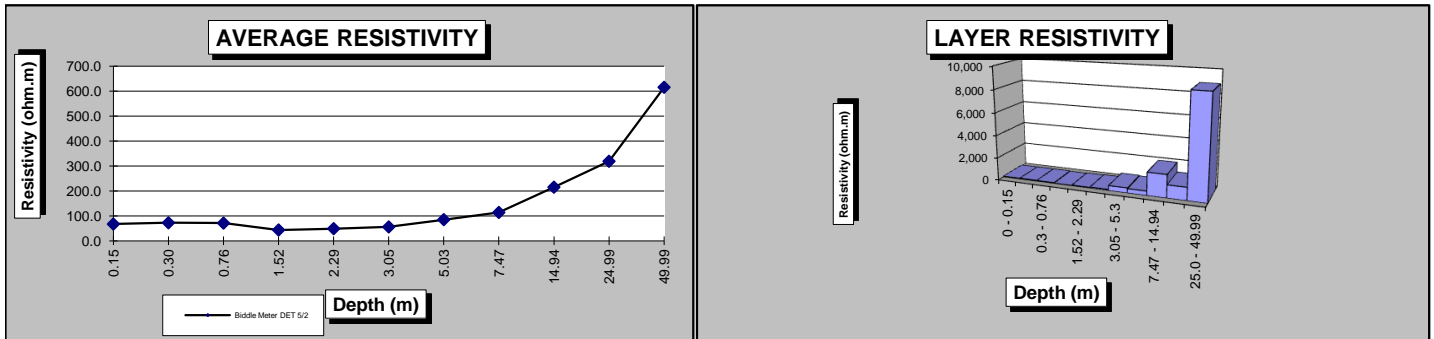
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-38  
**Date:** 5/5/2013  
**Location:** Open Field off River Rd  
 44 3.5072N, 73 9.5358W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 59F/Clear  
**Soil Description:** Hard packed dark soil



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	70.000	1	67.0	0.01429	n/a	n/a	n/a	0 - 0.15	67
1.00	0.30	37.600	2	72.0	0.02660	0.01231	81.235	1	0.15 - 0.3	78
2.50	0.76	14.780	5	70.8	0.06766	0.04106	24.353	3	0.3 - 0.76	70
5.00	1.52	4.520	10	43.3	0.22124	0.15358	6.511	5	0.76 - 1.52	31
7.50	2.29	3.380	14	48.5	0.29586	0.07462	13.401	5	1.52 - 2.29	64
10.00	3.05	2.900	19	55.5	0.34483	0.04897	20.421	5	2.29 - 3.05	98
16.50	5.03	2.680	32	84.7	0.37313	0.02831	35.327	12	3.05 - 5.3	440
24.50	7.47	2.420	47	113.5	0.41322	0.04009	24.945	15	5.03 - 7.47	382
49.00	14.94	2.290	94	214.9	0.43668	0.02346	42.629	47	7.47 - 14.94	2,000
82.00	24.99	2.030	157	318.8	0.49261	0.05593	17.880	63	14.94 - 25.0	1,130
164.00	49.99	1.960	314	615.6	0.51020	0.01759	56.840	157	25.0 - 49.99	8,926

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



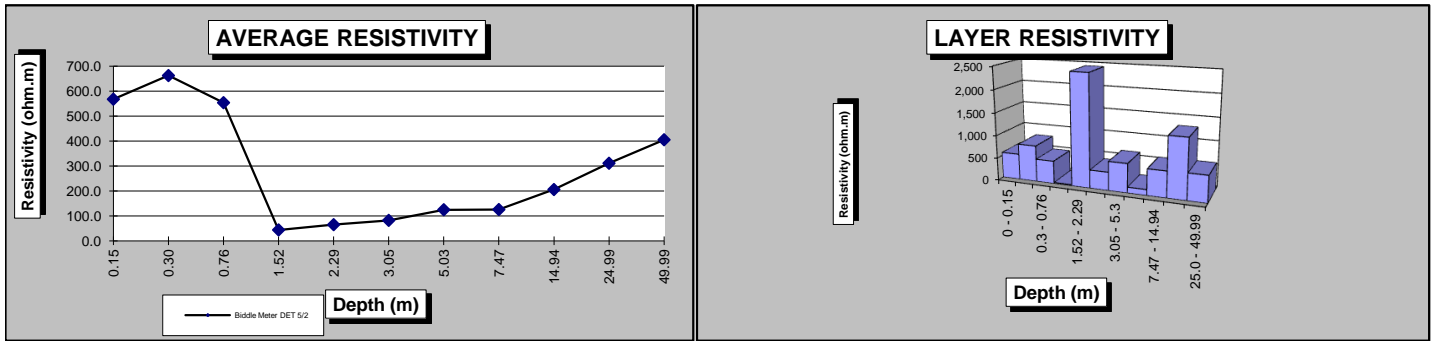
## SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-39  
**Date:** 5/5/2013  
**Location:** Rd Sd off US 7  
 44 2.9550N, 73 9.8744W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 59F/Clear  
**Soil Description:** Sandy, large rocks, and vegetation



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	593.000	1	567.8	0.00169	n/a	n/a	n/a	0 - 0.15	568
1.00	0.30	346.000	2	662.6	0.00289	0.00120	830.680	1	0.15 - 0.3	795
2.50	0.76	115.700	5	553.9	0.00864	0.00575	173.826	3	0.3 - 0.76	499
5.00	1.52	4.540	10	43.5	0.22026	0.21162	4.725	5	0.76 - 1.52	23
7.50	2.29	4.500	14	64.6	0.22222	0.00196	510.750	5	1.52 - 2.29	2,445
10.00	3.05	4.270	19	81.8	0.23419	0.01197	83.543	5	2.29 - 3.05	400
16.50	5.03	3.940	32	124.5	0.25381	0.01962	50.981	12	3.05 - 5.3	635
24.50	7.47	2.670	47	125.3	0.37453	0.12072	8.283	15	5.03 - 7.47	127
49.00	14.94	2.190	94	205.5	0.45662	0.08209	12.182	47	7.47 - 14.94	572
82.00	24.99	1.980	157	310.9	0.50505	0.04843	20.649	63	14.94 - 25.0	1,305
164.00	49.99	1.290	314	405.2	0.77519	0.27014	3.702	157	25.0 - 49.99	581

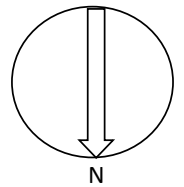
\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



US 7

Test

P



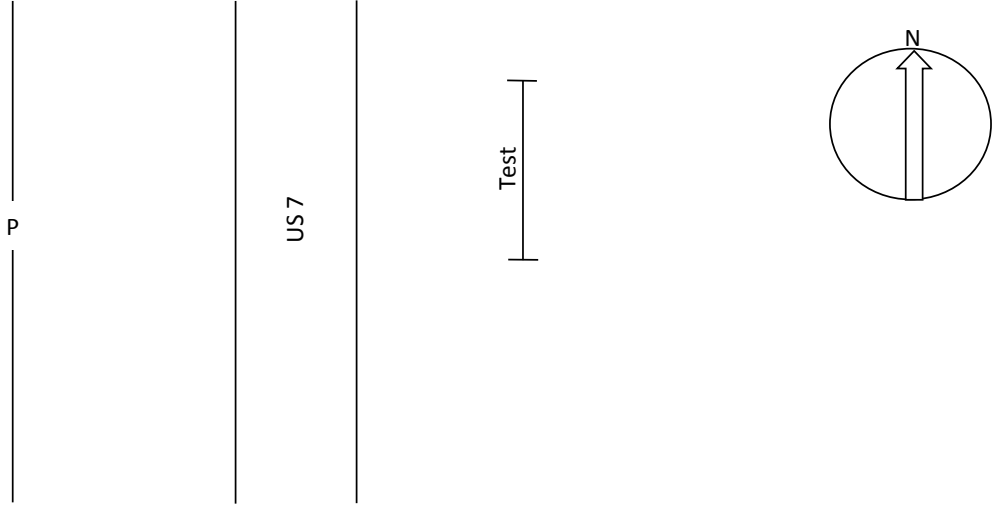
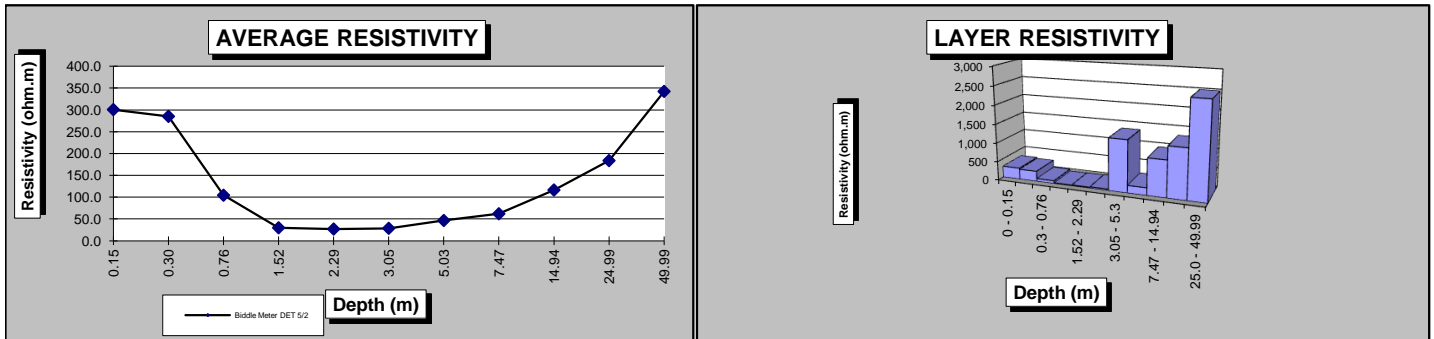
# SOIL RESISTIVITY DATA

**Project Name:** Vermont Gas Project  
 12-144-40  
**Date:** 5/5/2013  
**Location:** Rd Sd off US 7  
 44 2.3630N, 73 9.7127W  
**Testers:** KJ, LM  
**Methodology:**  $\rho = 2\pi dR$ , per ASTM G 57 & Barnes Method  
**Instrumentation:** Biddle Meter DET 5/2  
**Weather:** 61F/Clear  
**Soil Description:** Hard packed, rocky and vegetation



4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	$\Delta$ 1/R mhos	1/( $\Delta$ 1/R) ohms	Spacing Factor	Layer Resistivity*	
									Layer (m)	ohm.m
0.50	0.15	314.000	1	300.7	0.00318	n/a	n/a	n/a	0 - 0.15	301
1.00	0.30	148.900	2	285.2	0.00672	0.00353	283.190	1	0.15 - 0.3	271
2.50	0.76	21.800	5	104.4	0.04587	0.03916	25.539	3	0.3 - 0.76	73
5.00	1.52	3.110	10	29.8	0.32154	0.27567	3.628	5	0.76 - 1.52	17
7.50	2.29	1.870	14	26.9	0.53476	0.21322	4.690	5	1.52 - 2.29	22
10.00	3.05	1.490	19	28.5	0.67114	0.13638	7.332	5	2.29 - 3.05	35
16.50	5.03	1.470	32	46.5	0.68027	0.00913	109.515	12	3.05 - 5.3	1,363
24.50	7.47	1.320	47	61.9	0.75758	0.07730	12.936	15	5.03 - 7.47	198
49.00	14.94	1.240	94	116.4	0.80645	0.04888	20.460	47	7.47 - 14.94	960
82.00	24.99	1.170	157	183.7	0.85470	0.04825	20.726	63	14.94 - 25.0	1,310
164.00	49.99	1.090	314	342.3	0.91743	0.06273	15.941	157	25.0 - 49.99	2,503

\* Layer Resistivity may not correlate with Average Resistivity because of soil characteristic variations with depth



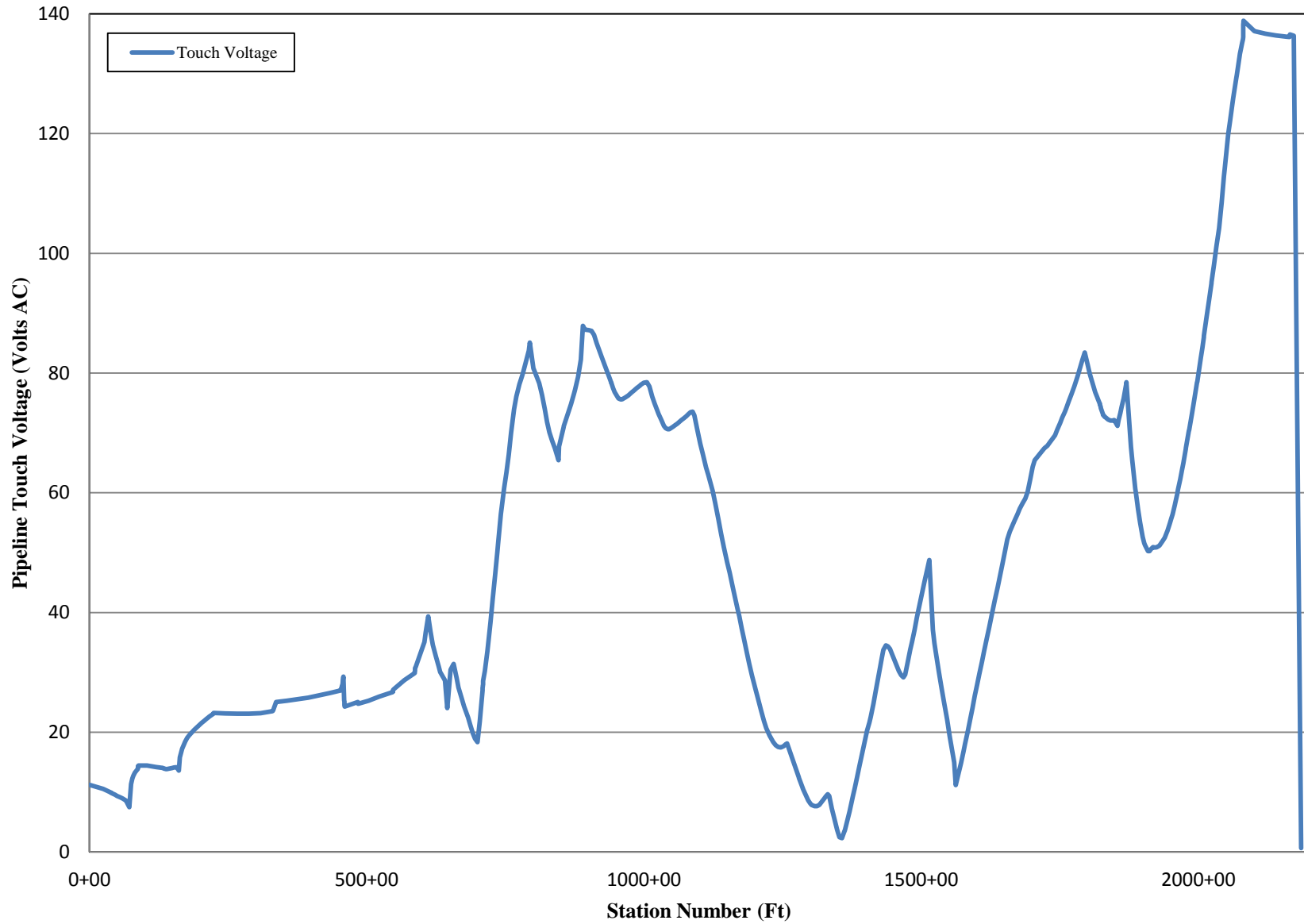
APPENDIX B –  
PIPELINE STEADY STATE, AC CURRENT DENSITY & FAULT PLOTS

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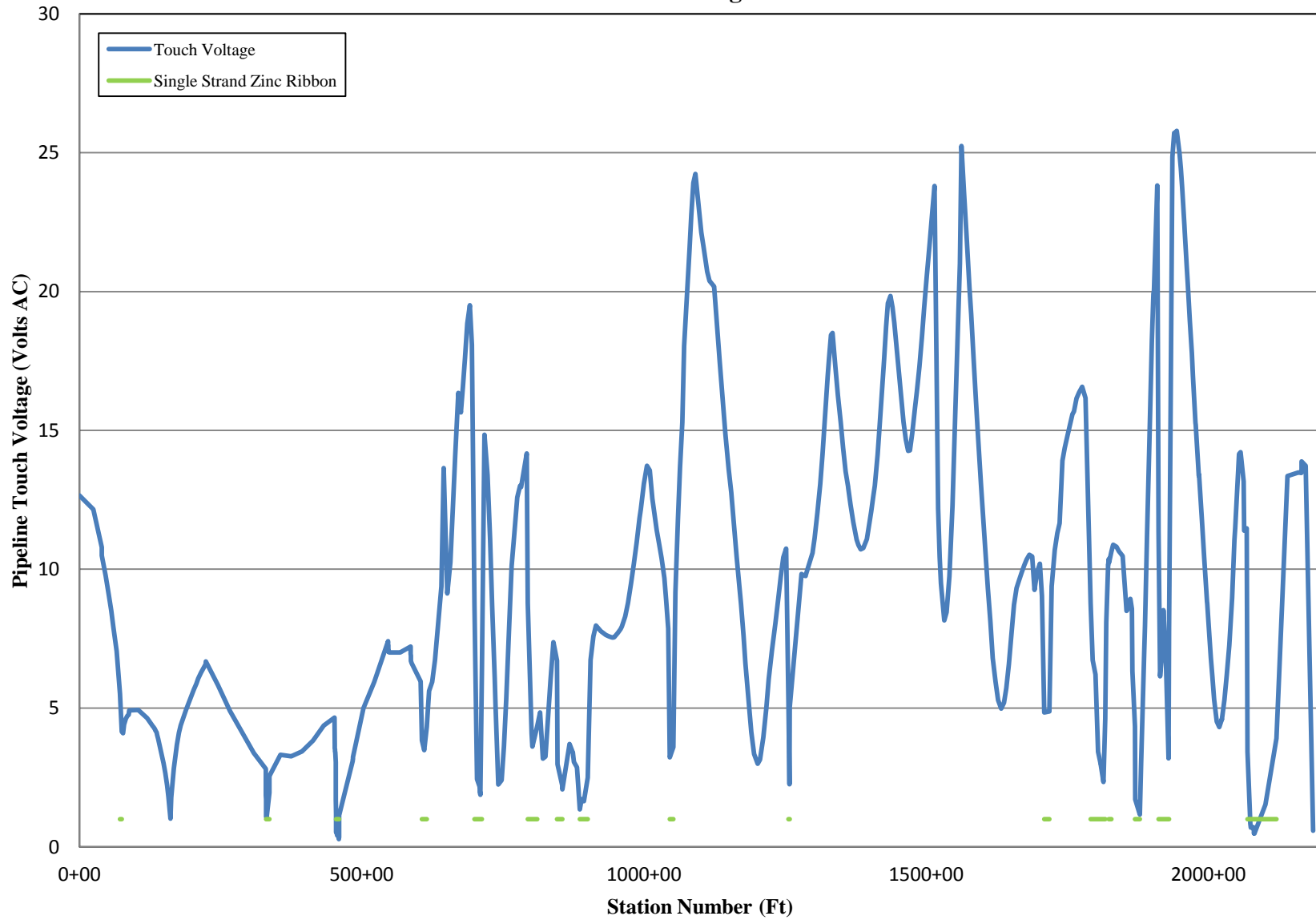
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## **STEADY STATE INDUCED**

### Coler & Colantonio - Vermont Gas Pipeline Project: 12" Proposed Pipeline Modeled AC Touch Voltage



Coler & Colantonio - Vermont Gas Pipeline Project: 12" Proposed Pipeline  
Modeled AC Touch Voltage  
With Mitigation

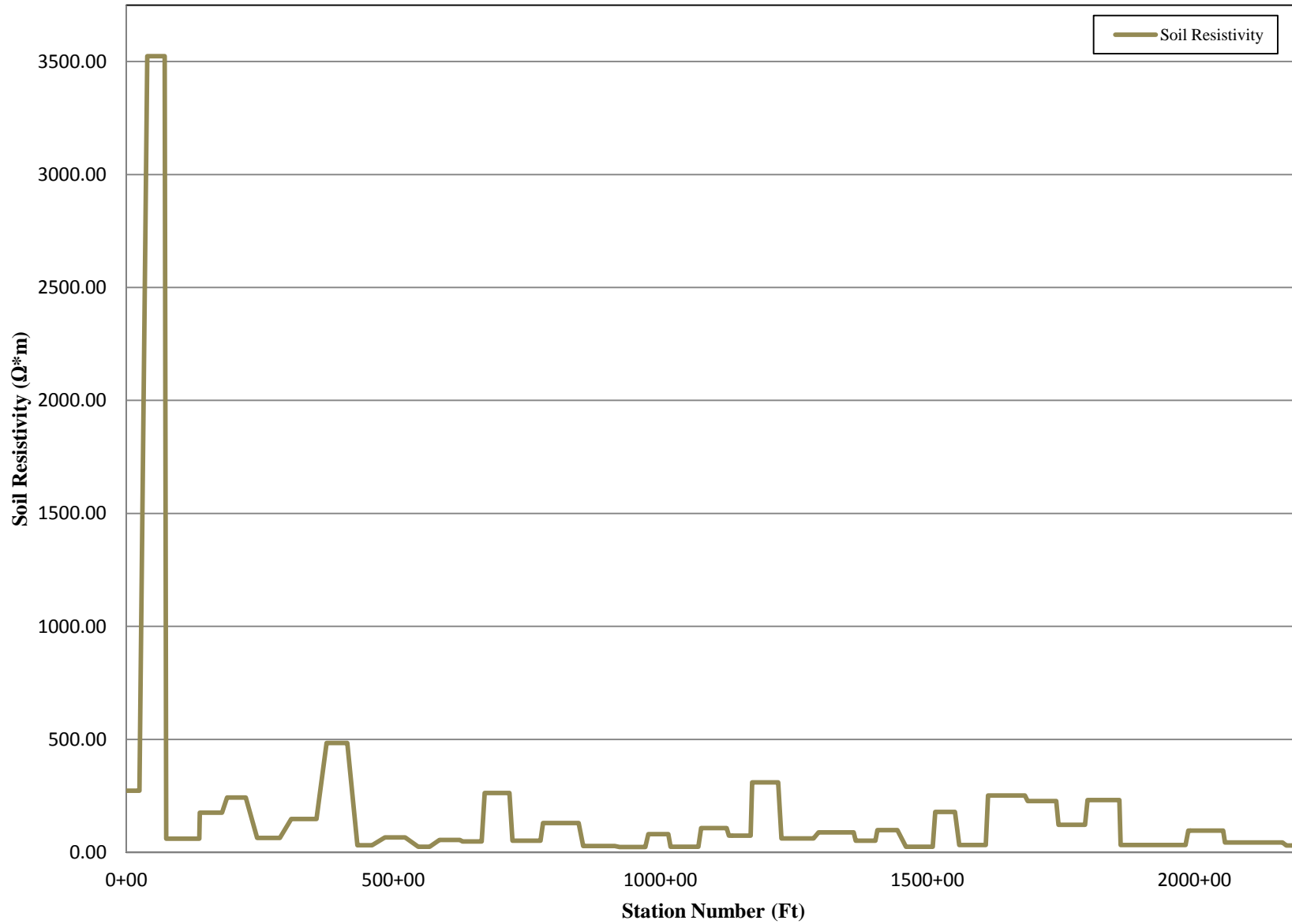


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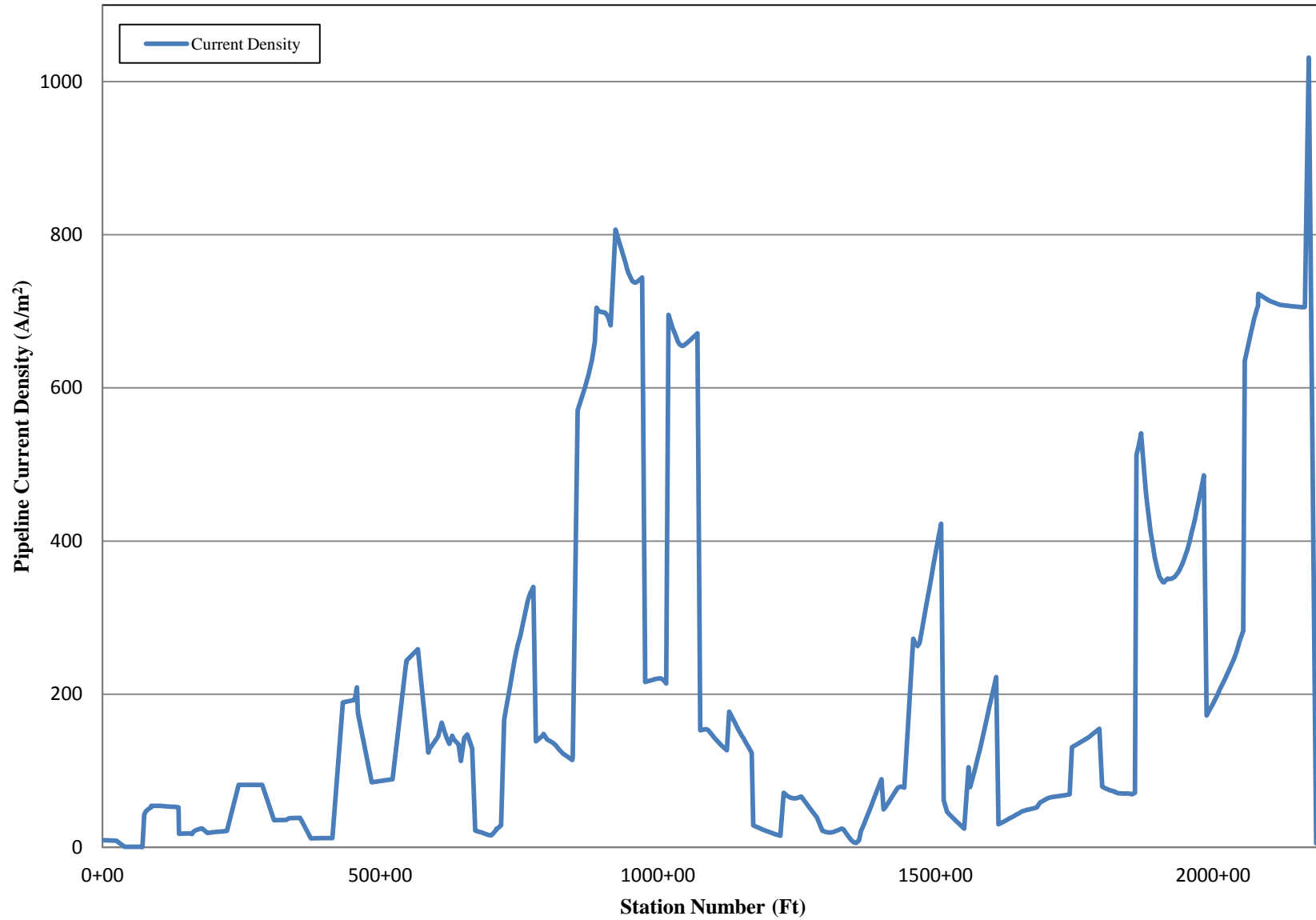
## CURRENT DENSITY



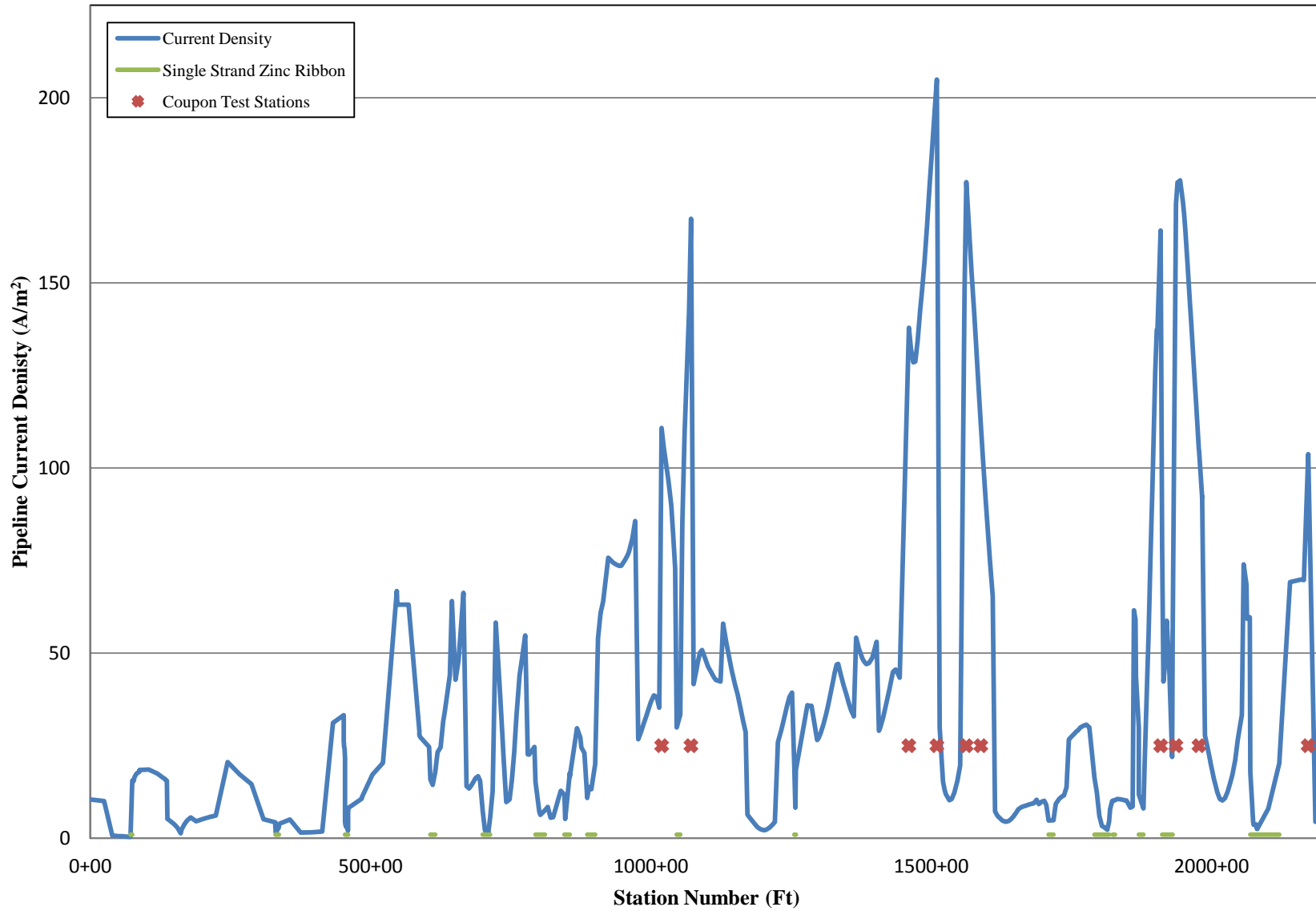
### Coler & Colantonio - Vermont Gas Pipeline Project: 12" Proposed Pipeline Measured Soil Resistivity



# Coler & Colantonio - Vermont Gas Pipeline Project: 12" Proposed Pipeline AC Current Density



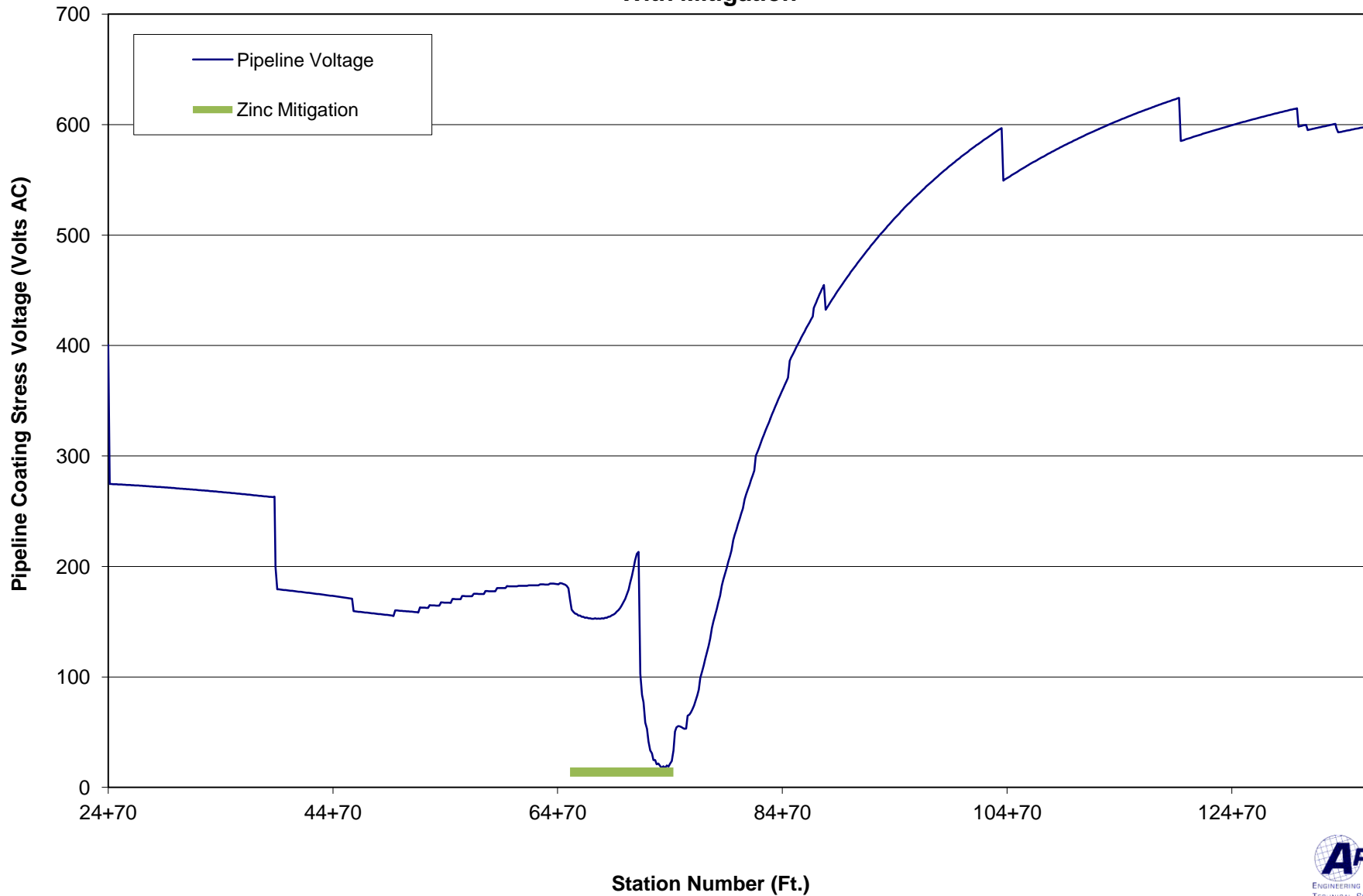
Coler & Colantonio - Vermont Gas Pipeline Project: 12" Proposed Pipeline  
AC Current Density  
With Mitigation



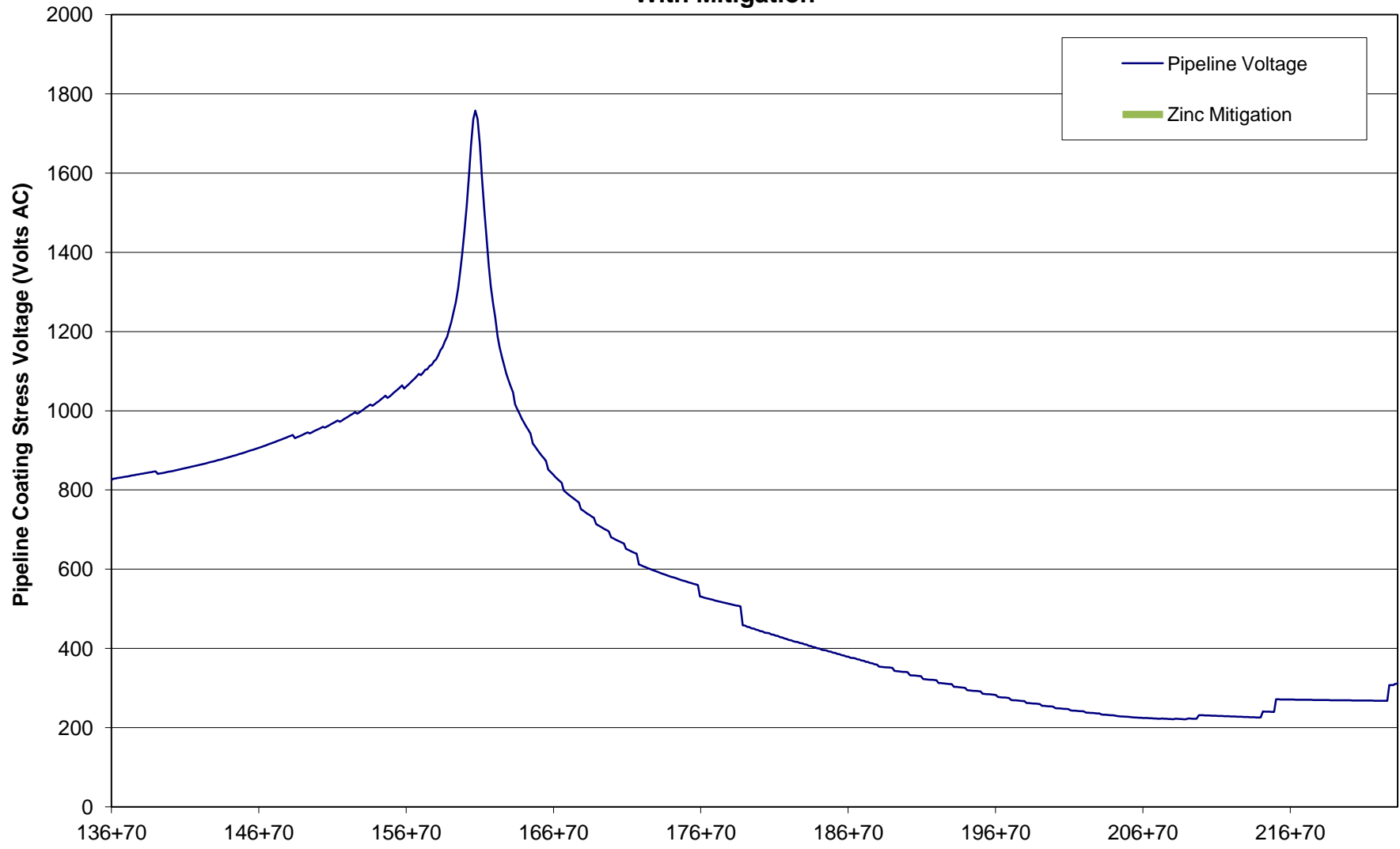
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## **FAULT – COATING STRESS VOLTAGE**

Coler & Colantonio - Vermont Gas Pipeline Project:  
12" Proposed Pipeline Coating Stress Voltage  
During Fault on 115 kV K22 Line  
With Mitigation

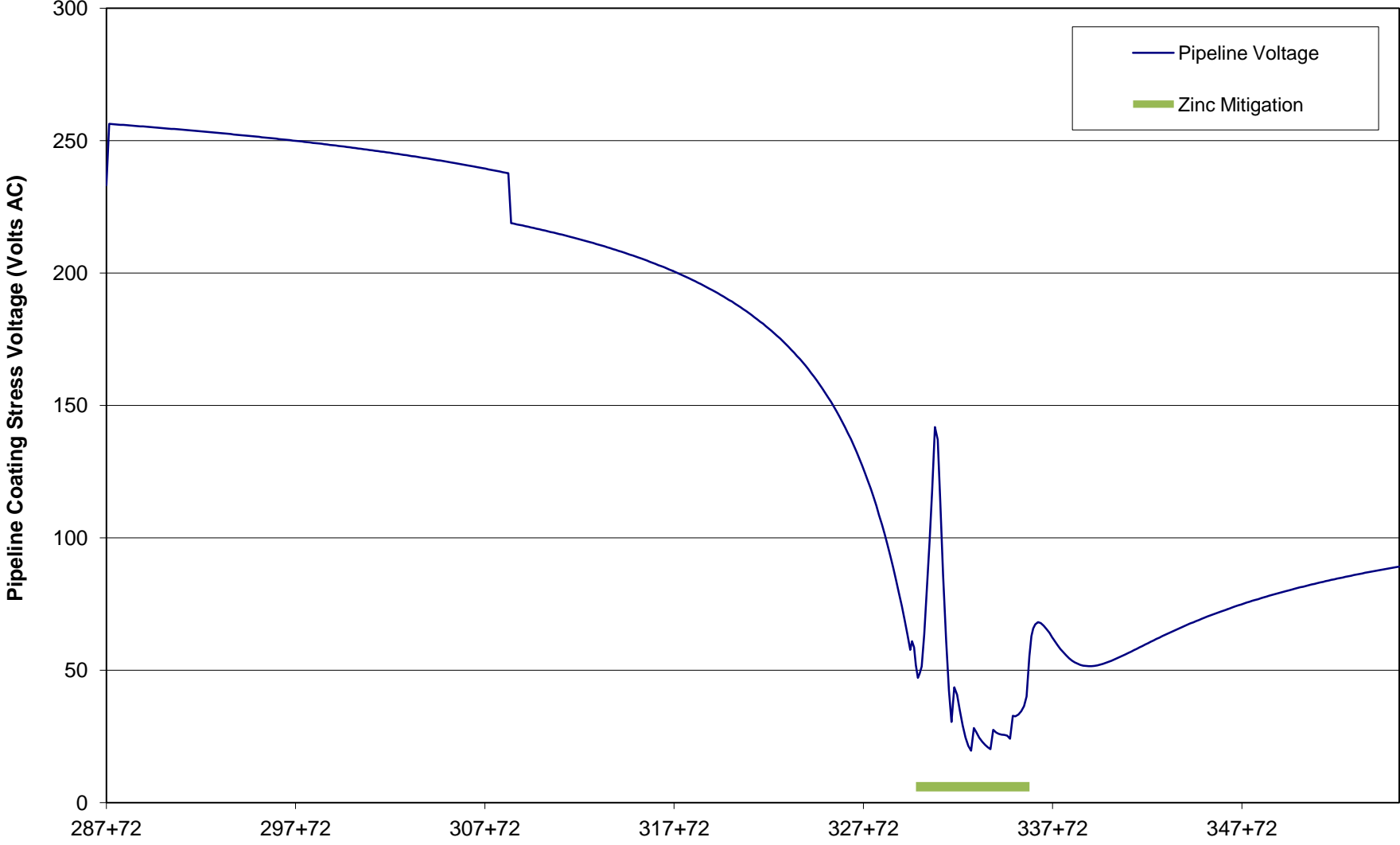


Coler & Colantonio - Vermont Gas Pipeline Project:  
12" Proposed Pipeline Coating Stress Voltage  
During Fault on 115 kV K21 Line  
With Mitigation



Station Number (Ft.)

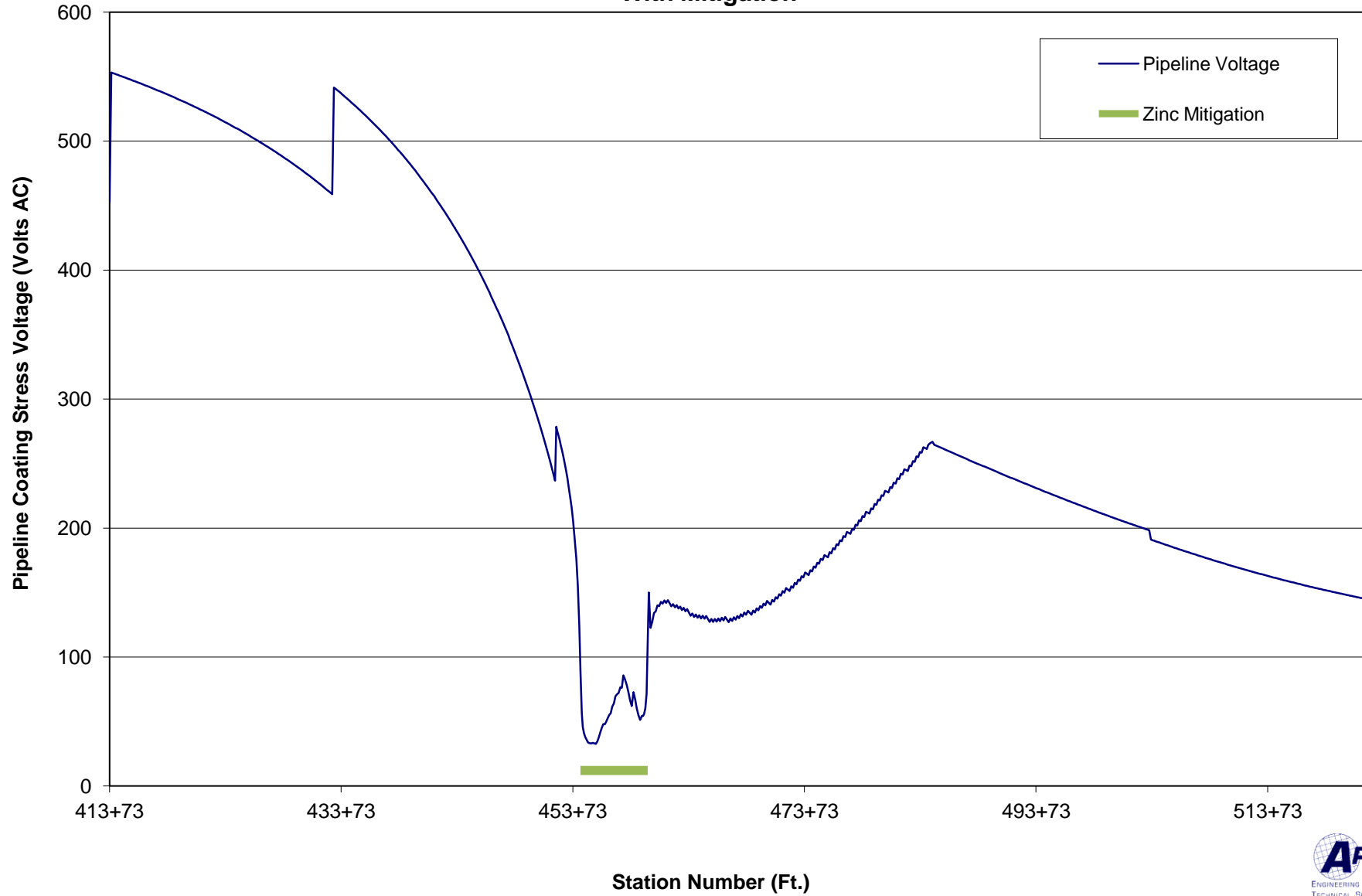
**Coler & Colantonio - Vermont Gas Pipeline Project:  
12" Proposed Pipeline Coating Stress Voltage  
During Fault on 34.5 kV Green Mountain Power Line  
With Mitigation**



Station Number (Ft.)

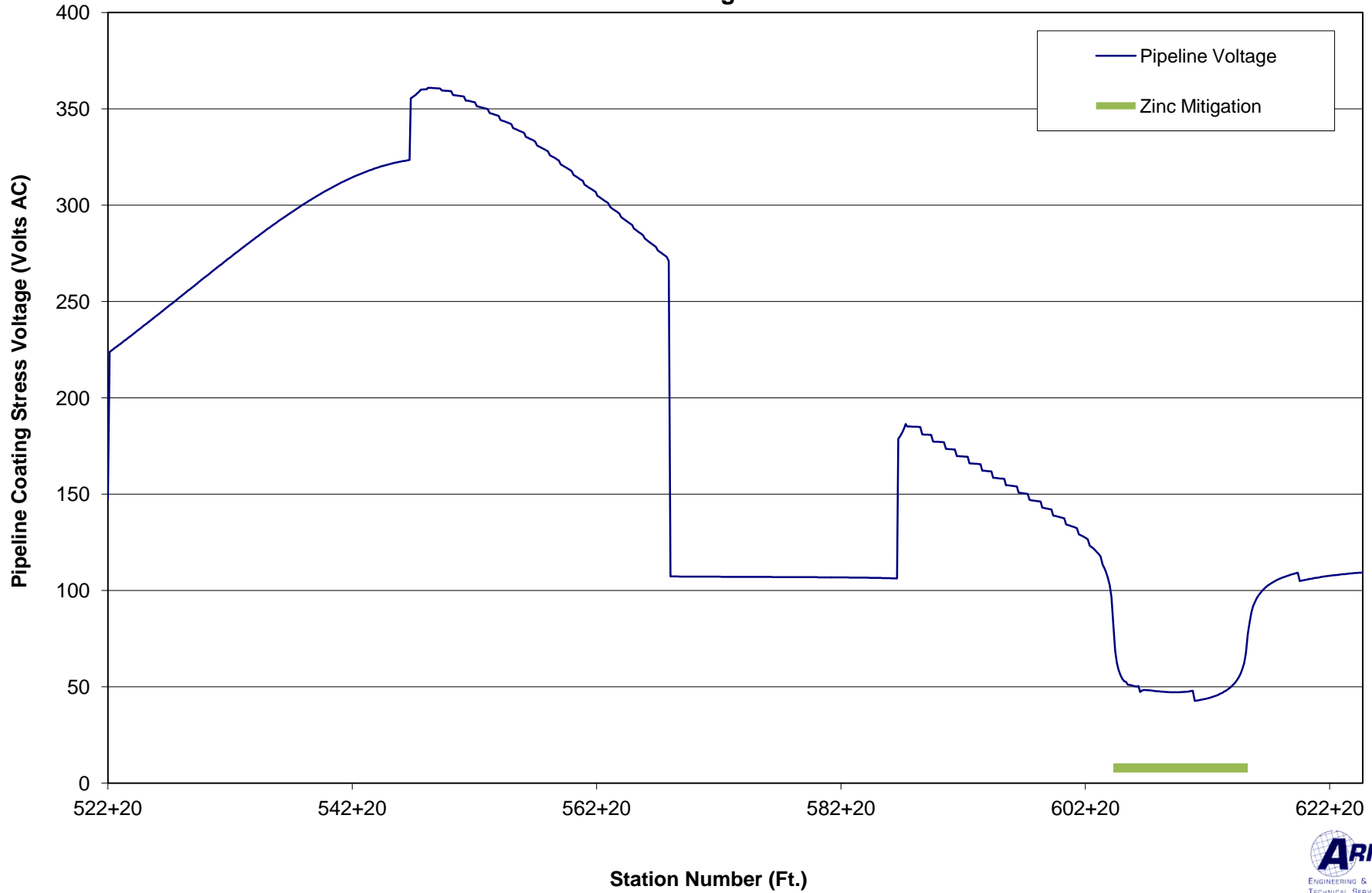


**Coler & Colantonio - Vermont Gas Pipeline Project:  
12" Proposed Pipeline Coating Stress Voltage  
During Fault on 115 kV K24 Line  
With Mitigation**

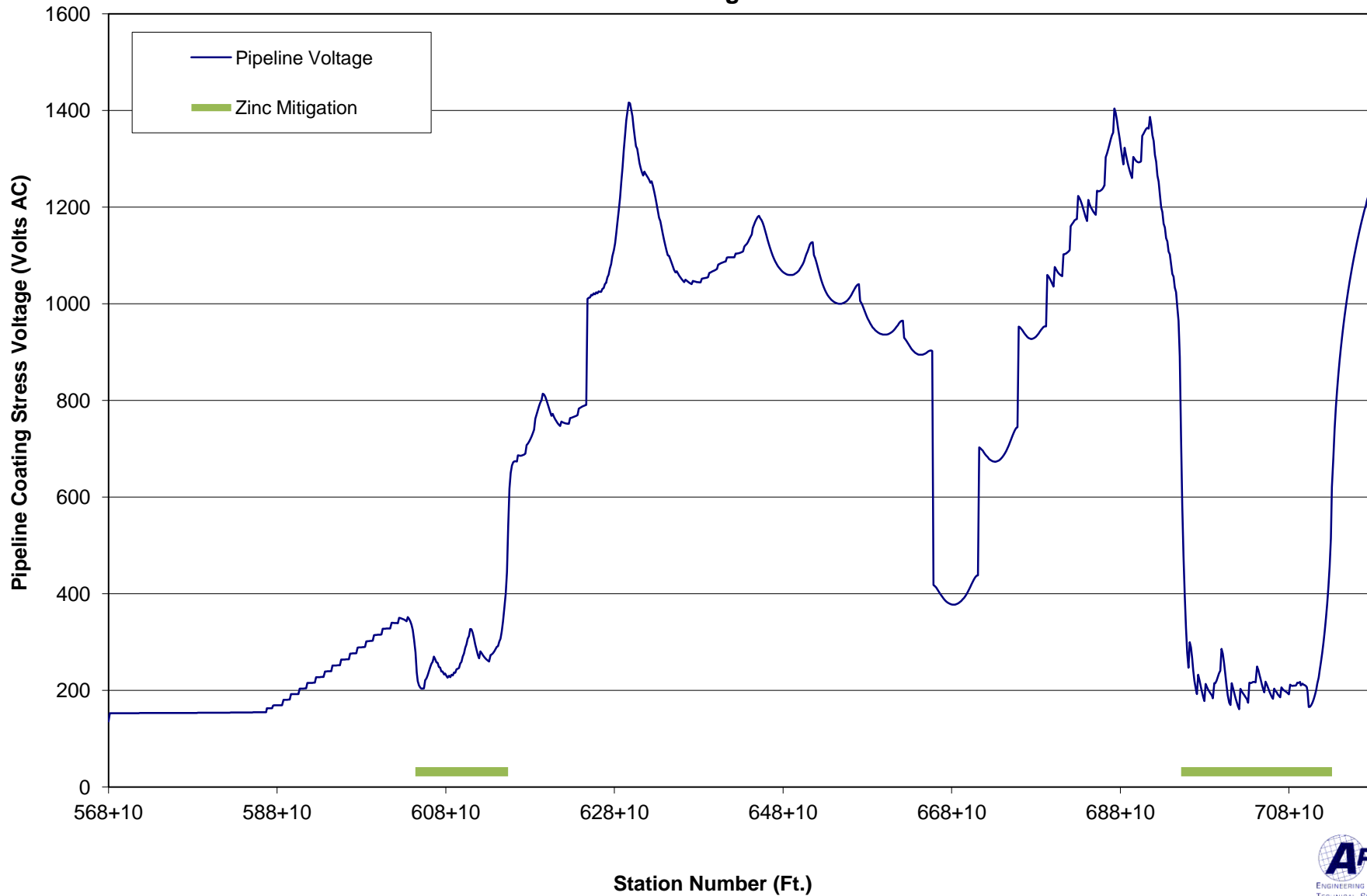




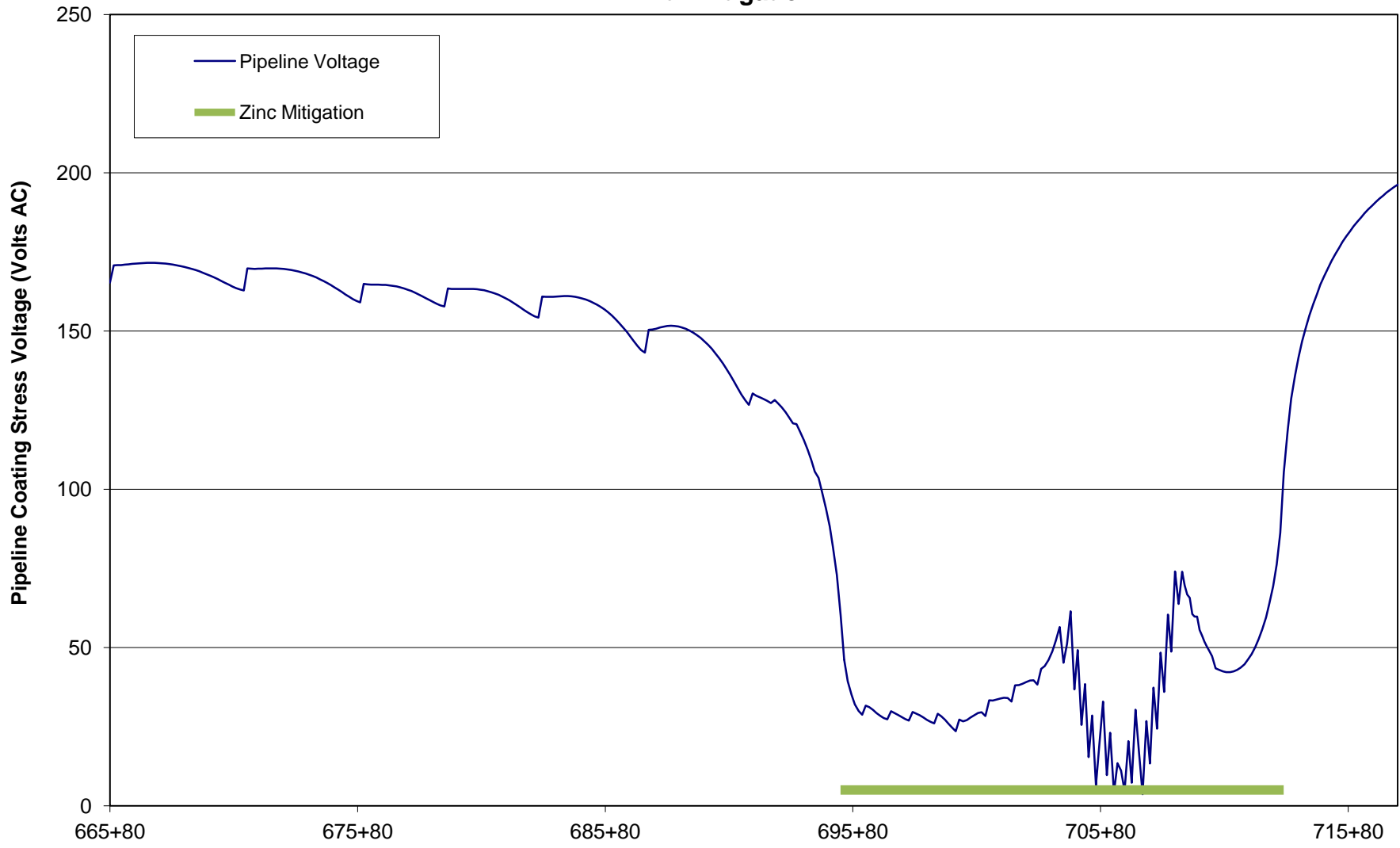
**Coler & Colantonio - Vermont Gas Pipeline Project:  
12" Proposed Pipeline Coating Stress Voltage  
During Fault on 115 kV K23 Line  
With Mitigation**



**Coler & Colantonio - Vermont Gas Pipeline Project:  
12" Proposed Pipeline Coating Stress Voltage  
During Fault on 115 kV K27 Line  
With Mitigation**

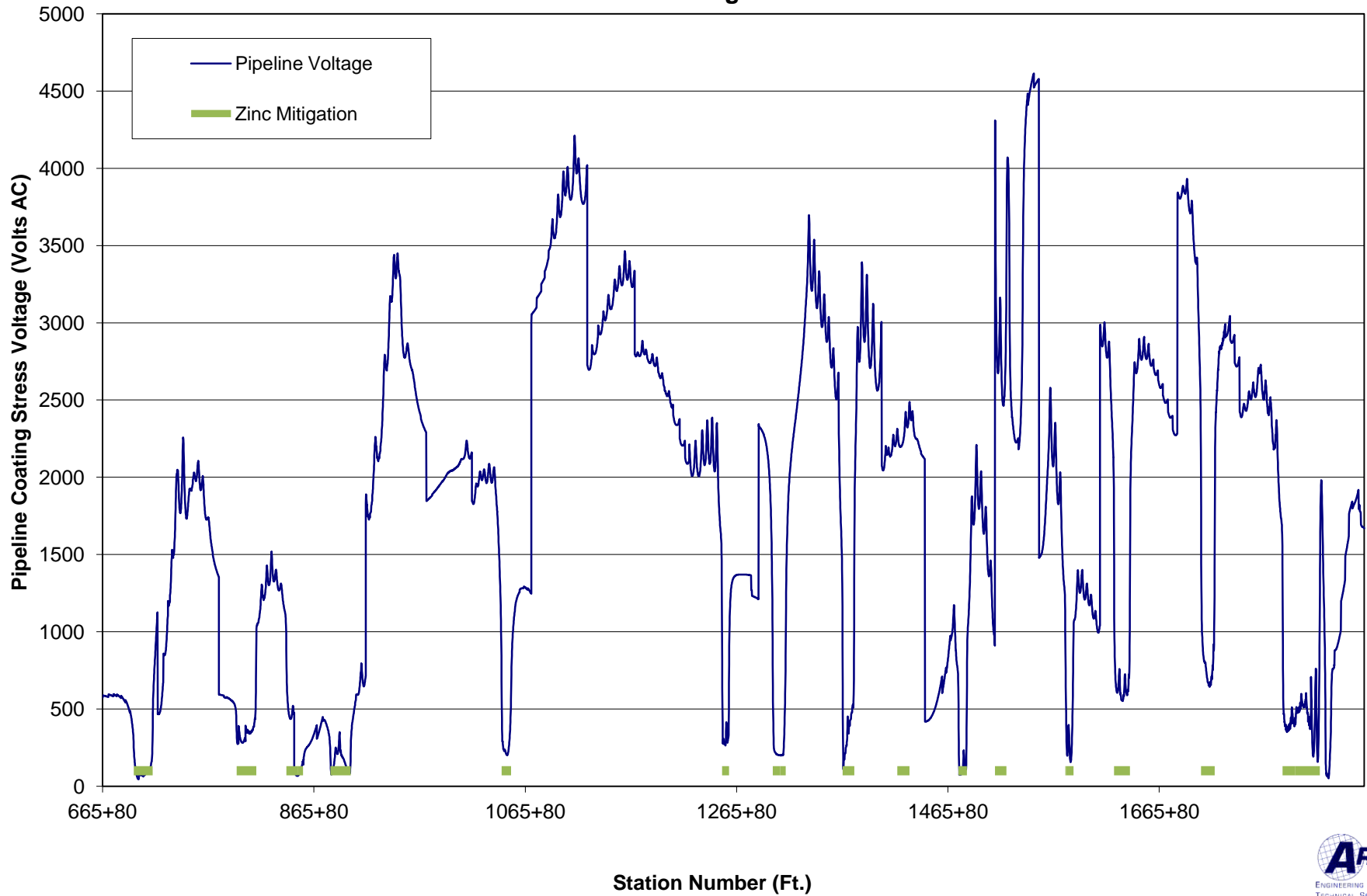


**Coler & Colantonio - Vermont Gas Pipeline Project:  
12" Proposed Pipeline Coating Stress Voltage  
During Fault on 115 kV K33 Line  
With Mitigation**

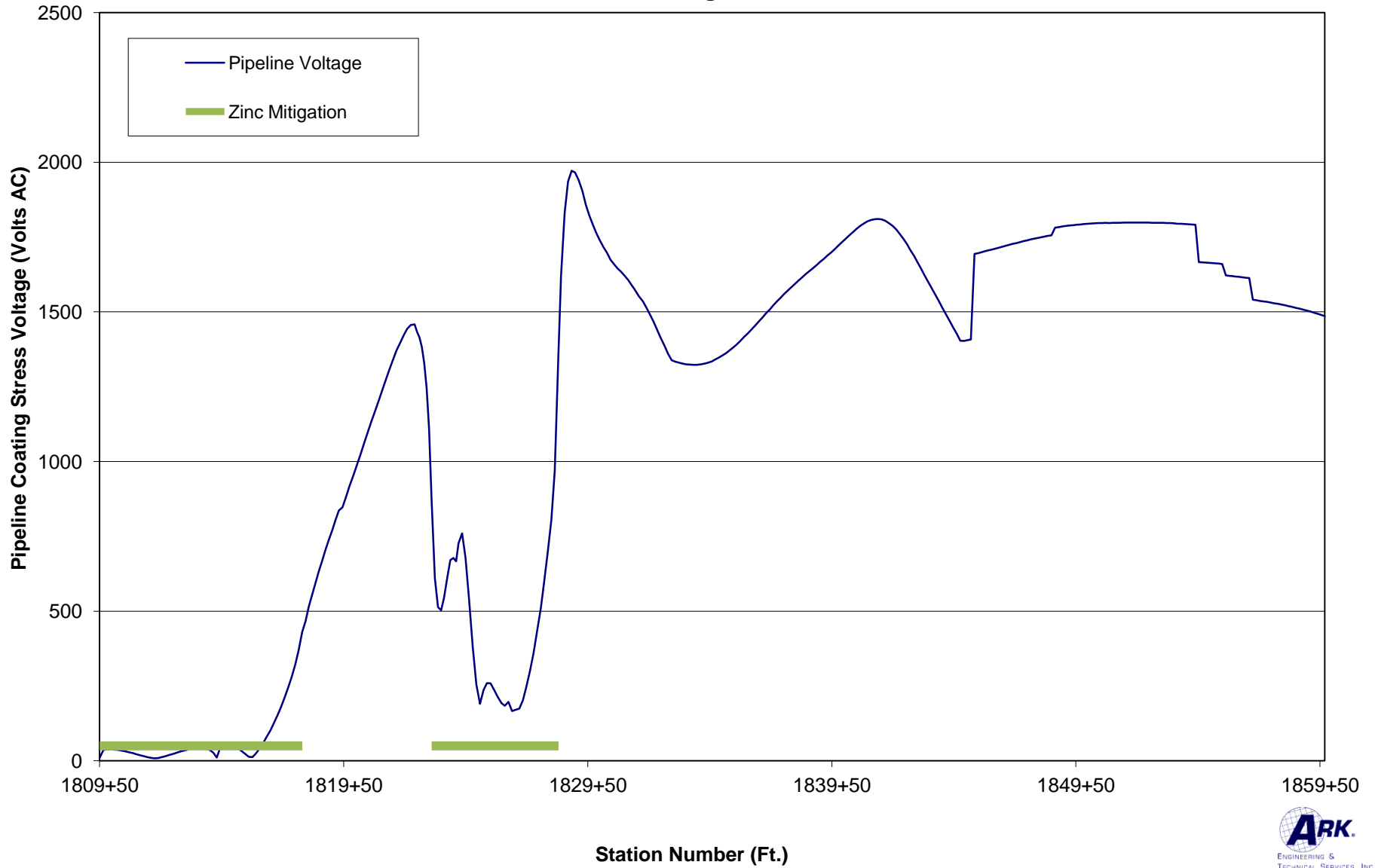


Station Number (Ft.)

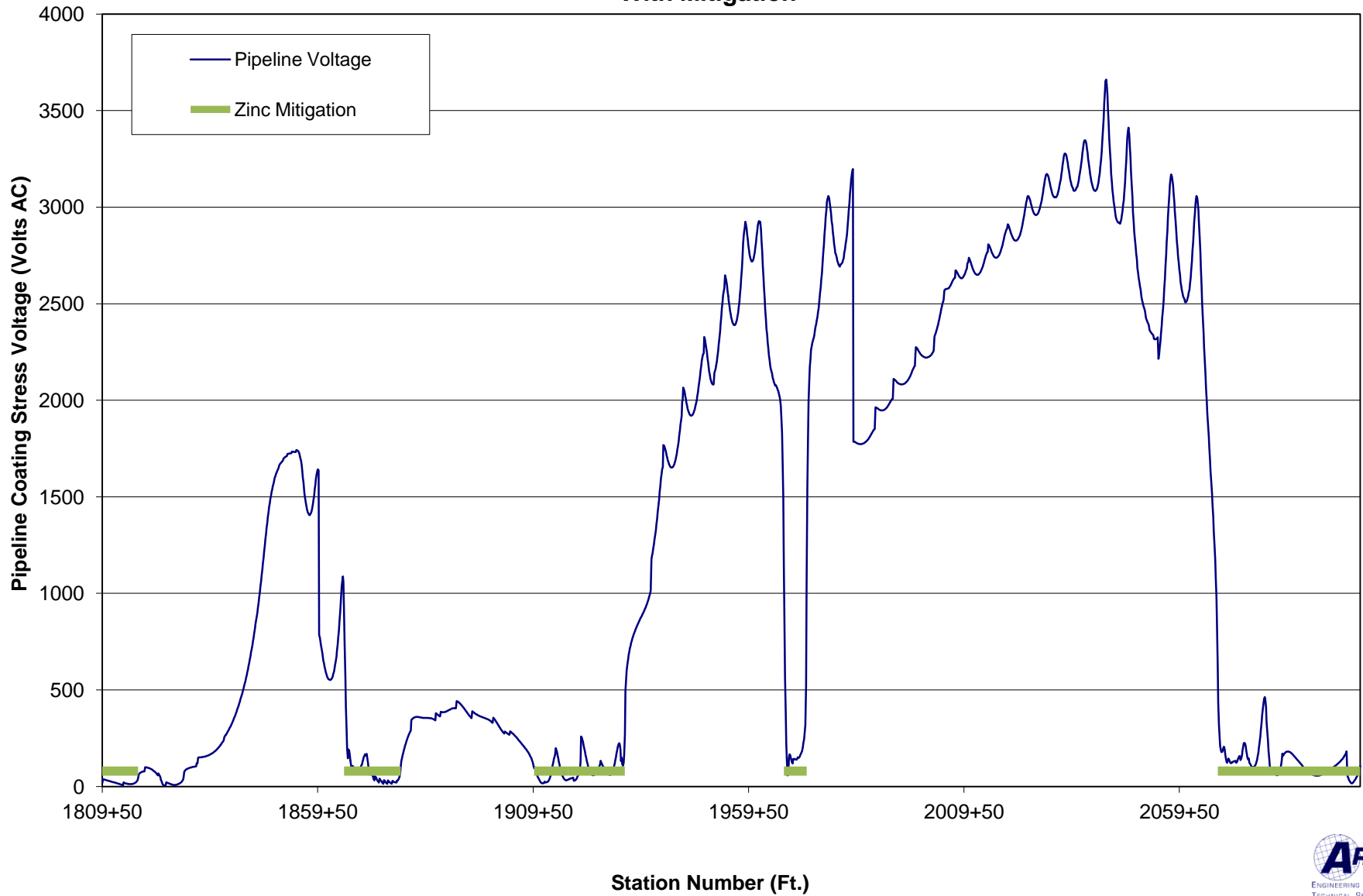
**Coler & Colantonio - Vermont Gas Pipeline Project:  
12" Proposed Pipeline Coating Stress Voltage  
During Fault on 115 kV K43 Line  
With Mitigation**



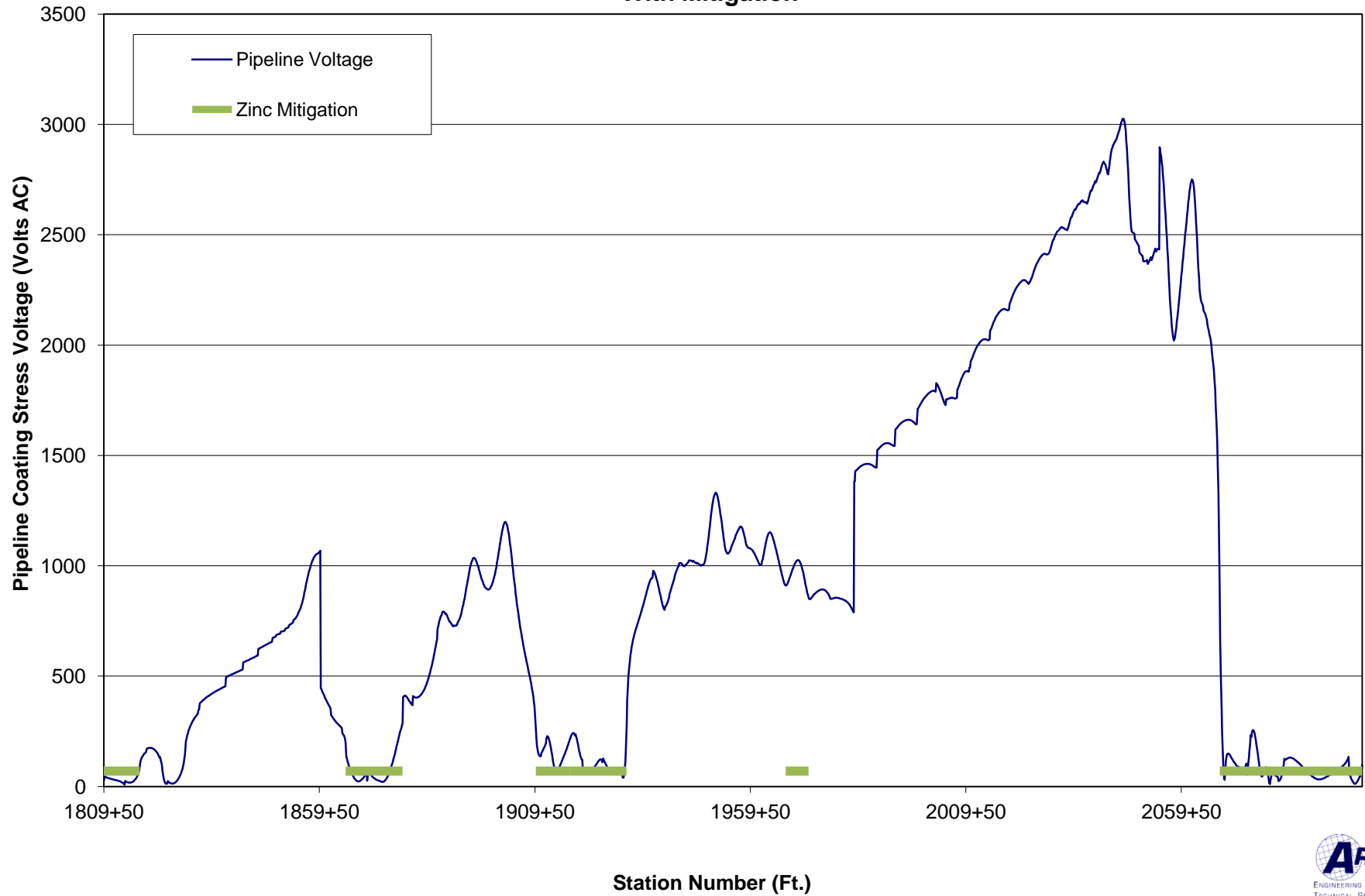
**Coler & Colantonio - Vermont Gas Pipeline Project:  
12" Proposed Pipeline Coating Stress Voltage  
During Fault on 115 kV K64 Line  
With Mitigation**



**Coler & Colantonio - Vermont Gas Pipeline Project:  
12" Proposed Pipeline Coating Stress Voltage  
During Fault on 115 kV K63 Line  
With Mitigation**



**Coler & Colantonio - Vermont Gas Pipeline Project:  
12" Proposed Pipeline Coating Stress Voltage  
During Fault on 345 kV K370 Line  
With Mitigation**

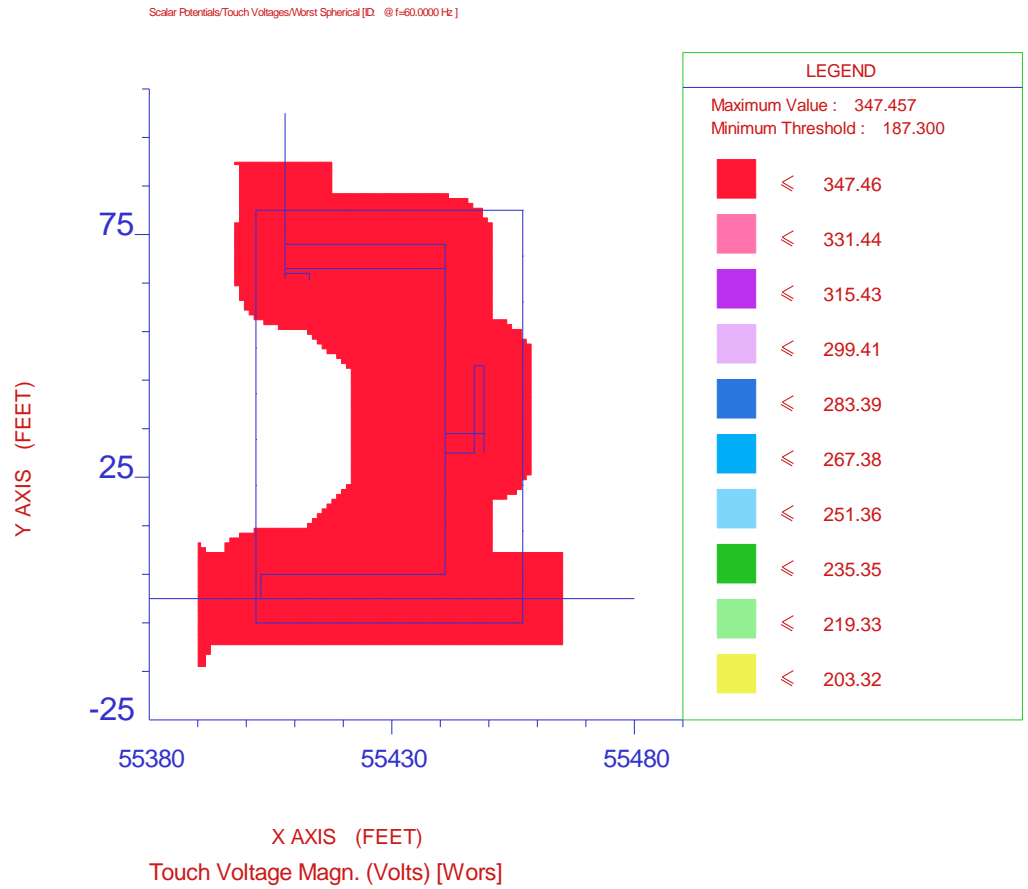


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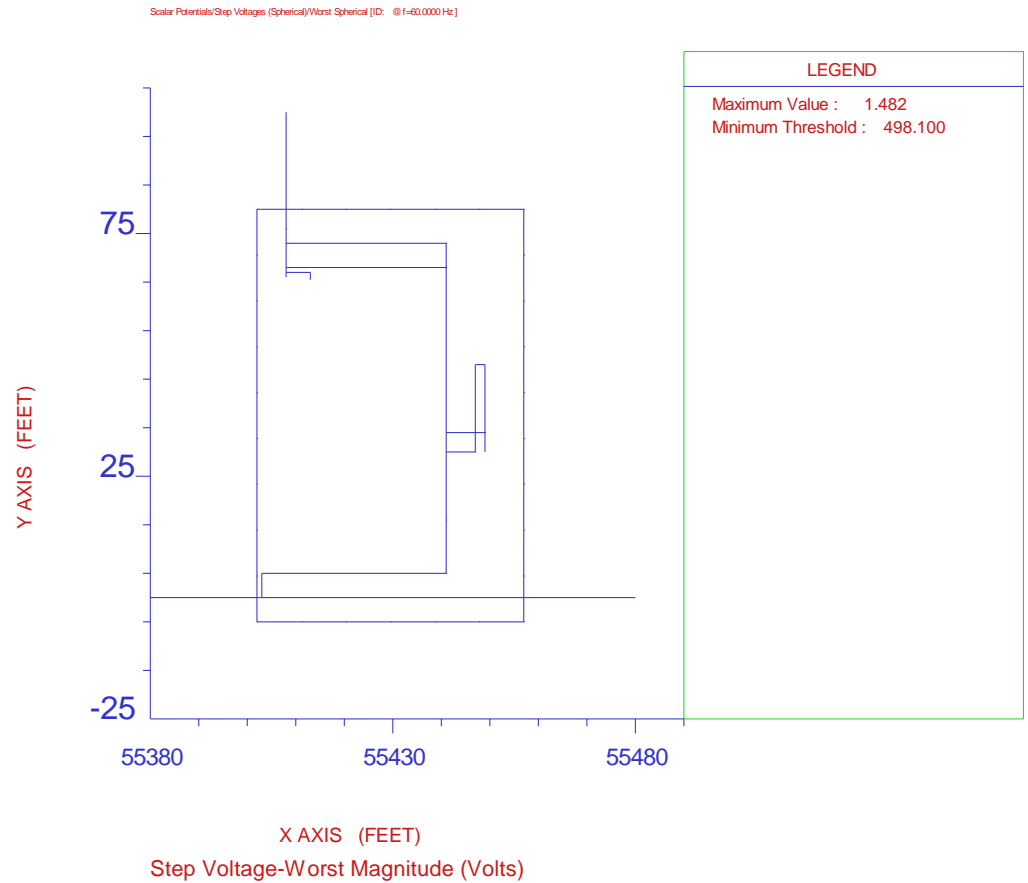
## **FAULT – TOUCH & STEP VOLTAGES**



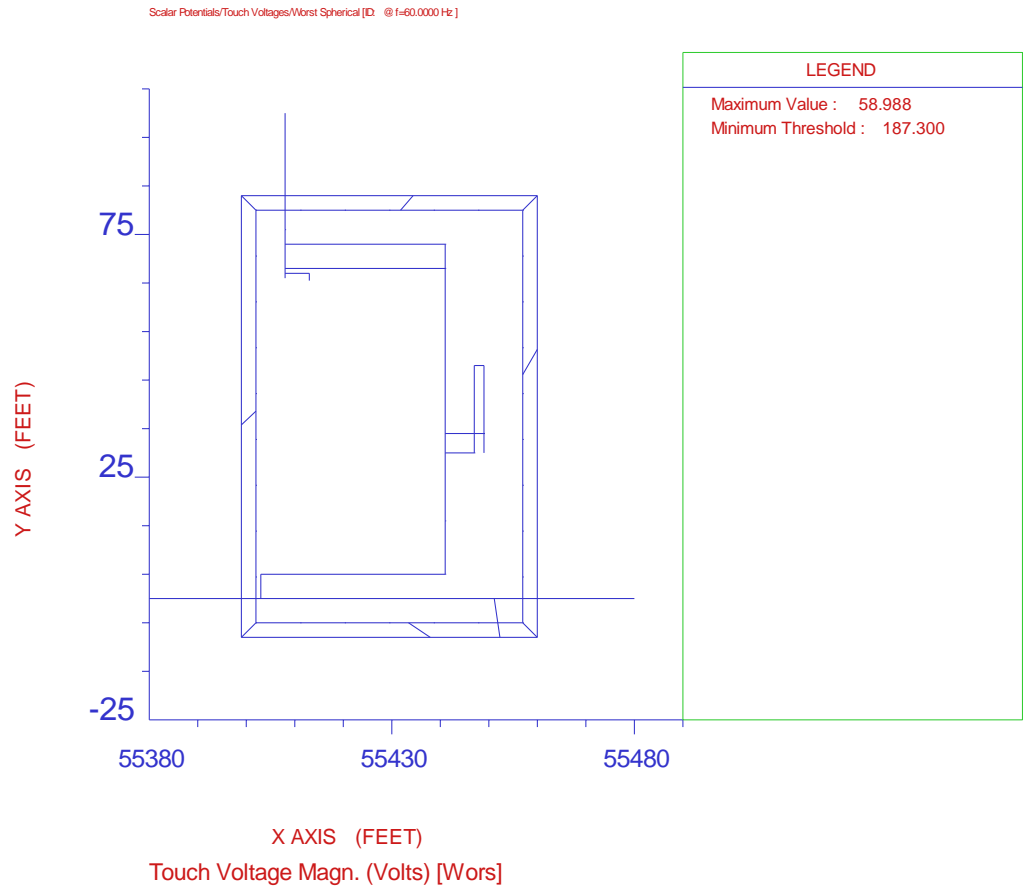
**Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline**  
**Williston M&R @ MP 10.43**  
**Faulted at Velco 115 kV K23 Tower**  
**Touch Voltages – Safety Limit 187.3 Volts.**



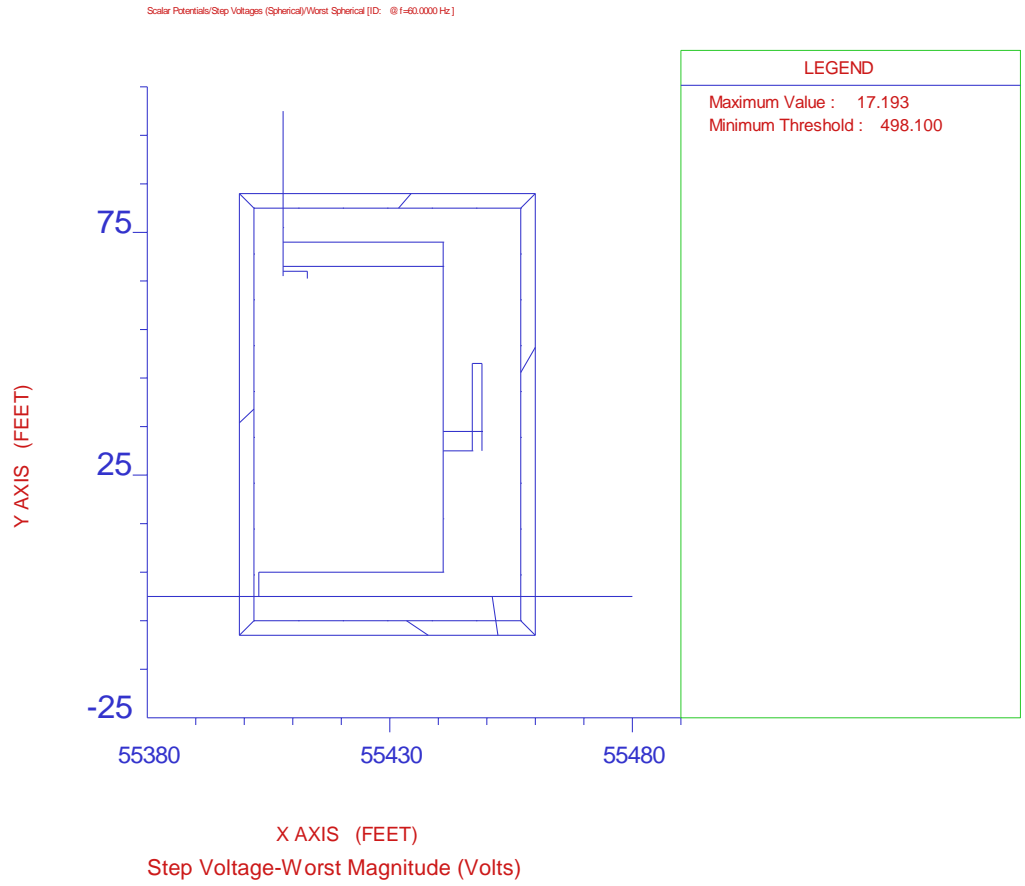
**Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline  
Williston M&R @ MP 10.43  
Faulted at Velco 115 kV K23 Tower  
Step Voltages – Safety Limit 498.1 Volts.**



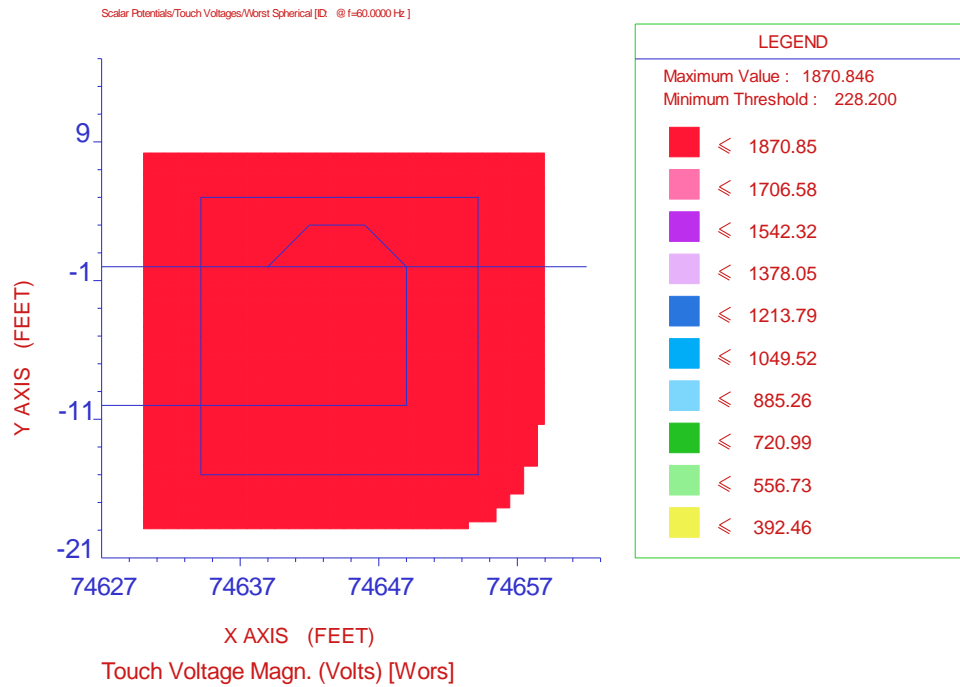
**Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline  
Williston M&R @ MP 10.43  
Faulted at Velco 115 kV K23 Tower  
Touch Voltages – Safety Limit 187.3 Volts.  
With Mitigation**



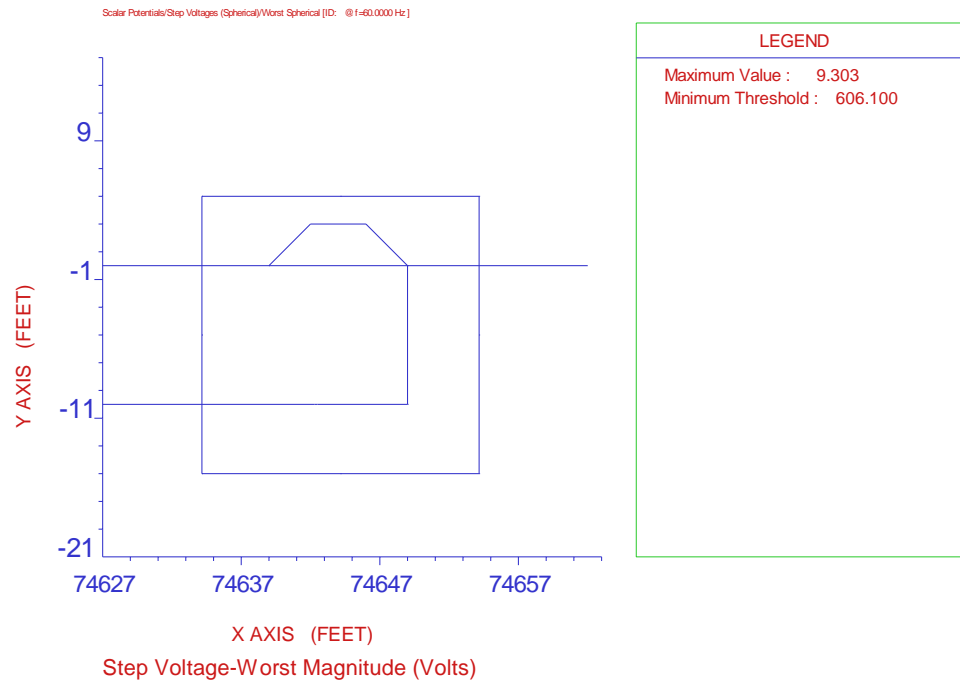
**Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline  
Williston M&R @ MP 10.43  
Faulted at Velco 115 kV K23 Tower  
Step Voltages – Safety Limit 498.1 Volts.  
With Mitigation**



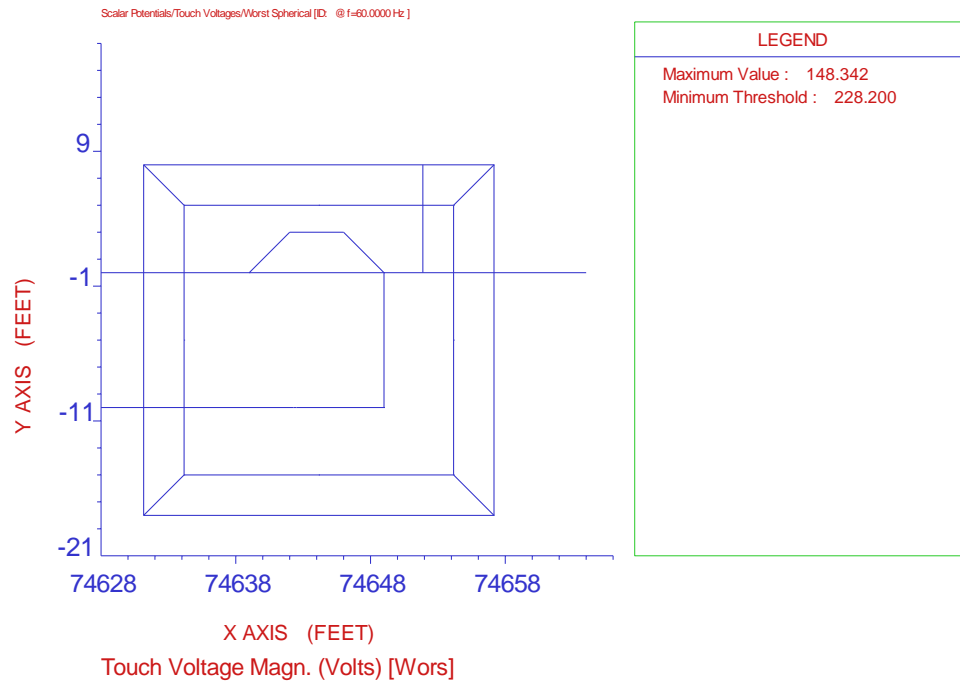
**Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline**  
**MLV-2 @ MP 14.3**  
**Faulted at Velco 115 kV K43 Tower**  
**Touch Voltages – Safety Limit 228.2 Volts.**



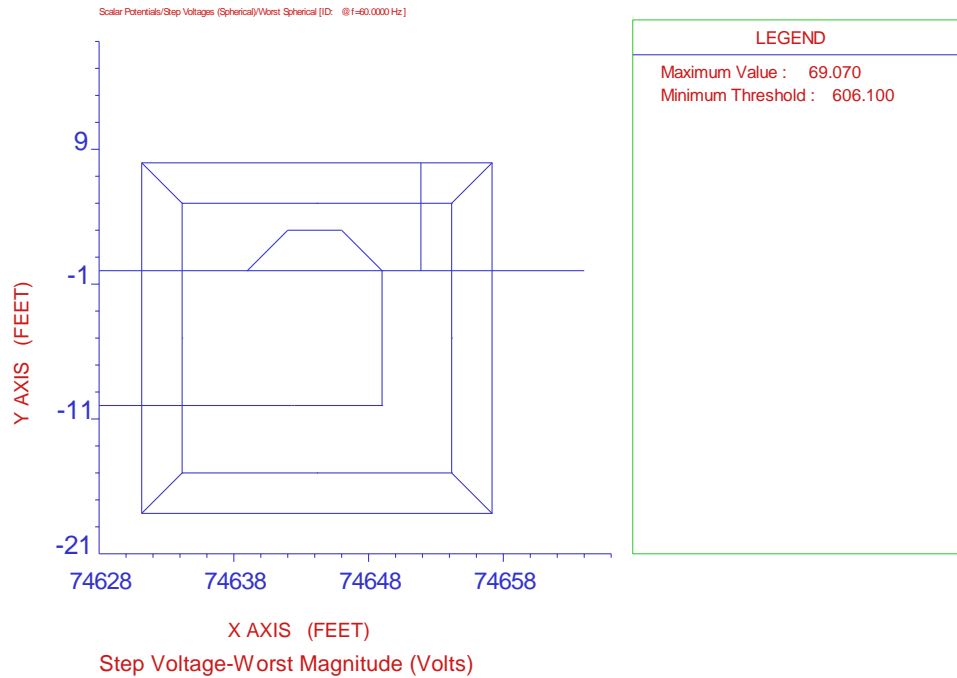
**Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline  
MLV-2 @ MP 14.3  
Faulted at Velco 115 kV K43 Tower  
Step Voltages – Safety Limit 606.1 Volts.**



**Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline  
MLV-2 @ MP 14.3  
Faulted at Velco 115 kV K43 Tower  
Touch Voltages – Safety Limit 228.2 Volts.  
With Mitigation**

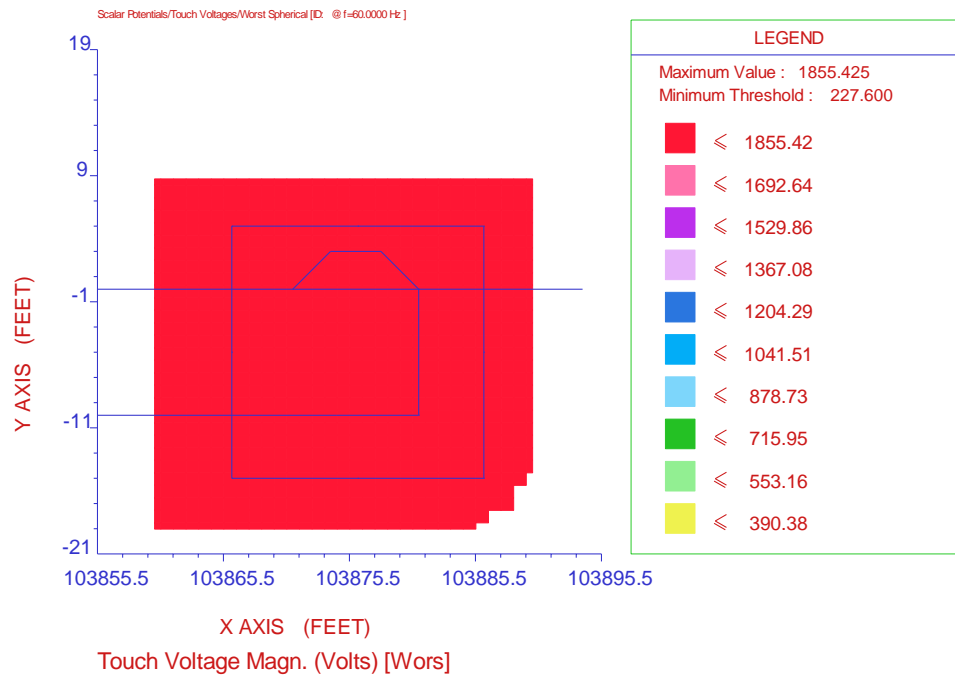


**Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline  
MLV-2 @ MP 14.3  
Faulted at Velco 115 kV K43 Tower  
Step Voltages – Safety Limit 606.1 Volts.  
With Mitigation**

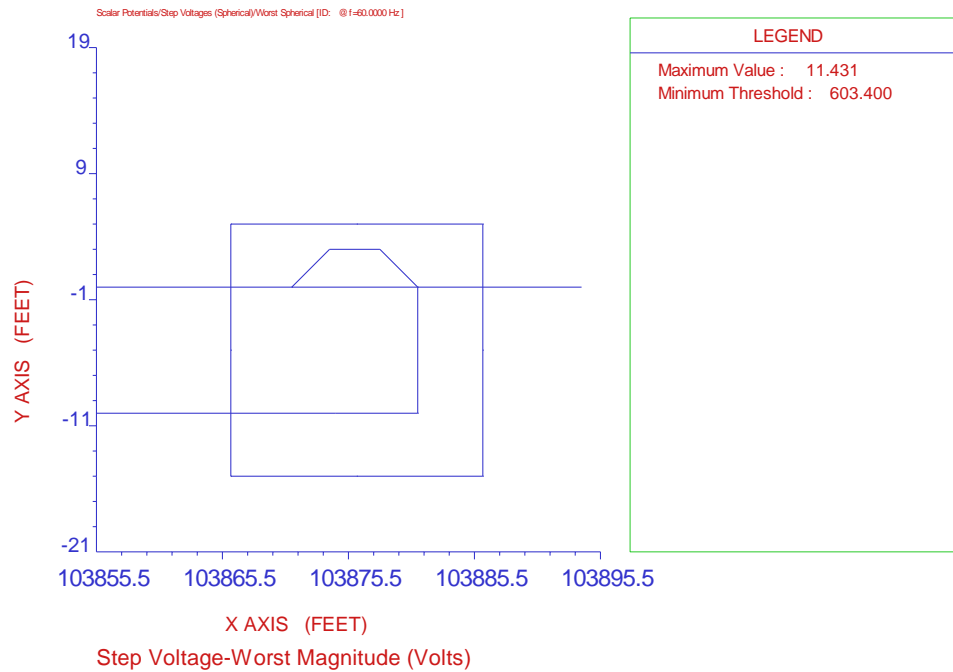




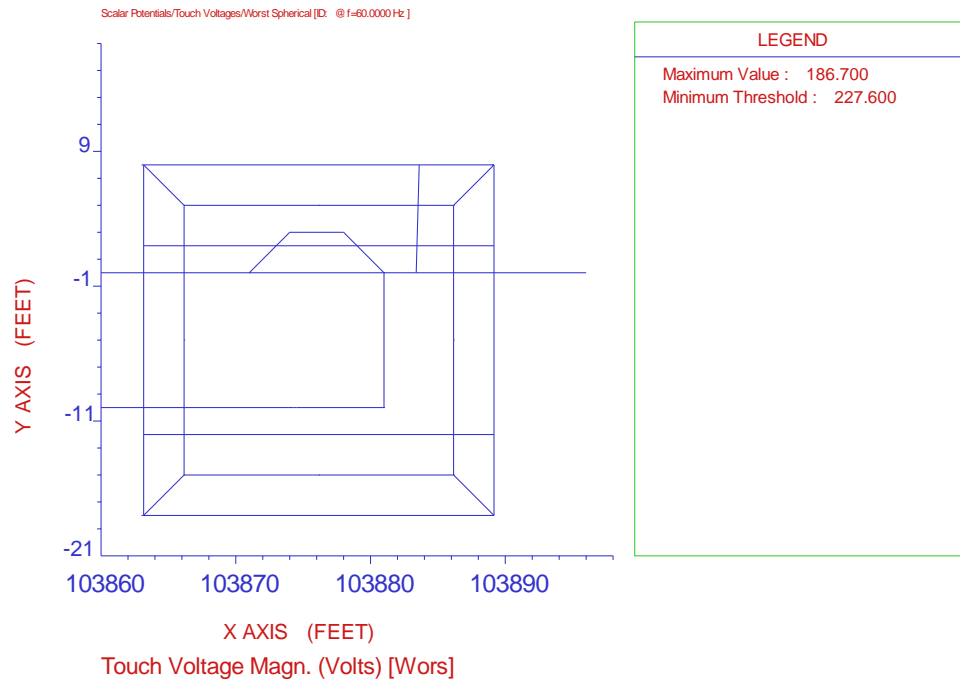
**Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline**  
**MLV-3 @ MP 19.81**  
**Faulted at Velco 115 kV K43 Tower**  
**Touch Voltages – Safety Limit 227.6 Volts.**



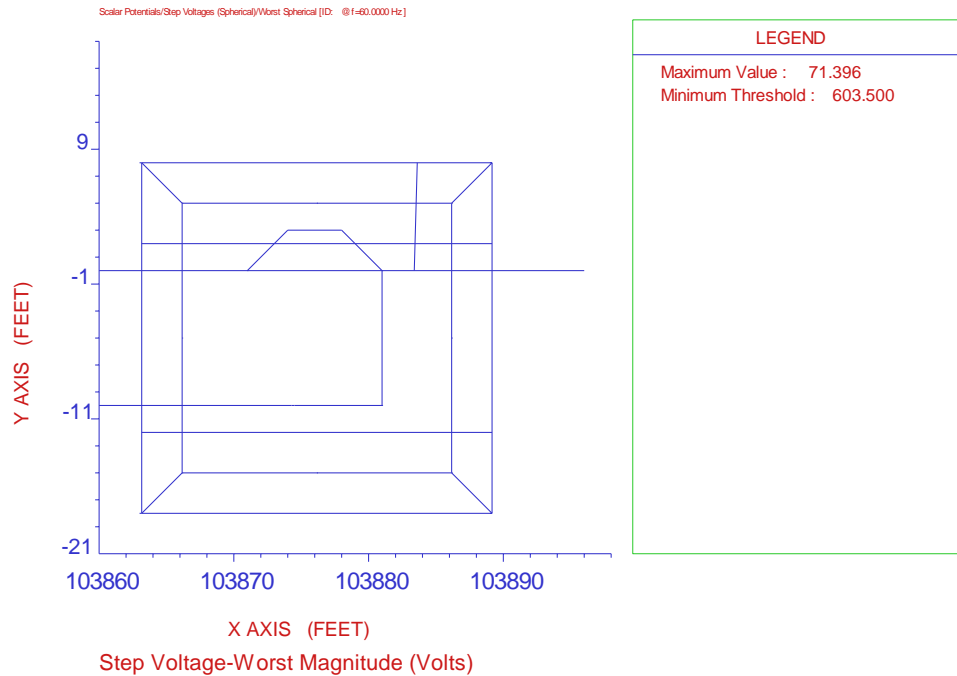
**Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline  
MLV-3 @ MP 19.81  
Faulted at Velco 115 kV K43 Tower  
Step Voltages – Safety Limit 603.4 Volts.**



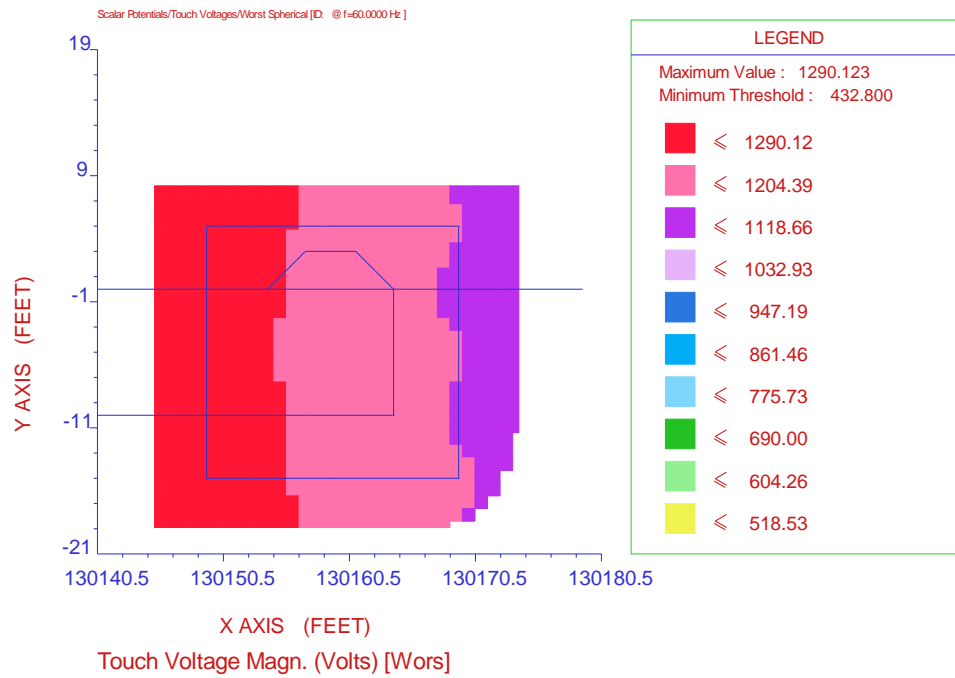
**Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline  
MLV-3 @ MP 19.81  
Faulted at Velco 115 kV K43 Tower  
Touch Voltages – Safety Limit 227.6 Volts.  
With Mitigation**



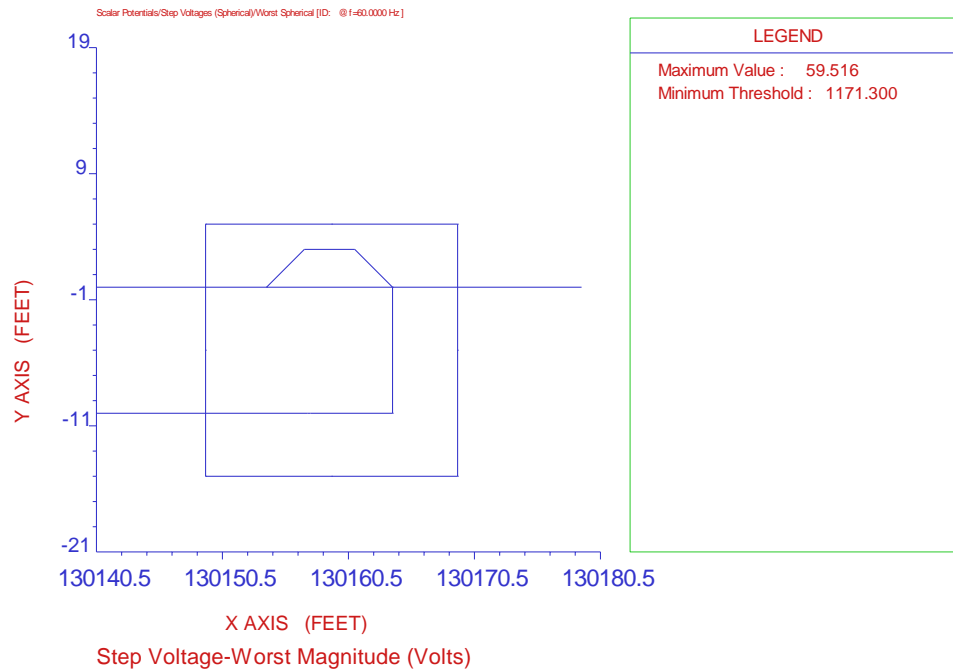
**Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline  
MLV-3 @ MP 19.81  
Faulted at Velco 115 kV K43 Tower  
Step Voltages – Safety Limit 603.5 Volts.  
With Mitigation**



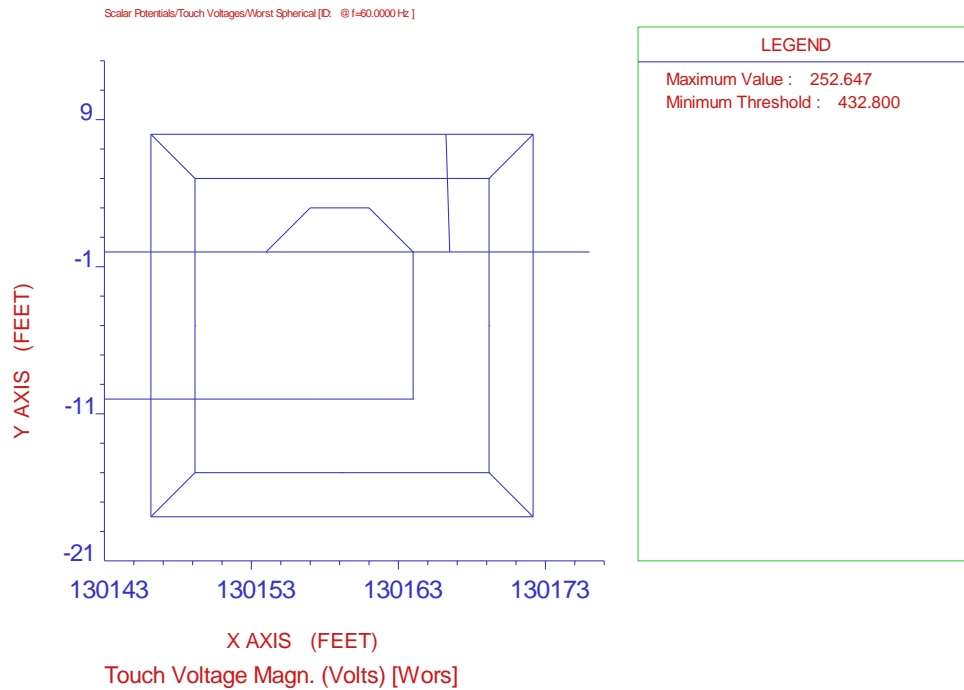
**Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline**  
**MLV-4 @ MP 24.8**  
**Faulted at Velco 115 kV K43 Tower**  
**Touch Voltages – Safety Limit 432.8 Volts.**



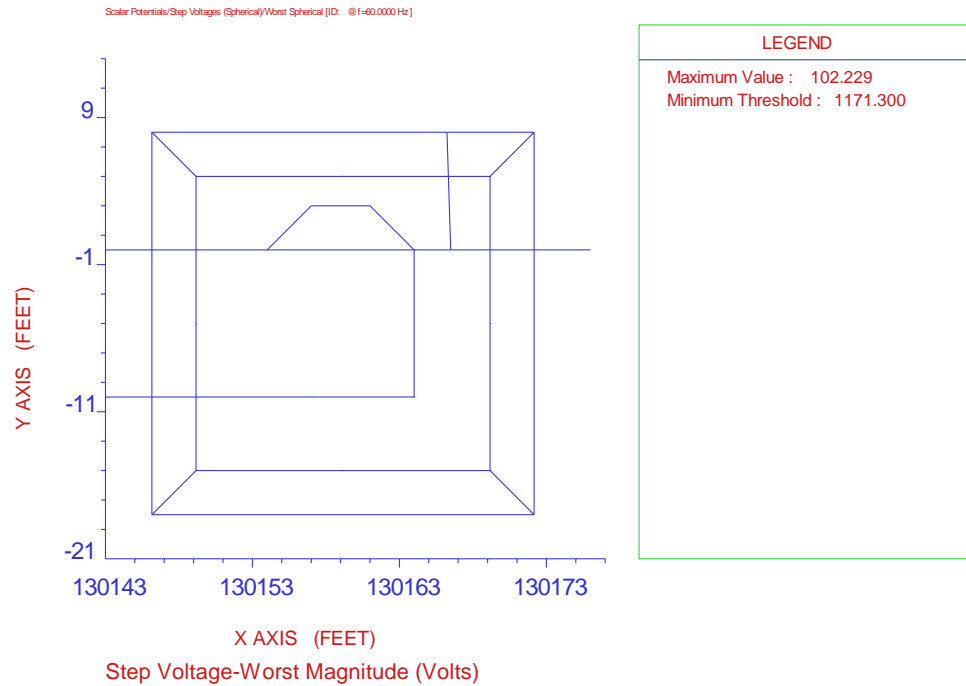
**Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline  
MLV-4 @ MP 24.8  
Faulted at Velco 115 kV K43 Tower  
Step Voltages – Safety Limit 1171.3 Volts.**



**Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline  
MLV-4 @ MP 24.8  
Faulted at Velco 115 kV K43 Tower  
Touch Voltages – Safety Limit 432.8 Volts.  
With Mitigation**

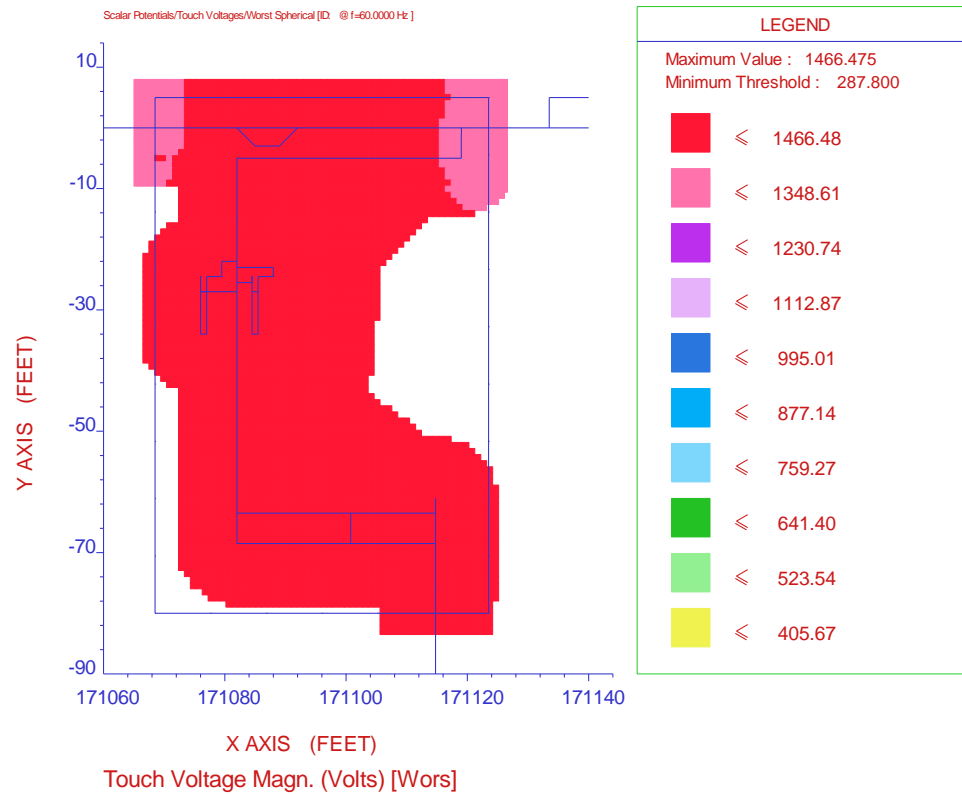


**Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline  
MLV-4 @ MP 24.8  
Faulted at Velco 115 kV K43 Tower  
Step Voltages – Safety Limit 1171.3 Volts.  
With Mitigation**

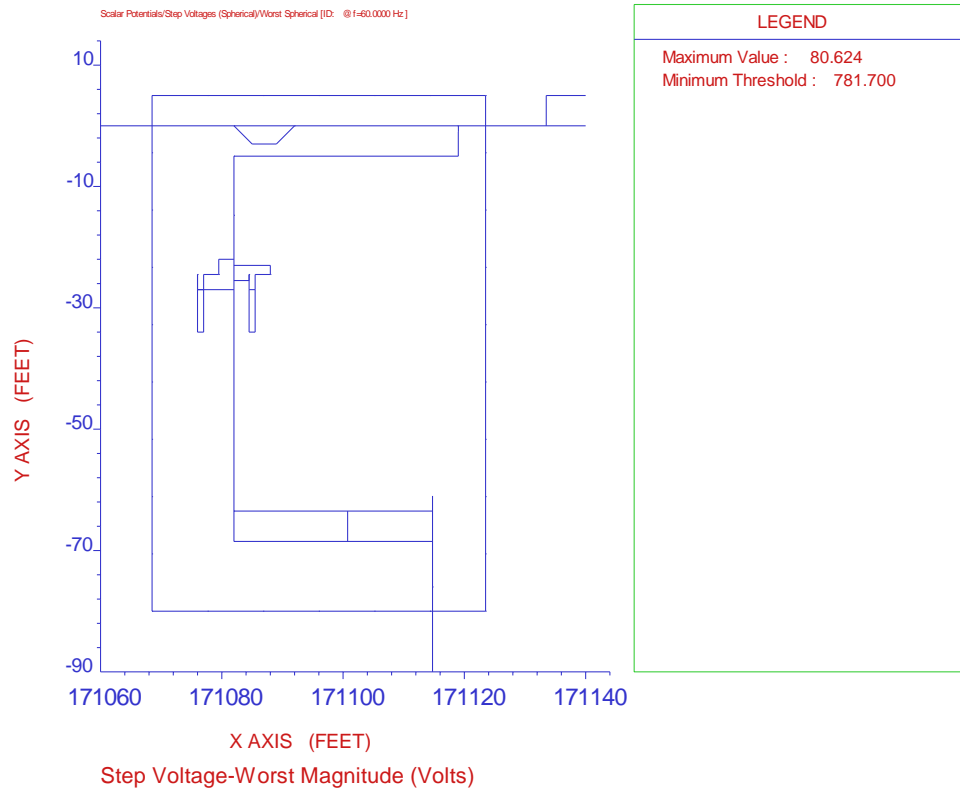




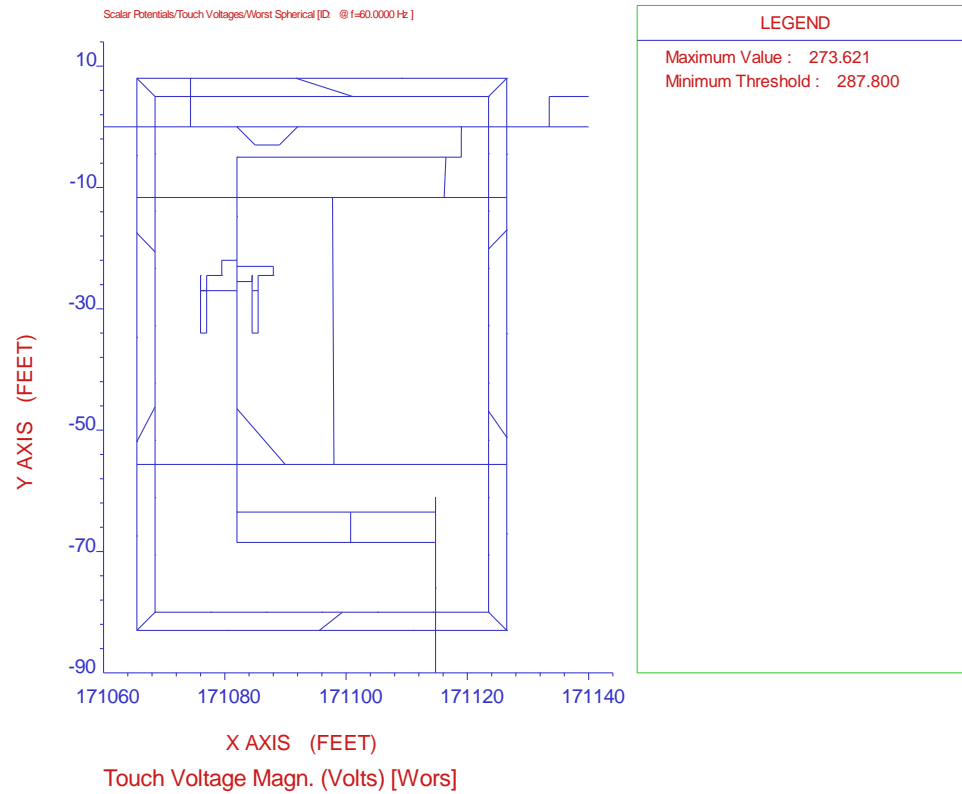
**Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline  
MLV-5/Plank Rd. M&R @ MP 32.54  
Faulted at Velco 115 kV K43 Tower  
Touch Voltages – Safety Limit 287.8 Volts.**



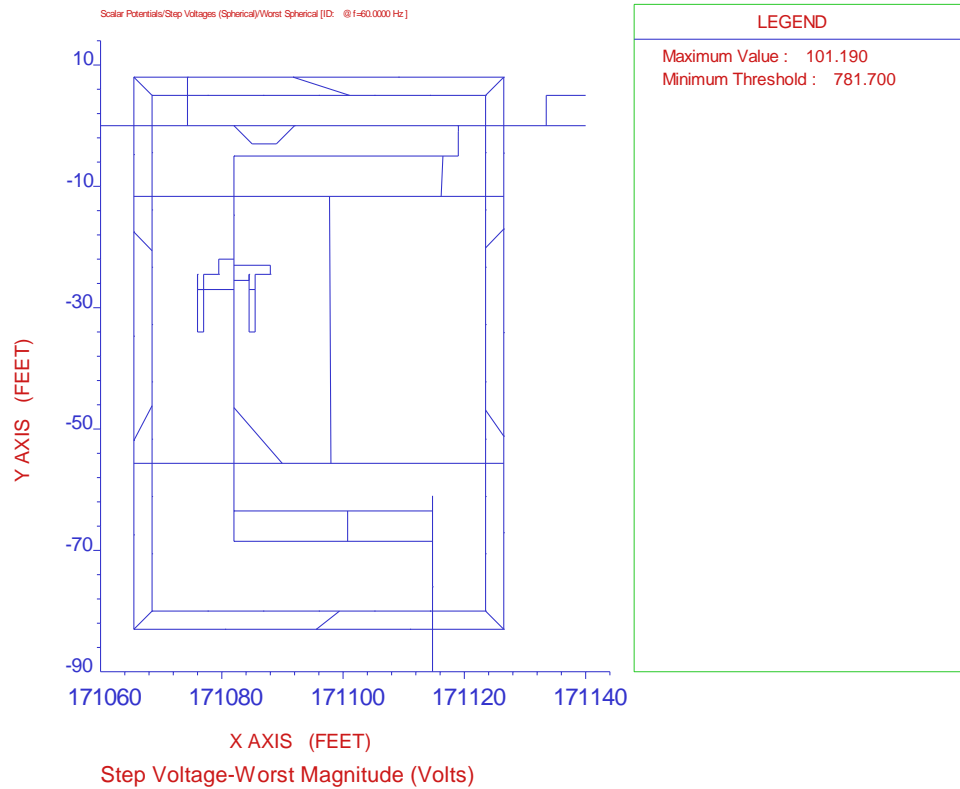
**Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline  
MLV-5/Plank Rd. M&R @ MP 32.54  
Faulted at Velco 115 kV K43 Tower  
Step Voltages – Safety Limit 781.7 Volts.**



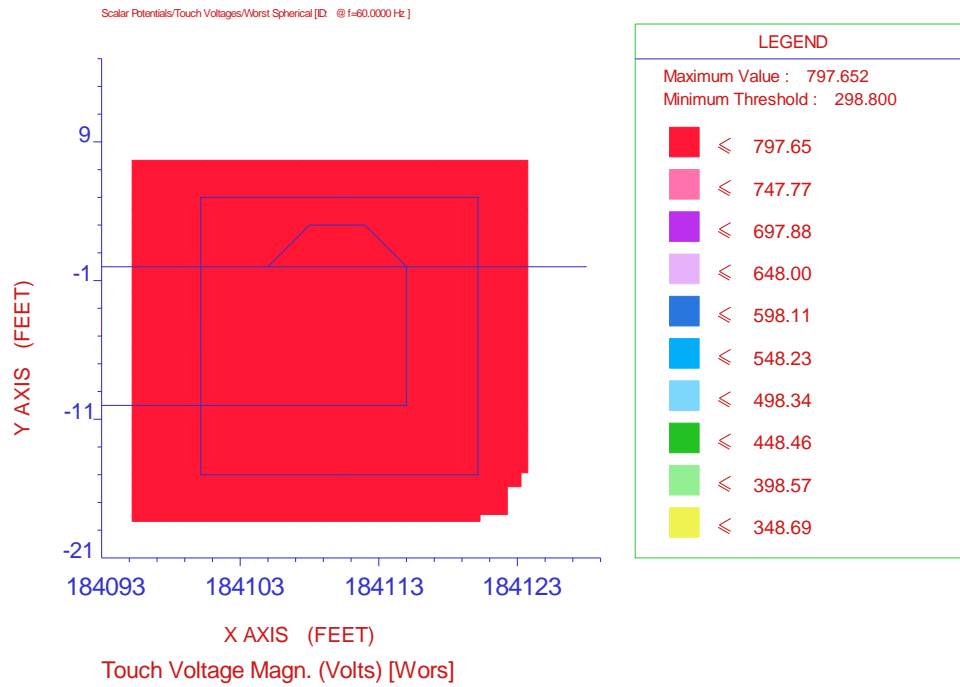
**Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline  
MLV-5/Plank Rd. M&R @ MP 32.54  
Faulted at Velco 115 kV K43 Tower  
Touch Voltages – Safety Limit 287.8 Volts.  
With Mitigation**



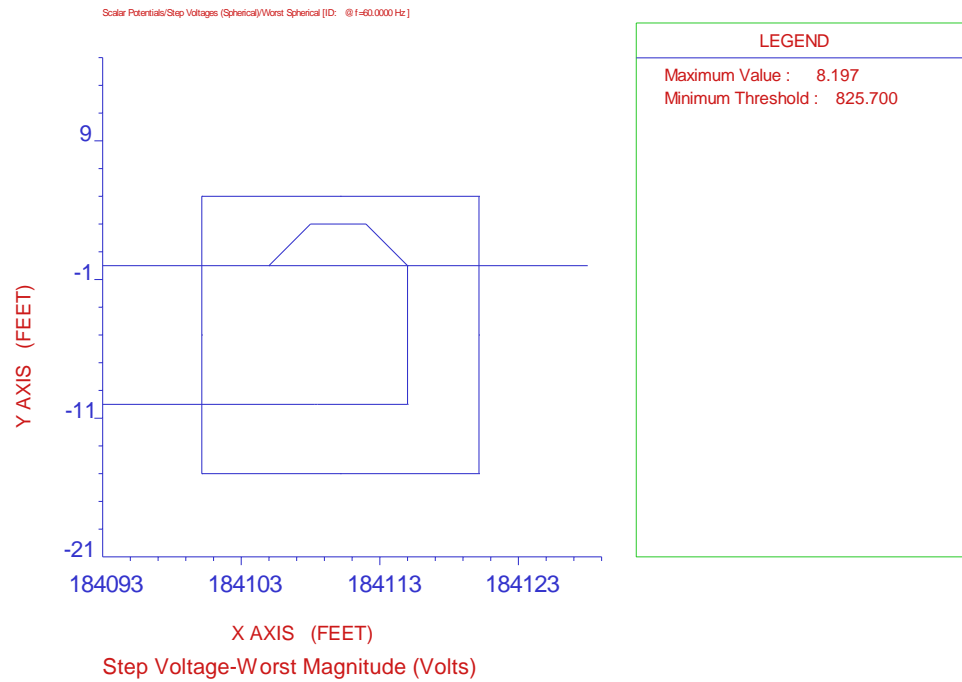
**Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline  
MLV-5/Plank Rd. M&R @ MP 32.54  
Faulted at Velco 115 kV K43 Tower  
Step Voltages – Safety Limit 781.7 Volts.  
With Mitigation**



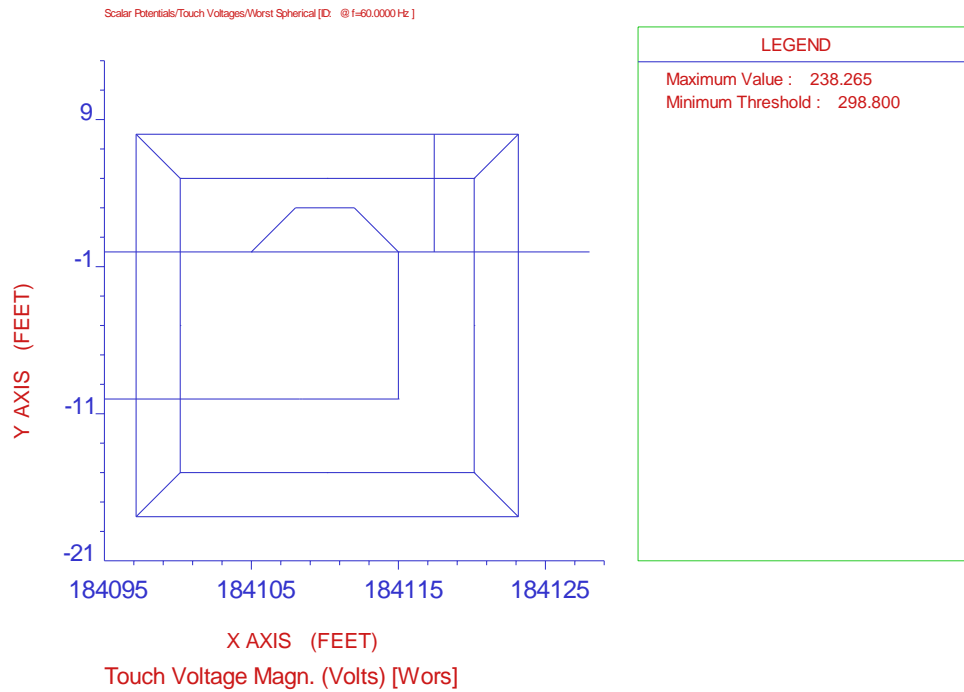
**Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline**  
**MLV-6 @ MP 35**  
**Faulted at Velco 115 kV K43 Tower**  
**Touch Voltages – Safety Limit 298.8 Volts.**



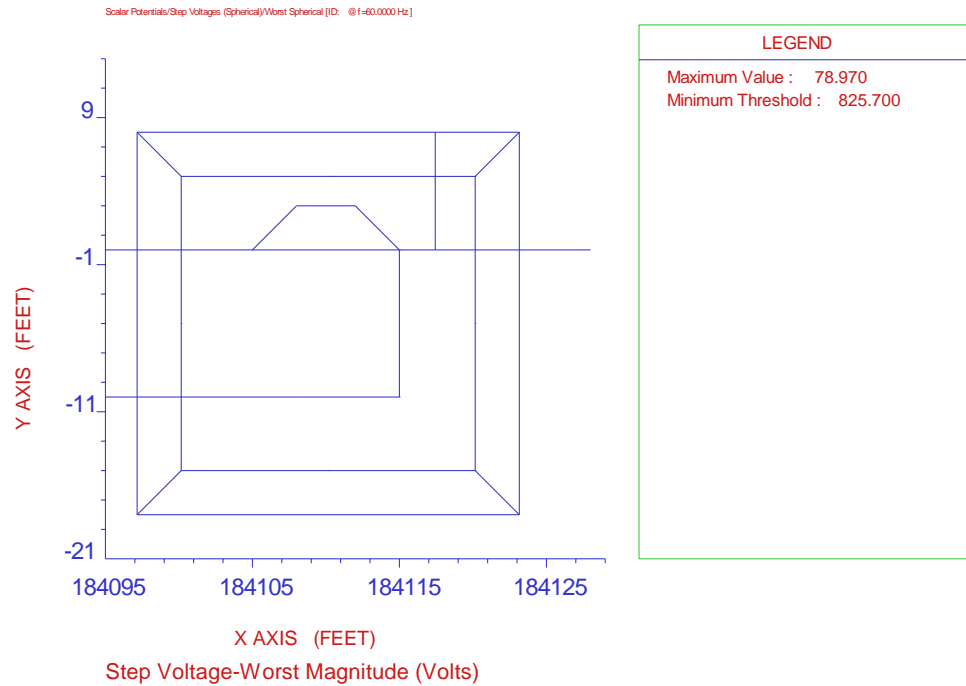
**Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline  
MLV-6 @ MP 35  
Faulted at Velco 115 kV K43 Tower  
Step Voltages – Safety Limit 825.7 Volts.**



**Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline  
MLV-6 @ MP 35  
Faulted at Velco 115 kV K43 Tower  
Touch Voltages – Safety Limit 298.8 Volts.  
With Mitigation**



**Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline  
MLV-6 @ MP 35  
Faulted at Velco 115 kV K43 Tower  
Step Voltages – Safety Limit 825.7 Volts.  
With Mitigation**





APPENDIX C –  
POWER & PIPELINE COMPANY DATA

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ARK Engineering

Line Data (General Electrical)

Circuit Name	Voltage (kV)	Origin Substation	Destination Substation	Not conductor rating!		Not conductor	
				Projected Future Maximum Load Current (A)	Projected Future Emergency Load Current (A)	Maximum Historical Imbalance (%) at 250A	Maximum Historical Imbalance (%) at 500A
K21	115	North (Georgia)	Essex	1050	1250	2.1%	1.6%
K22	115	North (Sand Bar)	Essex	1000	1250	6.4%	5.5%
K24 (Essex to Middlesex segment)	115	Essex	Middlesex	900	1100	10.2%	6.4%
K23 (Essex - Tafts Corner)	115	Essex	Tafts Corner	950	1500	5.1%	3.1%
K27	115	Tafts Corner	Williston	850	1500	6.5%	3.9%
K33	115	Queen City	Williston	650	1250	3.4%	3.1%
K43	115	Williston	New Haven	700	1250	7.2%	5.1%
K63	115	New Haven	Middlebury	900	1250	5.9%	N/A
K64	115	Vergennes	New Haven	550	1500	5.5%	1.8%
K370	345	New Haven	Middlebury West Rutland	400	1350	3.9%	N/A

\*please check no lines missing

Line Data (Physical Data)

Circuit Name	Conductor Data	Shield Wire Data (See structure profiles for number and location)	Avg Tower Impedance (ohms)	Avg Tower Grounding Depth (feet)	Structure Count	Total Length (feet)	Average Span (ft) (Rolling Span)	Minimum conductor height at midspan	Dimensioned tower Diagram (please provide diagram)	Tower Lat/Lon List
K21	1 x 954 (45/7) ACSR	2 x Copperweld 3 - #7	Unknown (note 1)	8' (note 2)	209	95437	457	20.1' (note 3)	Sent separately (first ~0.4mi. out of Essex is mostly A type but with shields directly over outer phases; then mostly A)	Attached
K22	1 x 954 (37) AAC	2 x Copperweld 3 - #7	Unknown (note 1)	8' (note 2)	151	58912	390	20.1' (note 3)	Sent separately (first ~0.4mi. out of Essex is mostly A3 type; then mostly A)	Attached
K24 (Essex to Middlesex segment)	1 x 795 (36/1) ACSR & ~0.53mi of 1 x 1272 (45/7) ACSR at Duxbury Tap (~19.1mi. out from Essex)	2 x Copperweld 3 - #7 & ~0.53mi of 3/8" EHS Steel at Duxbury Tap (~19.1mi. out from Essex)	Unknown (note 1)	8' (note 2)	308	139581	453	20.1' (note 3)	Sent separately (first ~0.6mi. out of Essex is mostly A3 type; then mostly A)	Attached
K23 (Essex - Tafts Corner)	1 x 1272 (45/7) ACSR	2 x Copperweld 3 - #7	Unknown (note 1)	8' (note 2)	40	16743	419	20.1' (note 3)	Sent separately (mostly A type)	Attached
K27	1 x 1272 (45/7) ACSR	2 x Copperweld 3 - #7	Unknown (note 1)	8' (note 2)	25	10610	432	20.1' (note 3)	Sent separately (mostly A type)	Attached
K33	1 x 927 (24/13) ACAR for ~4.54mi. from Williston to Pole 51; 1 x 1272 (45/7) ACSR for ~1.65mi. from Pole 51 to Queen City	2 x 3/8" EHS Steel (for ~4.25mi. out of Williston; then changes to 1 wire)	Unknown (note 1)	8' (note 2)	74	33112	447	20.1' (note 3)	Sent separately (first ~0.4mi. out of Williston is mostly A3 type; then mostly A for next ~3.8mi.)	Attached
K43	1 x 954 (45/7) ACSR	2 x Copperweld 3 - #7	Unknown (note 1)	8' (note 2)	245	110088	449	20.1' (note 3)	Sent separately (first ~0.6mi. out of New Haven is mostly Delta type; then mostly A)	Attached
K63	1 x 954 (45/7) ACSR	2 x Copperweld 3 - #7	Unknown (note 1)	8' (note 2)	84	39765	473	20.1' (note 3)	Sent separately (first ~0.3mi. out of Middlebury is mostly A3 type; then mostly A)	Attached
K64	1 x 1272 (45/7) ACSR	1 x 3/8" EHS Steel	Unknown (note 1)	8' (note 2)	99	35495	359	20.1' (note 3)	Sent separately (mostly Delta type)	Attached
K370	2 x 954 (45/7) ACSR	2 x 3/8" EHS Steel	Unknown (note 1)	10' (note 2)	298	186999	628	24.7' (note 3)	Sent separately (A3 for first ~7.4mi. out of New Haven)	Attached

\*please check no lines missing

Substation Data

Substation Name	Bus Voltage (kV)	Latitude (approx)	Longitude (approx)	Ground Grid Impedance
IBM Williston	Not a VELOCO facility	44.474460°	-73.088702°	Not a VELOCO facility
Tafts Corner	115, 34.5	44.440293°	-73.111650°	
Williston	115	44.413850°	-73.128681°	
New Haven	345, 115, 46	44.119001°	-73.165633°	

\*please check no lines missing

Fault Data (Parallel Lines)

See Attached KML for Fault Locations

Transmission Line	Distance Between Substations	Contributing Substation	Single Phase to Ground Fault Current at Tower (Amps)	Single Phase to Ground Fault Angle at Tower (Degrees)	Primary Fault Clearing Time (cycles) *Note 4	Breaker failure fault clearing time (cycles) *Note 5	Location
EXAMPLE: Bobville to Sallytown	At Bobville Substation	Bobville	10,542	87	5	-60	
		Sallytown	2,355	89	7	-60	
	25% of total line length	Bobville	9,254	87			
		Sallytown	4,165	89			
	50% of total line length	Bobville	7,968	87	9	-60	
		Sallytown	4,989	89			
	75% of total line length	Bobville	5,572	86	12	-60	
		Sallytown	6,022	89			
	At Sallytown Substation	Bobville	4,232	88	12	-60	
		Sallytown	6,971	88			
K21	1	North (Georgia)	3,525	77	42	65	4.15mi. from Essex
		Essex	5,700	78	8	25	23%
		North (Georgia)	2,775	77	42	65	3.38mi. from Essex
K22	2	Essex	12,450	77	8	25	19%
		North (Georgia)	2,700	77	42	65	2.70mi. from Essex
		Essex	13,950	77	8	25	15%
K23 (Essex to Middlesex segment)	3	North (Sandbar)	7,050	77	8	25	4.64mi. from Essex
		Essex	9,150	77	8	25	42%
		North (Sandbar)	6,300	77	8	25	3.88mi. from Essex
K24	4	Essex	10,950	77	8	25	35%
		North (Sandbar)	5,700	77	42	65	3.18mi. from Essex
		Essex	11,400	77	8	25	28%
K25	5	Essex	11,700	76	10	30	1.25mi. from Essex
		Middlesex	2,650	77	66	86	5%
		Essex	10,950	76	10	30	1.69mi. from Essex
K26	6	Middlesex	2,925	77	66	86	6%
		Essex	9,900	76	10	30	2.22mi. from Essex
		Middlesex	3,000	77	66	86	8%
K27 (Essex - Tafts Corner)	7	Essex	9,450	78	68	88	
		Tafts Corner (Total)	16,875	75	10	20	At Tafts bus
		Lime Kiln	1,800	81	92	112	
K28	8	Essex	10,200	78	23	43	0.61mi. from Tafts
		Tafts Corner	6,600	75	6	20	19%
		Lime Kiln	2,100	81	82	102	
K29	9	Tafts Corner	11,625	77	6	20	0.28mi. from Tafts
		Williston	5,250	79	24	44	14%
		Tafts Corner	11,250	77	6	20	0.54mi. from Tafts
K30	10	Williston	5,400	78	24	44	26%
		Tafts Corner	10,650	77	6	20	0.89mi. from Tafts
		Williston	5,475	79	24	44	43%
K31	11	Tafts Corner	10,500	77	6	20	0.98mi. from Tafts
		Williston	5,550	79	24	44	46%
		Tafts Corner	9,750	77	27	47	1.50mi. from Tafts
K32	12	Williston	5,775	79	6	20	73%
		Tafts Corner	9,150	77	27	47	1.98mi. from Tafts
		Williston	6,150	79	6	20	97%
K33	13	Queen City	3525	75	36	56	0.47mi. from Williston
		Williston	11250	75	6	20	7%
		Queen City	3375	75	36	56	At Williston bus
K34	14	Williston (Total)	15000	75	6	20	
		Williston (Total)	15000	77	6	20	At Williston bus
		New Haven	3150	80	54	74	
K35	15	Williston	10650	77	6	20	0.97mi. from Williston
		New Haven	3300	79	54	74	9%
		Williston	10125	77	6	20	1.54mi. from Williston
K36	16	New Haven	3375	78	54	74	7%
		Williston	9375	77	6	20	2.03mi. from Williston
		New Haven	3450	78	54	74	10%
K37	17	Williston	9300	78	6	20	2.47mi. from Williston
		New Haven	3525	78	54	74	12%
		Williston	8700	77	6	20	2.78mi. from Williston
K38	18	New Haven	3600	78	54	74	13%
		Williston	8325	78	6	20	3.09mi. from Williston
		New Haven	3675	78	54	74	15%
K39	19	Williston	7950	77	6	20	3.61mi. from Williston
		New Haven	3750	78	54	74	17%
		Williston	7300	78	6	20	4.59mi. from Williston
K40	20	New Haven	4050	78	54	74	22%
		Williston	6600	77	6	20	5.71mi. from Williston
		New Haven	4275	78	54	74	27%
K41	21	Williston	6000	77	6	20	6.72mi. from Williston
		New Haven	4500	78	54	74	32%
		Williston	5,475	78	6	20	7.83mi. from Williston
K42	22	New Haven	4,875	78	6	20	38%
		Williston	6,050	78	6	20	8.89mi. from Williston
		New Haven	5,250	78	6	20	43%
K43	23	Williston	4,800	78	6	20	9.87mi. from Williston
		New Haven	5,625	78	6	20	47%
		Williston	4,500	78	6	20	10.89mi. from Williston
K44	24	New Haven	6,150	78	6	20	52%
		Williston	4,200	78	6	20	11.96mi. from Williston
		New Haven	6600	78	6	20	57%
K45	25	Williston	3900	78	6	20	13.08mi. from Williston
		New Haven	7425	78	6	20	63%
		Williston	3750	78	6	20	14.24mi. from Williston
K46	26	New Haven	8250	78	6	20	68%
		Williston	3600	78	6	20	14.78mi. from Williston
		New Haven	8850	78	6	20	71%
K47	27	Williston	3,450	78	6	20	15.26mi. from Williston
		New Haven	9,300	78	6	20	73%
		Williston	3,300	78	30	50	16.48mi. from Williston
K48	28	New Haven	10,800	78	6	20	79%
		Williston	3,000	78	30	50	17.82mi. from Williston
		New Haven	12,975	78	6	20	85%
K49	29	Williston	2,925	78	30	50	18.14mi. from Williston
		New Haven	13,500	78	6	20	87%
		Williston	2,775	78	30	50	18.77mi. from Williston
K50	30	New Haven	15,450	78	6	20	90%
		Williston	2,550	79	30	50	19.74mi. from Williston
		New Haven	19,200	78	6	20	95%
K51	31	Williston	2,400	79	30	50	20.45mi. from Williston
		New Haven	22,500	78	6	20	98%
		Williston	2,250	79	30	50	At New Haven bus
K52	32	New Haven (Total)	26,700	78	10	30	
		New Haven (Total)	26,700	74	10	30	
		Middlebury	2,400	72	38	63	At New Haven bus
K53	33	New Haven	21,450	74	6	20	0.63mi. from New Haven
		Middlebury	2,550	72	38	63	8%
		New Haven	18,825	74	6	20	1.13mi. from New Haven
K54	34	Middlebury	2,700	72	38	63	15%
		New Haven	16,950	74	6	20	1.60mi. from New Haven
		Middlebury	2,850	72	38	63	21%
K55	35	New Haven	13,800	74	6	20	2.61mi. from New Haven
		Middlebury	3,150	72	38	63	35%
		New Haven	11,700	74	6	20	3.64mi. from New Haven
K56	36	Middlebury	3,525	72	8	25	48%
		New Haven	10,800	74	6	20	4.24mi. from New Haven
		Middlebury	3,750	72	8	25	56%
K57	37	New Haven	10,050	74	30	50	4.83mi. from New Haven
		Middlebury	4,050	72	8	20	64%
		Vergennes	2,700	79	30	50	1.02mi. from New Haven
K58	38	New Haven	18,600	80	6	20	15%
		Vergennes	2,250	79	30	50	0.43mi. from New Haven
		New Haven	21,750	80	6	20	6%
K59	39	Vergennes	2,175	79	30	50	At New Haven bus
		New Haven (Total)	26,700	80	10	30	
		New Haven (Total)	11,400	75	10	30	At New Haven bus
K60	40	West Rutland	5,475	83	29	49	
		New Haven	7,500	75	5	20	0.63mi. from New Haven
		West Rutland	5,475	83	29	49	2%
K61	41	New Haven	7,425	75	5	20	1.13mi. from New Haven
		West Rutland	5,513	83	29	49	3%
		New Haven	7,275	80	5	20	1.60mi. from New Haven
K62	42	West Rutland	5,560	83	29	49	5%
		New Haven	7,200	80	5	20	2.61mi. from New Haven
		West Rutland	5,625	83	29	49	7%
K63	43	New Haven	7,050	84	5	20	3.64mi. from New Haven
		West Rutland	5,700	82	29	49	10%
		New Haven	6,900	84	5	20	4.24mi. from New Haven
K64	44	West Rutland	5,775	82	29	49	12%
		New Haven	6,825	84	5	20	4.83mi. from New Haven
		West Rutland	5,850	82	29	49	14%
*please check no lines missing	At Origin Substation	Origin					
		Destination					
	25% of total line length	Origin					
		Destination					
	50% of total line length	Origin					
		Destination					
75% of total line length	Origin						
	Destination						
At Destination Substation	Origin						
	Destination						

Notes:  
1. Average tower impedance numbers are unknown.  
2. Standard tower grounding depths are 8' for 115kV and 10' for 345kV.  
3. Heights given are typical minimum ground clearances for 115kV and 345kV (from VELCO Design Criteria, Rev. B, Table N-1, no VELCO adder, vertical clearance to ground over roads, streets, and other areas subject to traffic, at max operating temperature.  
4. Primary Clearing Time assumes no high-speed teleprotection in service.  
5. Breaker Failure times are specific to corresponding fault location and assume delayed step distance or 67N operation. BFTT is assumed to be functional on adjacent lines if available.

Line Data (General Electrical)

Circuit Name	Voltage (KV)	Origin Substation	Destination Substation	Not conductor rating! Assumed Future Emergency Load Current (A)
GMP	-	-	-	1000
*please check no lines missing				

Fault Data (Parallel Lines) See Attached KML for Fault Locations

Transmission Line	Distance Between Substations	Contributing Substation	Single Phase to Ground Fault Current at Tower (Amps)	Single Phase to Ground Fault Angle at Tower (Degrees)	Primary Fault Clearing Time (cycles) *Note 4	Breaker failure fault clearing time (cycles) *Note 5	Location
EXAMPLE: Bobville to Sallytown	At Bobville Substation	Bobville	10.542	87	5	-60	
		Sallytown	2.355	89			
	25% of total line length	Bobville	9.254	87	7	-60	
		Sallytown	4.165	89			
	50% of total line length	Bobville	7.868	87	9	-60	
		Sallytown	4.989	89			
	75% of total line length	Bobville	5.872	88	12	-60	
		Sallytown	6.022	89			
	At Sallytown Substation	Bobville	4.232	88	12	-60	
		Sallytown	6.971	88			
GMP	1	Start	10.000	90			0% of Line
		End	10.000	90			
	2	Start	10.000	90			50% of Line
		End	10.000	90			
	3	Start	10.000	90			100% of Line
		End	10.000	90			
*please check no lines missing	At Origin Substation	Origin					
		Destination					
	25% of total line length	Origin					
		Destination					
	50% of total line length	Origin					
		Destination					
	75% of total line length	Origin					
		Destination					
	At Destination Substation	Origin					
		Destination					

DWG NO.	TITLE
115-0.0	Index to Drawings
115-0.1	Index to Drawings
115-1.0	Type A, Tangent Structure
115-1.1	Type A, Pole Top Details
115-2.0	Type A-2, Tangent Structure - Special Spans
115-2.1	Type A-2, Pole Top Details
115-3.0	Type A-3 & D-3, Special Framing
115-4.0	Type A-4 & D-4, Special Framing
115-5.0	Type B Structure - Angles 0° - 10°
115-5.1	Type B, Pole Top Details
115-6.0	Type B-2 Structures, Angles 10° - 27°
115-6.1	Type B-2, Pole Top Details
115-7.0	Type C Structure, Angles 27° - 50°
115-7.1	Type C, Pole Top Details
115-8.0	Type D Structure - Highway & Railroad Crossings
115-8.1	Type D, Pole Top Details
115-9.0	Type DA Structure - Angles over 50°
115-9.1	Type DA, Pole Top Details
115-10.0	Type E Structure - Deadend
115-10.1	Type E, Pole Top Details
115-11.0	Type DA-T Structure - Straight Line Deadend
115-11.1	Type DA-T, Pole Top Details
115-12.0	Crossarm Detail - Types A, B, B-2 & E

		INDEX TO DRAWINGS	
		115 KV CONSTRUCTION	
		VERMONT ELECTRIC POWER COMPANY, INC.	
		DRAWN BY JM	CHECKED BY
		DATE 6/77	
DATE	CH-K BY	SCALE	APPROVED BY
		none	DW
REVISIONS		DWG # 115-0.0	

DWG NO.	TITLE
115-12.1	Crossarm Detail - Types C, D, DA, DA-T & F
115-13.0	Pole Boring, Gaining & Pole Roof
115-14.0	Plate & Channel Detail
115-14.1	Plate & Channel Detail
115-15.0	Bayonet Detail
115-15.1	Type A, Shield Wire Deadend Detail
115-16.0	Anchor Rods, Anchor Logs & Guy Wire Connections
115-16.1	Rock Anchor & Swamp Anchor Detail
115-17.0	Ground Rod Detail
115-18.0	Guying - Types A, D & E
115-18.1	Guying - Types B, B-2, C & F
115-18.2	Guying - Type DA
115-18.3	Guying - Type DA-T
115-19.0	Guy Grounding - Types B, B-2, C & DA
115-19.1	Guy Grounding - Types D & E
115-20.0	Bog Shoe Detail - Type A
115-20.1	Bog Shoe Detail - Type B & C
115-21.0	Clearing for 150' Right of Way
115-22.0	Type F Structure - Transposition - Three Phase
115-22.1	Type F Structure - Transposition - Two Phase
115-22.2	Type F Structure - Pole Top Details

INDEX TO DRAWINGS 115 KV CONSTRUCTION			
VERMONT ELECTRIC POWER COMPANY, INC.			
DRAWN BY JM		CHECKED BY	DATE 6/77
DATE	CHK BY	SCALE	APPROVED BY DW
REVISIONS		none	DWG # 115-0.1

VERMONT ELECTRIC POWER COMPANY, INC.  
MATERIAL FOR TYPE A STRUCTURE  
115 KV

Mark	Quant.	Description	Manuf.	Cat. No.
1	2	Bayonets, complete w/plate, filler washer, w/ bolts, nuts and washers 2" x 5/8" and 2 1/2" x 5/8"	L M	LM-DN-3B2
3	4	Bolts, 5/8" x 10" for bayonet (12")	Joslyn	J 8810 J 8812
4	4	Bolts, brace 1/2" x 10"	Joslyn	J 8710
5	2	Bolts, 5/8" x 12" for crossarm brace	Joslyn	J 8812
7	3	Bolts, x-arm clamps 3/4" x 8"	Joslyn	J 8908
11	2	Bolts, machine 3/4" x 16" for crossarm	Joslyn	J 8916
19	2 pr	Brace - Wood xarm 60"	Hughes	2000CC
22	2	Preformed guy grips DE - for cross tie	Preformed	GDE-1107
23	4	Preformed "L" taps for guy to static	"	LC-MS-5963
26	2	Clevis - deadend for cross tie	Joslyn	456
33	1	Crossarm-Type A	Haley	
41	2	Rods, ground 3/4" x 8'	Joslyn	J 5338
44	2	Clamps, ground rod	L M	DN 14G1
46	2	Clamps, suspension-static wire	Lapp Bethea	N95750 FS-46
49	3	Clamps, suspension - conductor w/ socket ftg.	Bethea	ACFS-114-19-25S
51	3	Clamps, crossarm	Joslyn	J 1820
53	5	Washers, coil spring 3/4"		
54	6	Washers, coil spring 5/8"		
55	4	Washers, coil spring 1/2"		
56	4	Washers, 2" x 2" x 1/8" w/9/16" hole - square	Joslyn	J 1073
57	2	Washers, 4" x 4" x 1/4" w/13/16" hole -curved	Lapp MIF	304082 P144
60	2	Washers, 3" x 3" x 3/16" w/11/16" hole -curved	Lapp MIF	304078 P143
63	2	Plates, reinforcement for xarms	Joslyn	J 4047
64	75	Staples - 3/8" x 1-3/4" (down leads)	Joslyn	J 173
67	120'	Down Lead 3/8" galv. 3-strd. (common grade)		
72	3	Ball eye - long	Lapp BTC	6422 3014

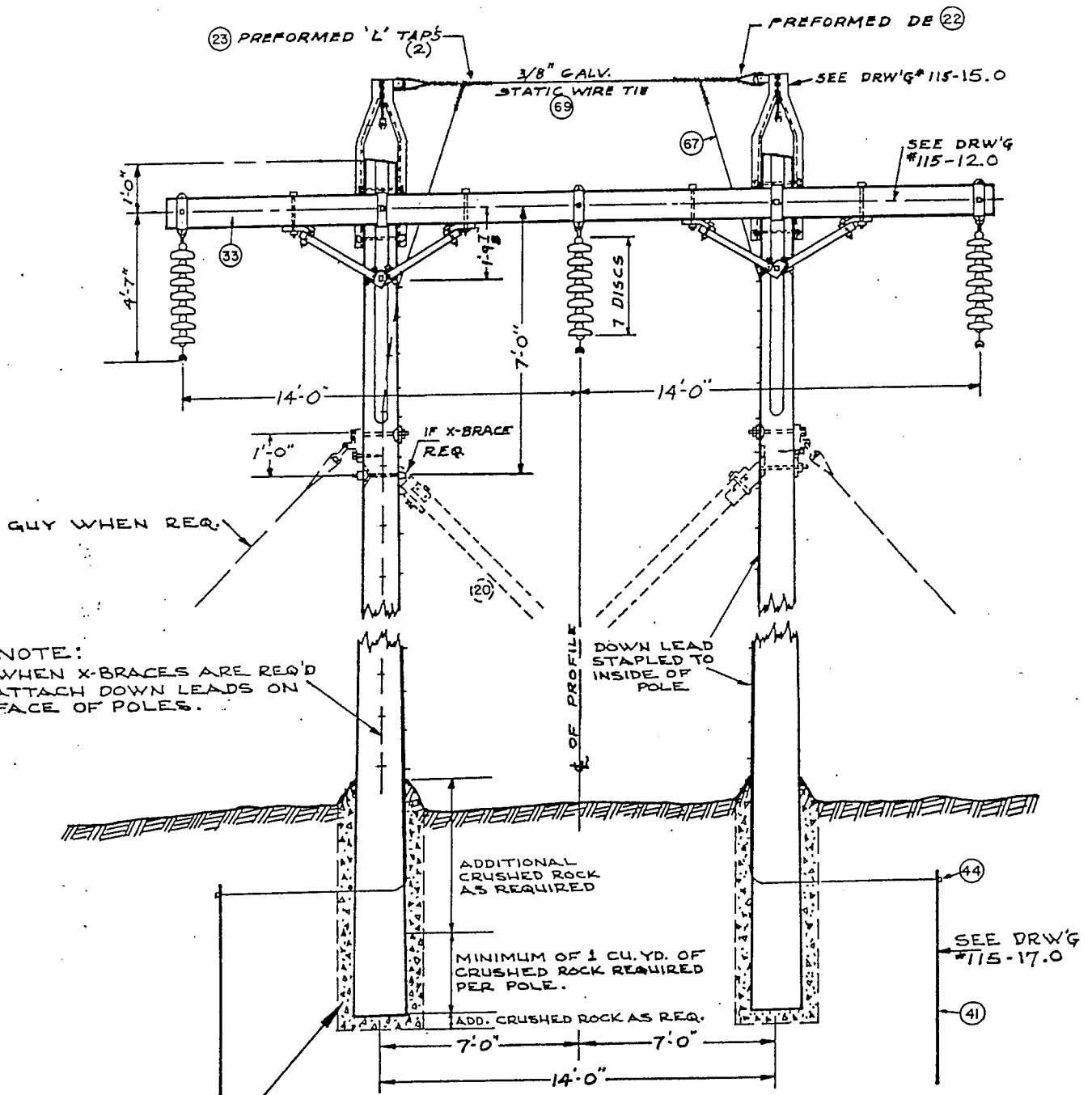
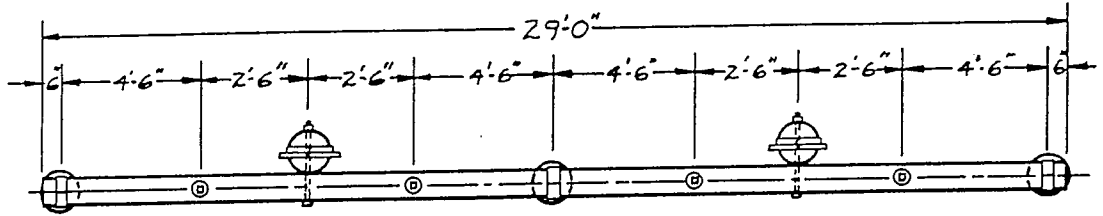
Rev. 2/77  
Rev. 2/74

VERMONT ELECTRIC POWER COMPANY, INC.  
MATERIAL FOR TYPE A STRUCTURE  
115 KV

Mark	Quant.	Description	Manuf.	Cat. No.
69	14'	Cable, 3/8" galv. for cross tie		Common Grade
76	2	Sheave Wheel for cross tie (roller eye)	Joslyn	J 6288
82	21	Insulators, suspension 9" disc (7 per string)	Lapp GE	9000-70 155-409- ASA-70
<u>When Required</u>				
20	1	X-brace w/ mounting hardware	Hughes	1042X
73	3	150# Weights	Bethea	ASM 389-150 M-H
74	3 sets	Armor Rods		
79		Pole Roof, non metallic (used if pole cut off in field)	Joslyn	J 2108
<u>Side Guys - When Required</u>				
11	2	Bolts, machine 3/4" x 16" (pole eye plate)	Joslyn	J 8916
22	4	Preformed DE guy grips	Preformed	GDE 1107
24	2	Thimble Clevis	Lapp MIF	304056 PA 271
31	2	Anchor logs 4'	Koppers	
40	2	Rods, anchor 3/4" x 8'	Joslyn	J 7328
40A		Rock anchors	Chance	R360 R 384 R372 R 396
42	4	Lags, screw 1/2" x 4"	Joslyn	8754 P
53	2	Washers, coil spring 3/4"		
55	4	Washers, coil spring 1/2"		
57	2	Washers, 4" x 4" x 1/4" w/13/16" hole- curved	Lapp MIF	304082 P144
58	2	Washers, 4" x 4" x 1/4" w/ 7/8" hole -flat	Joslyn	J 1082
61	2	Guard Guy- metal	Oliver	808
68	135'	Cable, 3/8" EHS galv. steel		
77	2	Pole Eye Plate	Lapp MIF	304021 PX 88
59	4	Washers, round 9/16"		

Rev. 2/77  
Rev. 2/74





NOTE:  
WHEN X-BRACES ARE REQ'D  
ATTACH DOWN LEADS ON  
FACE OF POLES.

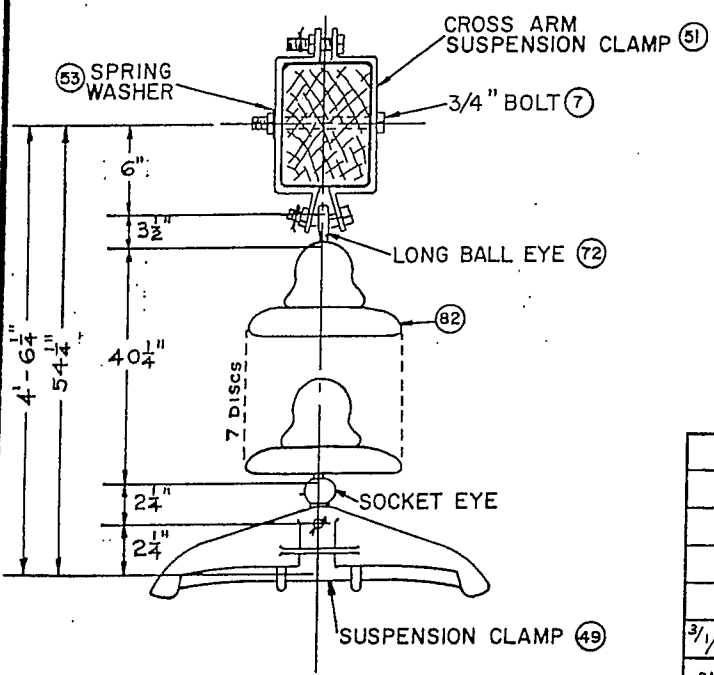
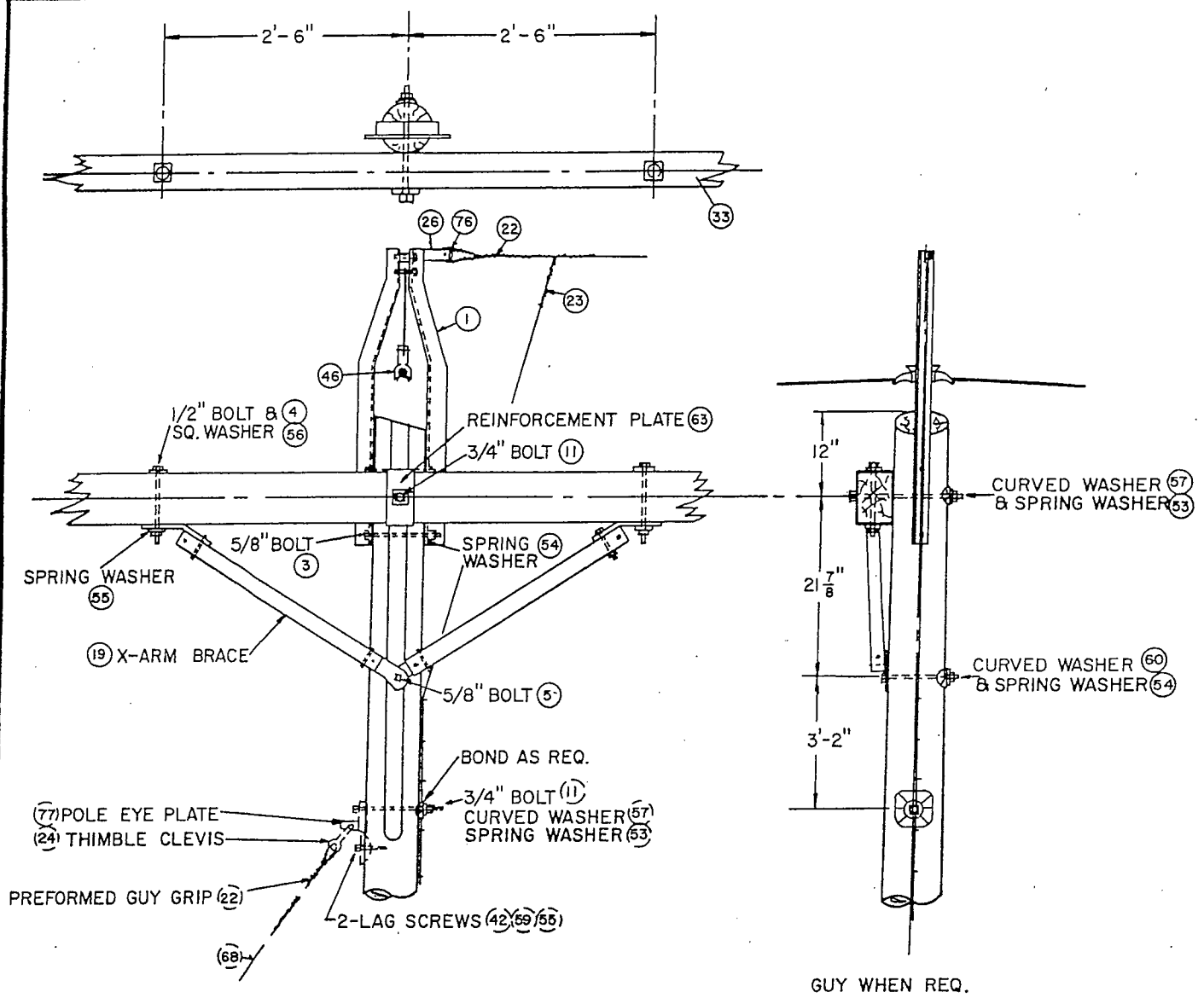
NOTE:  
TYPICAL CRUSHED ROCK  
BACKFILL.

1. WHEN SHIELD WIRE REQUIRES  
DEADENDING SEE DWG #115-15.1 FOR  
ASSEMBLY & CROSSARM ATTACHMENT  
DETAIL, AND MATERIAL LIST.

## TYPE-A TANGENT STRUCTURE 115 KV CONSTRUCTION

VERMONT ELECTRIC POWER COMPANY, INC.

DATE	3/1/77	DRAWN	M.	SCALE	NONE	DATE	4/10/72
REVISIONS						DWG #	115-1.0



POLE TOP DETAILS TYPE "A" STRUCTURES 115KV CONSTRUCTION			
VERMONT ELECTRIC POWER COMPANY, INC.			
3/1/77	DE	CHECKED BY	DATE 2/28/72
DATE	C'H'K BY	SCALE	APPROVED BY
		NONE	DWG # 115-1.1
REVISIONS			

VERMONT ELECTRIC POWER COMPANY, INC.  
MATERIAL FOR TYPE A-2 STRUCTURE

115 Kv

Mark	Quant	Description	Manuf	Cat. No.
1	2	Bayonets, complete w/plate, filler washer, w/bolts, nuts & washers	L M	DN-3B2
3	4	Bolts, 5/8" x 10" (12") for bayonets	Joslyn	J 8810 J 8812
4	8	Bolts, brace 1/2" x 10"	Joslyn	J 8710
5	2	Bolts, 5/8" x 12" for crossarm	Joslyn	J 8812
13	2	Bolts, machine 3/4" x (24")(26") (28")	Joslyn	J 8924, 8926 J 8928
14	3	Bolts, eye - forged shoulder w/washer nut, MF locknut & Cotter pin	Joslyn	J 2180
15	6	Bolts, 5/8" x 10" for plate & channel	L M	DF 3B10
19	4pr	Brace wood - Xarm 60"	Hughes	2000CC
21	3	Channel & Plate	L M	66D901M1 DP23A3
22	2	Preformed guy grip deadend -cross tie	Preformed	GDE 1107
23	4	Preformed "L" taps for top guy to static	Preformed	LCMS 5963
26	2	Clevis - deadend for cross tie	Joslyn	J 456
28	3	Clevis - ball	Lapp OB	6227 70689
33	2	Crossarms Type D		
41	2	Rods, ground 3/4" x 8'	Joslyn	J 5338
44	2	Clamps, ground rod	L M	DNL4G1
46	2	Clamps, suspension - static wire	Lapp Bethea	N95750 FS-46
49	3	Clamps, suspension - conductor w/socket ftg.	Bethea	ACFS 114-19 25S
53	2	Washers, coil spring 3/4"		
54	12	Washers, coil spring 5/8"		
55	8	Washers, coil spring 1/2"		
56	8	Washers, 2" x 2" x 1/8" w/9/16" hole - square	Joslyn	J 1073

Rev. 1/78  
Rev 2/77  
Rev. 2/74

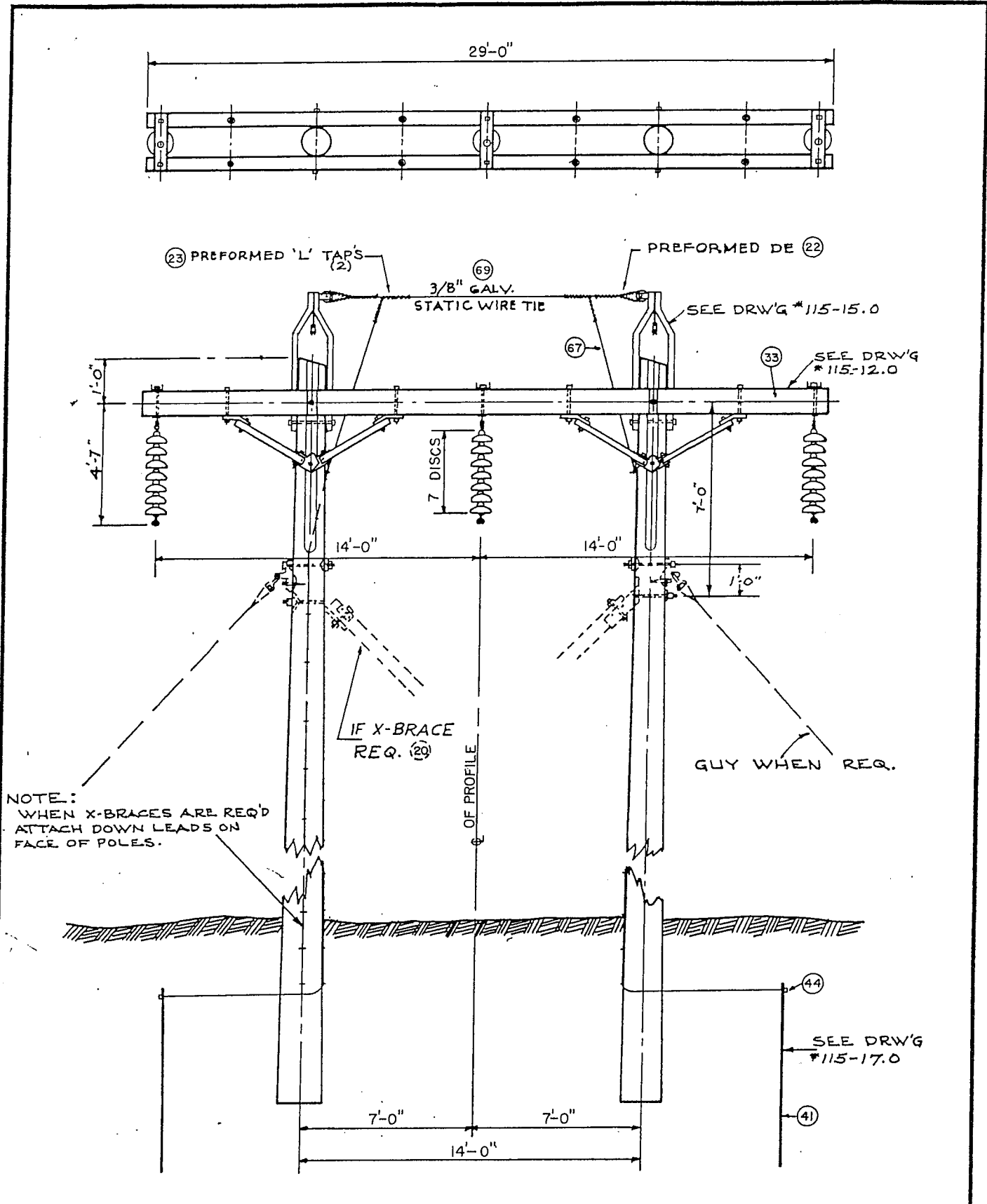
VERMONT ELECTRIC POWER COMPANY, INC.  
MATERIAL FOR TYPE A-2 STRUCTURE  
115 Kv

Mark	Quant	Description	Manuf.	Cat. No.
63	4	Plates, reinforcement for xarms	Joslyn	J 4047
64	75	Staples 3/8" x 1-3/4" (down leads)	Joslyn	J 173
67	120'	Down Lead 3/8 " galv. 3-strd. (common grade)		
69	14'	Cable, 3/8" galv. for cross tie		Common Grade
76	2	Sheave wheel (roller eye) cross tie	Joslyn	J 6288
82	21	Insulators, suspension 9" disc (7/string)	Lapp GE	9000-70 155-409- ASA-70
<u>When Required</u>				
20	1	X-brace w/mounting hardware	Hughes	1042X
73	3	150# Weights	Bethea	ASM 389-150 M-H
74	3sets	Armor rods		
79		Pole roof, non metallic (used if pole cut off in the field)	Joslyn	J 2108
<u>Side Guys - When Required</u>				
11	2	Bolts, machine 3/4" x 16" (pole eye plate)	Joslyn	J 8916
22	4	Preformed deadend guy grips	Preformed	GDE 1107
24	2	Thimble Clevis	Lapp MIF	304056 PA 271
31	2	Anchor logs 4'	Koppers	
40	2	Rods, anchor 3/4" x 8'	Joslyn	J 7328
40A		Rock anchors	Chance	R 360 R384 R 372 R396
42	4	Lags, screw 1/2" x 4"	Joslyn	8754P
53	2	Washers, coil spring 3/4"		
55	4	Washers, coil spring 1/2"		
57	2	Washers, 4" x 4" x 1/4" w/13/16" hole-curved	Lapp MIF	304082 P 144
58	2	Washers, 4" x 4" x 1/4" w/ 7/8 " hole - flat	Joslyn	J 1082
61	2	Guy Guards - metal	Oliver	808
59	4	Washers, round 9/16"		

Rev 1/78

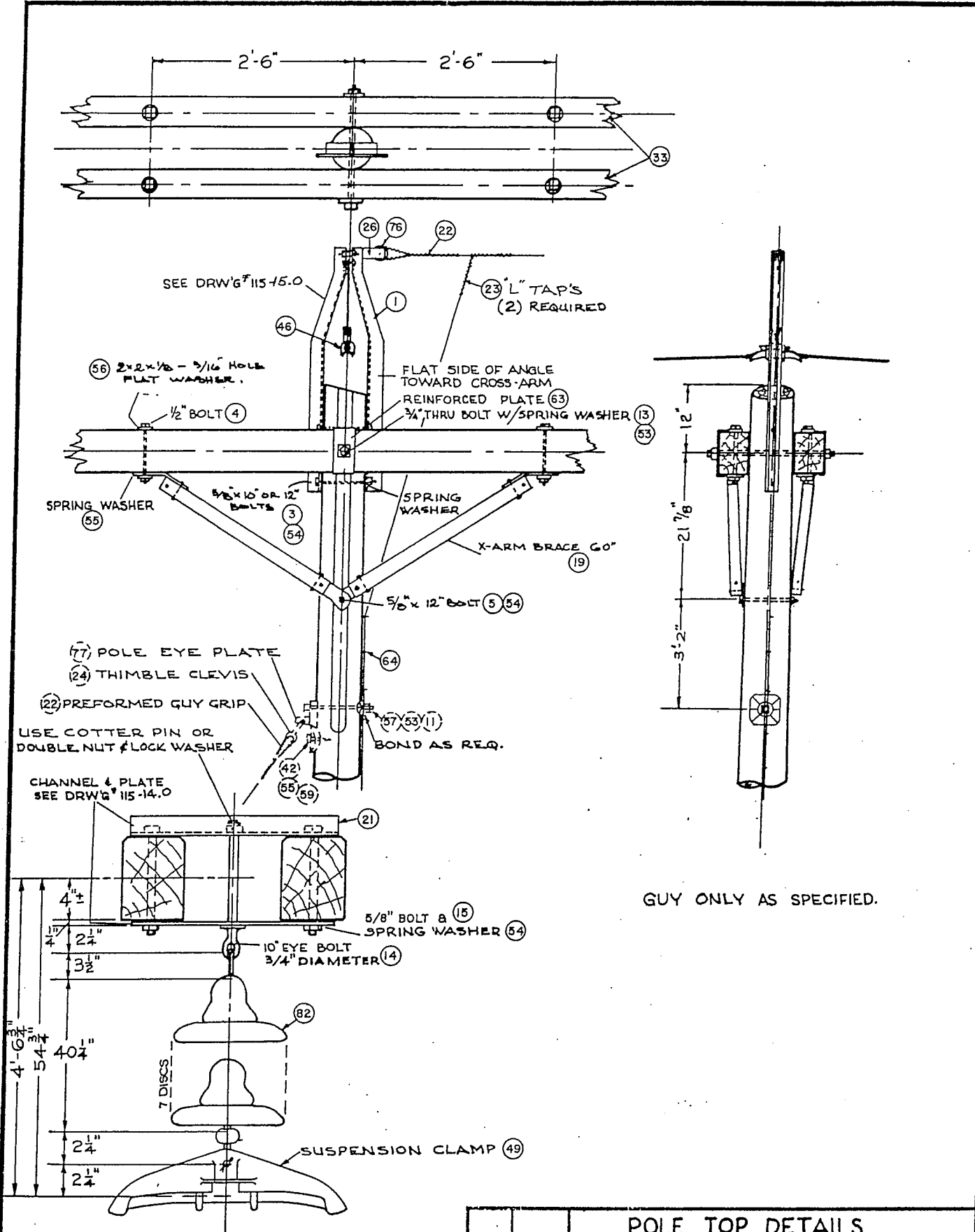
Rev 2/77  
Rev. 2/74





NOTE:  
WHEN X-BRACES ARE REQ'D  
ATTACH DOWN LEADS ON  
FACE OF POLES.

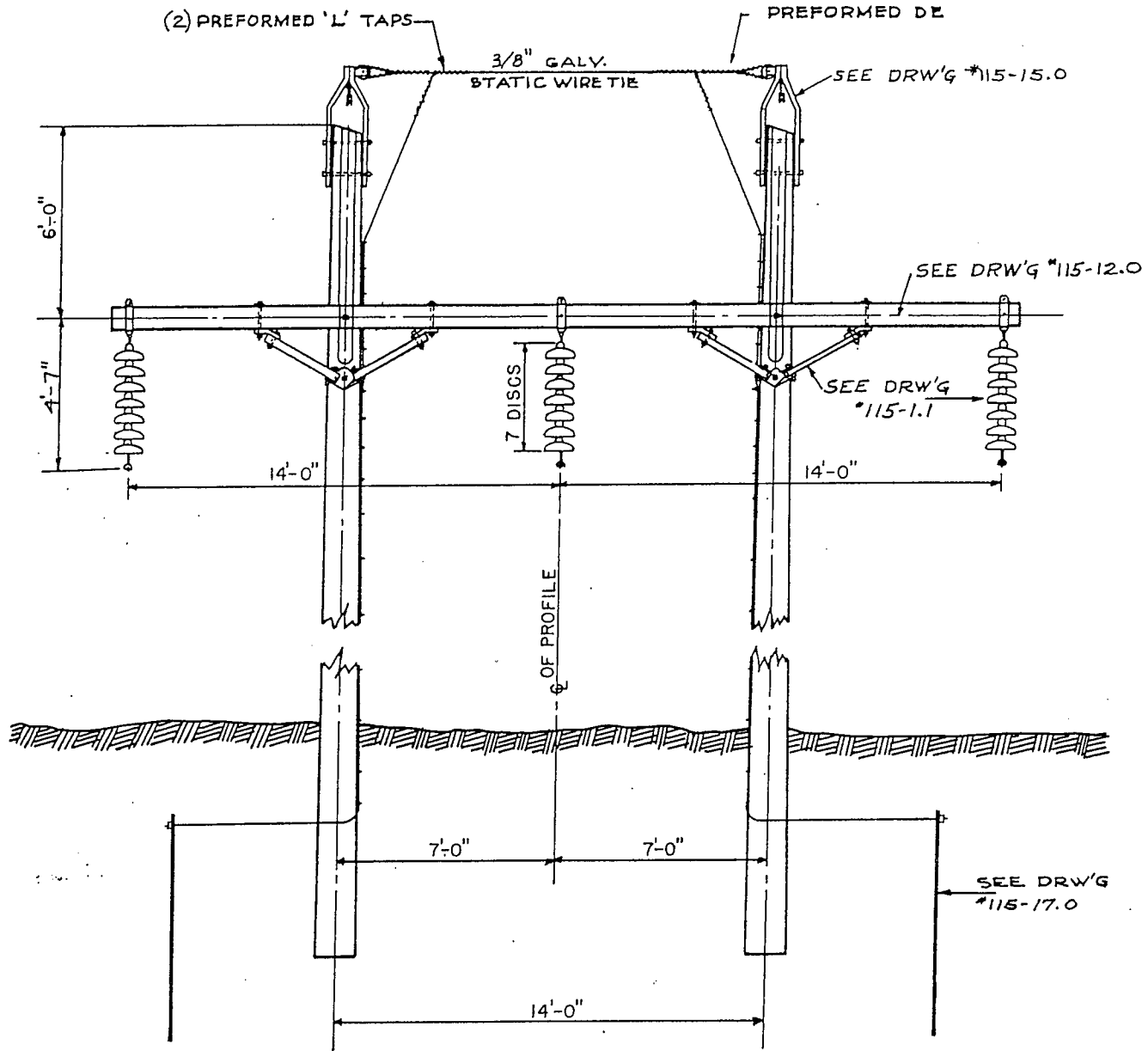
<b>TYPE A-2</b> <b>TANGENT STRUCTURE</b> <b>SPECIAL SPANS</b> <b>115 KV CONSTRUCTION</b>			
VERMONT ELECTRIC POWER COMPANY, INC.			
3/1/77	JM	DRAWN BY JM	CHECKED BY
DATE	CH'K BY	SCALE	APPROVED BY
REVISIONS		NONE	DWG #115-2.0



TYPE A-2 DOUBLE ARM STRUCTURE  
INSULATOR ASSEMBLY

GUY ONLY AS SPECIFIED.

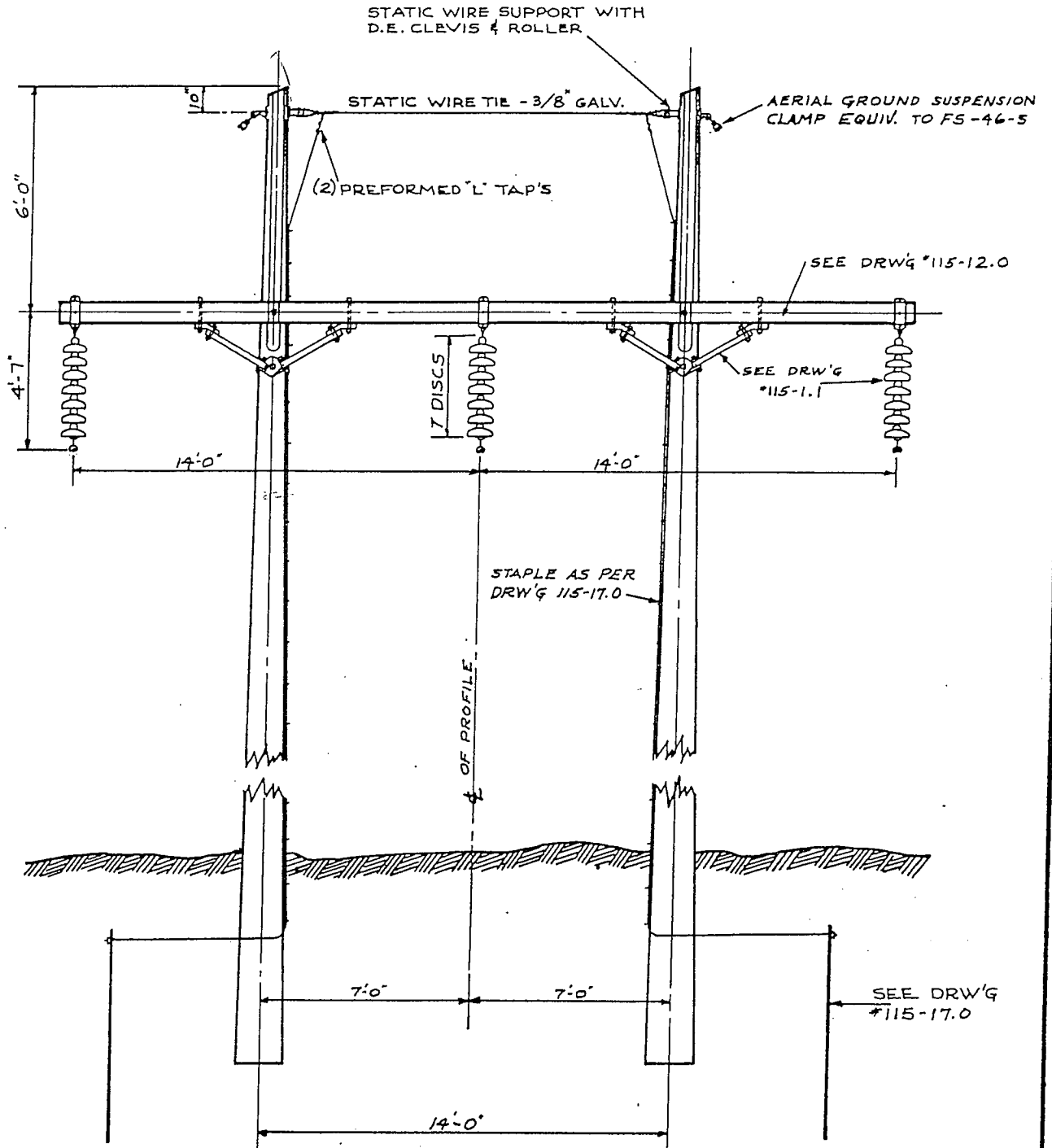
<b>POLE TOP DETAILS</b> <b>TYPES A-2 STRUCTURES</b> <b>115 KV. CONSTRUCTION</b>			
VERMONT ELECTRIC POWER COMPANY, INC.			
5/1/77	[Signature]	DRAWN BY PDA	CHECKED BY
DATE	CH'K BY	SCALE	APPROVED BY
REVISIONS	NONE	DATE 4-11-72	DWG #115-2.1



NOTE: FOR DETAILS NOT INDICATED ON THIS DRW'G SEE TYPE A DRW'G 115-1.0 & 115-8.0 MATERIAL SAME AS TYPE A

<h2 style="margin: 0;">TYPE A-3 &amp; D-3</h2> <h3 style="margin: 0;">SPECIAL FRAMING</h3> <h3 style="margin: 0;">115 KV CONSTRUCTION</h3>			
VERMONT ELECTRIC POWER COMPANY, INC.			
3/1/77	Jp	DRAWN BY M	CHECKED BY
DATE	CHK BY	SCALE	APPROVED BY
REVISIONS		NONE	DWG #115-3.0
			DATE 4/17/72





NOTE: FOR DETAILS NOT INDICATED ON THIS DRW'G SEE TYPE A & TYPE D DRW'G 115-1.0 & 115-8.0 RESPECTIVELY.

		<b>TYPE A-4 &amp; D-4</b>	
		<b>SPECIAL FRAMING</b>	
		<b>115 KV. CONSTRUCTION</b>	
		<b>VERMONT ELECTRIC POWER COMPANY, INC.</b>	
2/1/77	JP	DRAWN BY JM	CHECKED BY
2/13/74			DATE 4/17/72
DATE	CHK BY	SCALE	APPROVED BY
		NONE	
REVISIONS		DWG # 115-4.0	

VERMONT ELECTRIC POWER COMPANY, INC.  
MATERIAL FOR TYPE B STRUCTURE  
115 KV

Mark	Quant	Description	Manuf.	Cat. No.
4	5	Bolts, brace 1/2" x 10"	Joslyn	J 8710
5	3	Bolts, machine 5/8" x 12" for crossarm brace	Joslyn	J 8812
6	6	Bolts, cone head	Joslyn	J 6277
7	3	Bolts, xarm clamps 3/4" x 8"	Joslyn	J 8908
9	1	Bolt, machine 3/4" x 10" pole top	Joslyn	J 8910
10	1	Bolt, machine 3/4" x 12"	Joslyn	J 8912
12	3	Bolts, machine 3/4" x 18" crossarm	Joslyn	J 8918
16	3	Bands, pole - small	Joslyn	J 6280
19	2 1/2 Pr	Brace, wood xarm 60"	Hughes	2000CC
22	8	Preformed DE guy grips	Preformed	GDE 1107
23	6	Preformed "L" taps top guy to static	Preformed	LC MS 5963
26	4	Clevis - deadend	Joslyn	J 456
27	1	Clevis - clevis	Lapp Chance	91597 904-0154
32	1	Anchor log 8'	Koppers	
34	1	Crossarm Type B		
40	3	Rods, anchor 3/4" x 8'	Joslyn	J 7328
40A		Rock Anchors	Chance	R 360 R384 R 372 R 396
41	2	Rods, ground 3/4" x 8'	Joslyn	J 5338
42	8	Lags, screw 1/2" x 4"	Joslyn	8754P
44	2	Clamps, ground rod	L M	DN 14G1
45	1	Clamp, guy ground	Joslyn	1050
47	2	Clamps, suspension for static wire w/ socket fittings	Lapp Bethea	N95750-S FS 46 S
49	3	Clamps, suspension for conductor w/socket fittings	Bethea	ACFS 114-19 25 S
51	3	Clamps, crossarm	Joslyn	J 1820
53	8	Washers, coil spring 3/4"		

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## VERMONT ELECTRIC POWER COMPANY, INC.

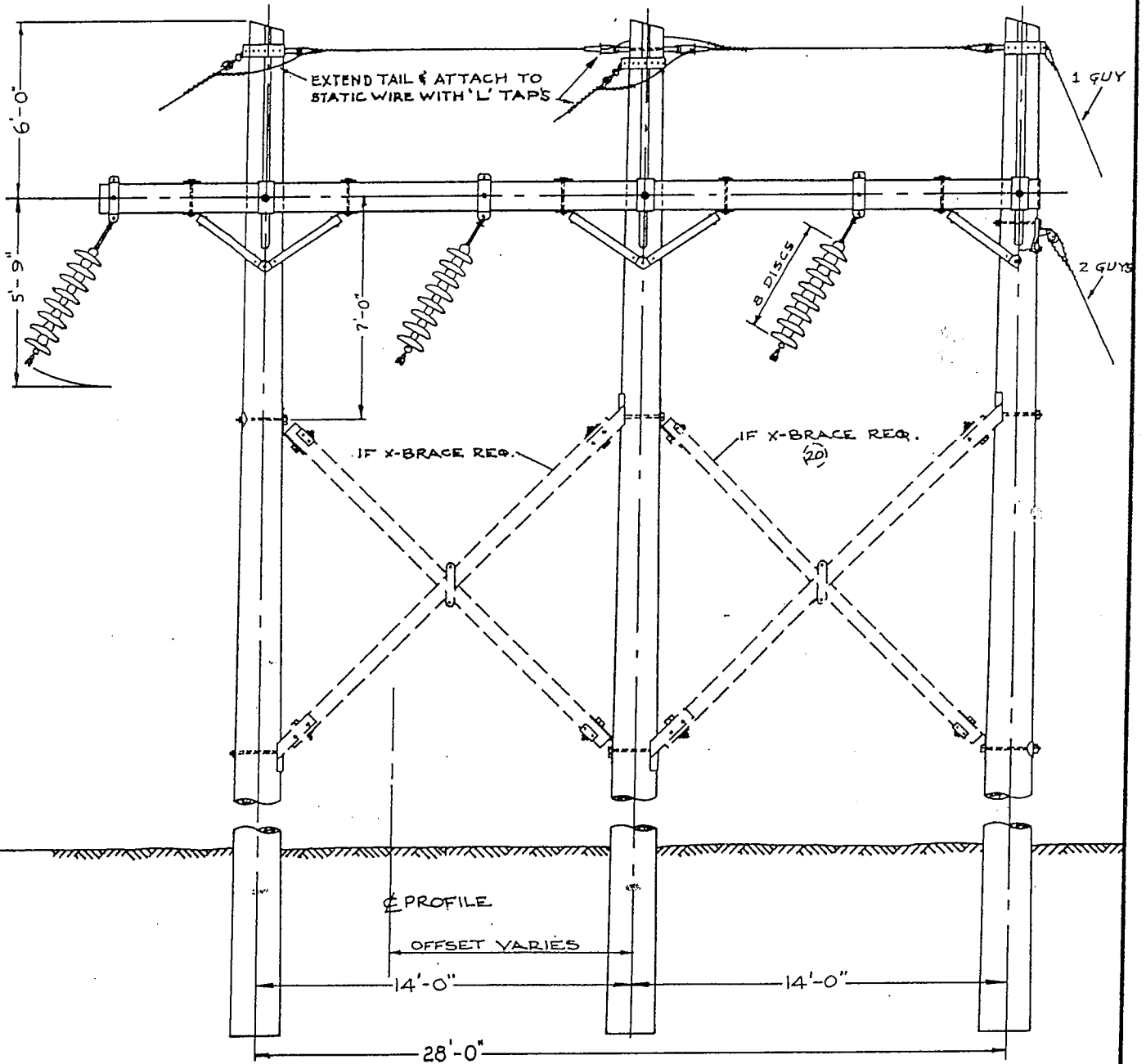
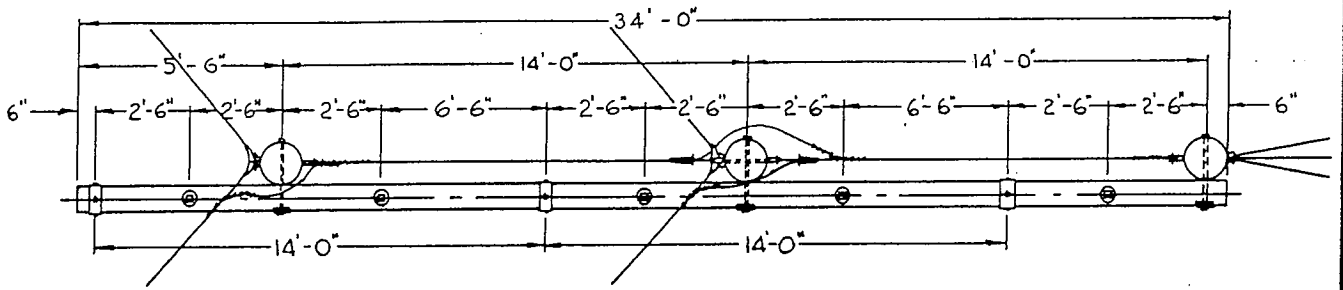
## MATERIAL FOR TYPE B STRUCTURE

115 Kv

Mark	Quant	Description	Manuf.	Cat. No.
54	3	Washers, coil spring 5/8"		
55	13	Washers, coil spring 1/2"		
56	5	Washers, square 2" x 2" x 1/8" 9/16" hole	Joslyn	J 1073
57	4	Washers, curved 4" x 4" x 1/4" 13/16" hole	LAPP MIF	304082 P144
58	3	Washers, square 4" x 4" x 1/4" 7/8" hole	Joslyn	J 1082
59	8	Washers, round 9/16"		
60	3	Washers, curved 3" x 3" x 3/16" 11/16" hole	Lapp MIF	304078 P143
61	3	Guy Guards - metal	Oliver	808
62	2	Strandvise for span guys	Reliable	5152
63	3	Reinforcement plates for xarms	Joslyn	J 4047
66	20'	Cable, buried grd, 3/8" galv. 3-strd	(common grade)	
68	230'	Cable, guying 3/8" E HS galv. steel		
69	35'	Cable, cross tie 3/8" EHS		
72	2	Ball eye, long	Lapp BTC	6422 3014
70	3	Oval eye ball extension link	Lapp BTC	300024 3004 HT
76	5	Sheave wheel	Joslyn	J 6288
77	1	Pole eye plate	MIF	PX88
78	1	Guy attachment double sheave	Joslyn	J6274
82	24	Insulators, susp, 9" disc (8 per string )	Lapp GE	9000-70 155-409-
				ASA-70
		<u>When Required</u>		
20	2	X-brace w/mounting hardware	Hughes	1042X
73	3	150# Weights	Bethea	ASM 389-150 M-H
74	3 sets	Rods, armor		
79		Pole roof, non metallic (used if pole cut in field)	Joslyn	J 2108

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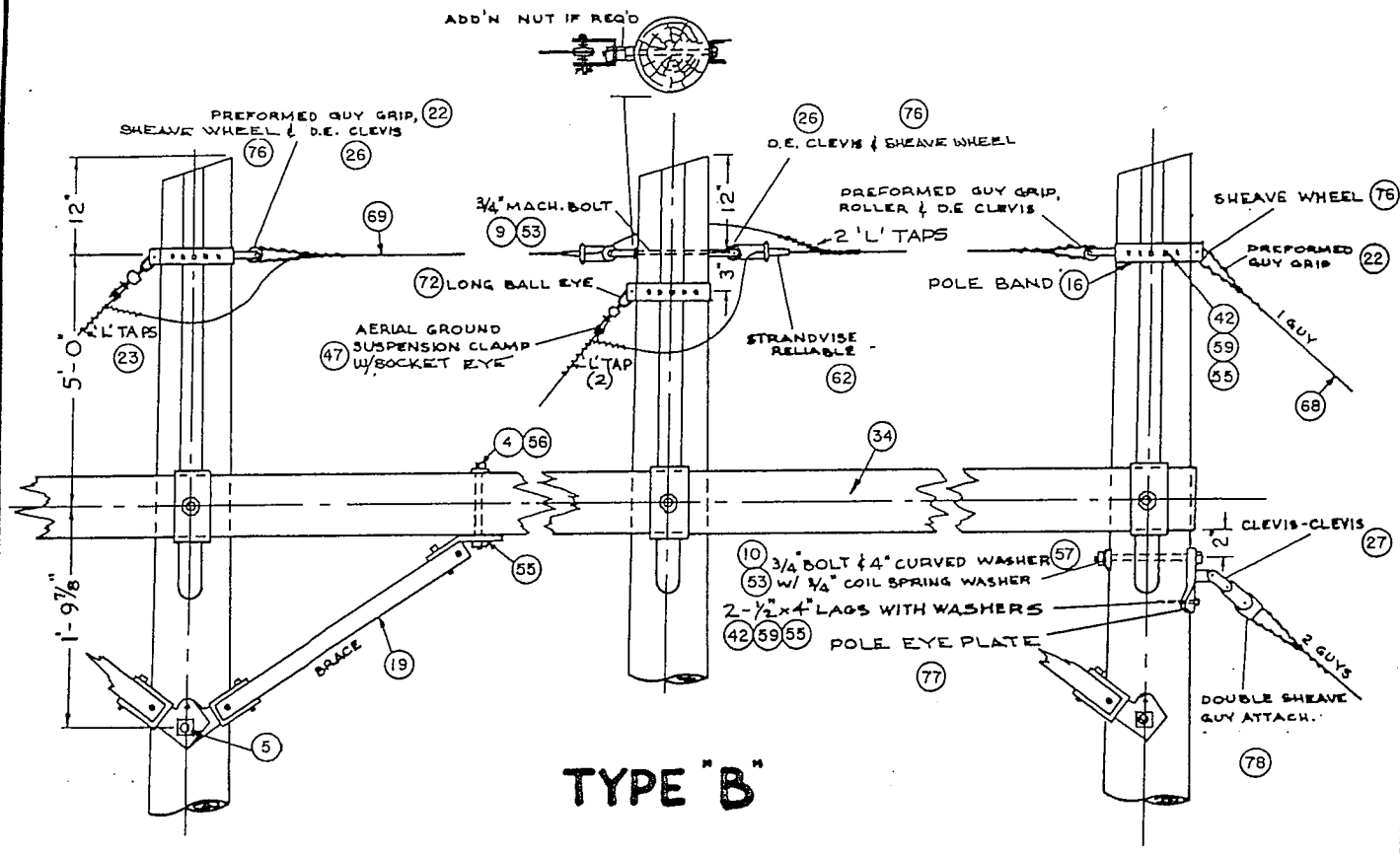
Rev. 2/74



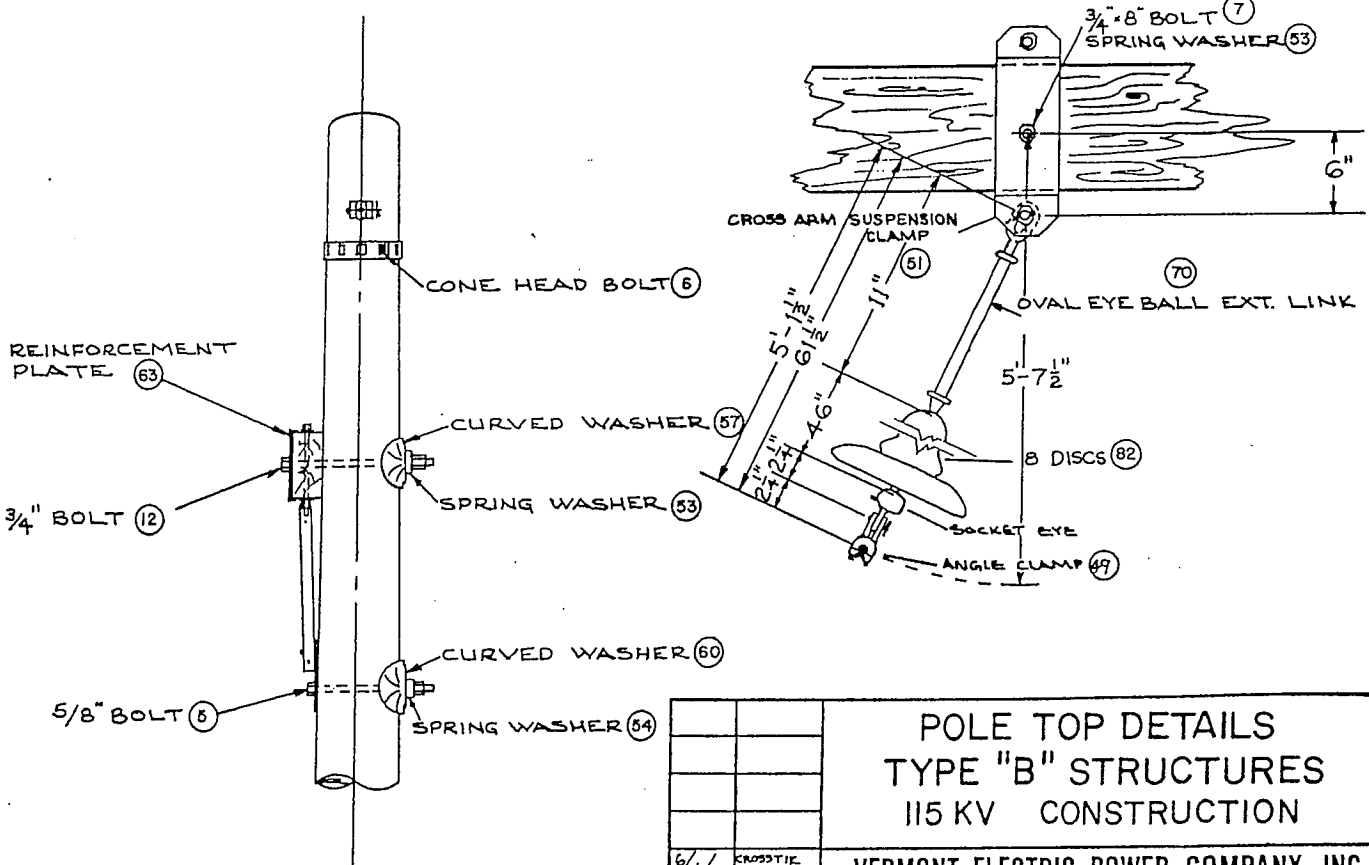
**-NOTES-**

1. FOR 1/2 0°-3° CONSIDER TYPE 'A'. (SEE DESIGN LIMITATIONS). GUYING DRWG #115-18.0.
2. POLE BANDS TO BE TIGHT & LAGGED WITH 2 LAGS, ROUND WASHER & SPRING WASHERS.
3. CONE HEAD BOLTS NOT UNDER TENSION TO BE SECURED WITH LOCKNUT.

		<b>TYPE "B" STRUCTURE FOR ANGLES TO 10°</b>	
		<b>115 KV. CONSTRUCTION</b>	
		<b>VERMONT ELECTRIC POWER COMPANY, INC.</b>	
6/1/77	CADRETS PR	DRAWN BY P.D.A.	CHECKED BY
3/1/77	JSC	DATE 4-14-72	
DATE	C'H'K BY	SCALE	APPROVED BY
		NONE	DWG #115-5.0
REVISIONS			



### TYPE "B"



		<b>POLE TOP DETAILS TYPE "B" STRUCTURES 115 KV CONSTRUCTION</b>		
		<b>VERMONT ELECTRIC POWER COMPANY, INC.</b>		
6/1/77	CROSS TIE PR	DRAWN BY JM	CHECKED BY	DATE 3/9/72
3/1/77	de	SCALE	APPROVED BY	DWG # 115-5.1
REVISIONS		NONE		

## VERMONT ELECTRIC POWER COMPANY, INC.

## MATERIAL FOR TYPE B-2 STRUCTURE

115 Kv

Mark	Quant	Description	Manuf.	Cat. No.
2	3	Swinging angle bracket, w/washer bolt, and locknut, washer nut	Hughes	2821.1A
4	10	Bolts, 1/2" x 10" - brace	Joslyn	J 8710
5	3	Bolts, 5/8" x 12" for crossarm brace	Joslyn	J 8812
6	6	Bolts, cone head	Joslyn	J 6277
9	1	Bolt, thru 3/4" x 10"	Joslyn	J 8910
10	1	Bolt, thru 3/4" x 12"	Joslyn	J 8912
13	3	Bolts, thru 3/4" x (24") (26") (28")	Joslyn	J 8924, 8926 J 8928
14	6	Bolts, eye - forged shoulder w/washer nut MF locknut and cotter pin	Joslyn	J 2180
15	12	Bolts, 5/8" x 10" for plate and channel	L M	DF 3B10
16	3	Pole bands, small	Joslyn	J6280
19	5 prs	Xarm brace wood 60"	Hughes	2000CC
21-1	6 sets	Plate and channel 21" long		
22	8	Preformed guy grips deadend	Preformed	GDE 1107
23	6	Preformed "L" taps	Preformed	LC MS 5963
25	3	Clevis - ball extension link	Lapp BTC	90258A 3094-2
26	4	Clevis - deadend	Joslyn	456
27	1	Clevis - clevis	Lapp Chance	91597 904-0154
32	1	Anchor log 8'	Koppers	
34	2	Crossarm Type B	Haley	
40	3	Anchor rod 3/4" x 18'	Joslyn	J 7328
40A		Rock anchors	Chance	R 360 R 384 R 372 R 396
41	2	Ground rod 3/4" x 8'	Joslyn	J 5338
42	8	Lags, screw 1/2" x 4"	Joslyn	8754P
44	2	Clamps, ground rod	L M	DNL4G1
45	1	Clamp, guy ground	Joslyn	J 1050

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rev 2/77

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## VERMONT ELECTRIC POWER COMPANY, INC.

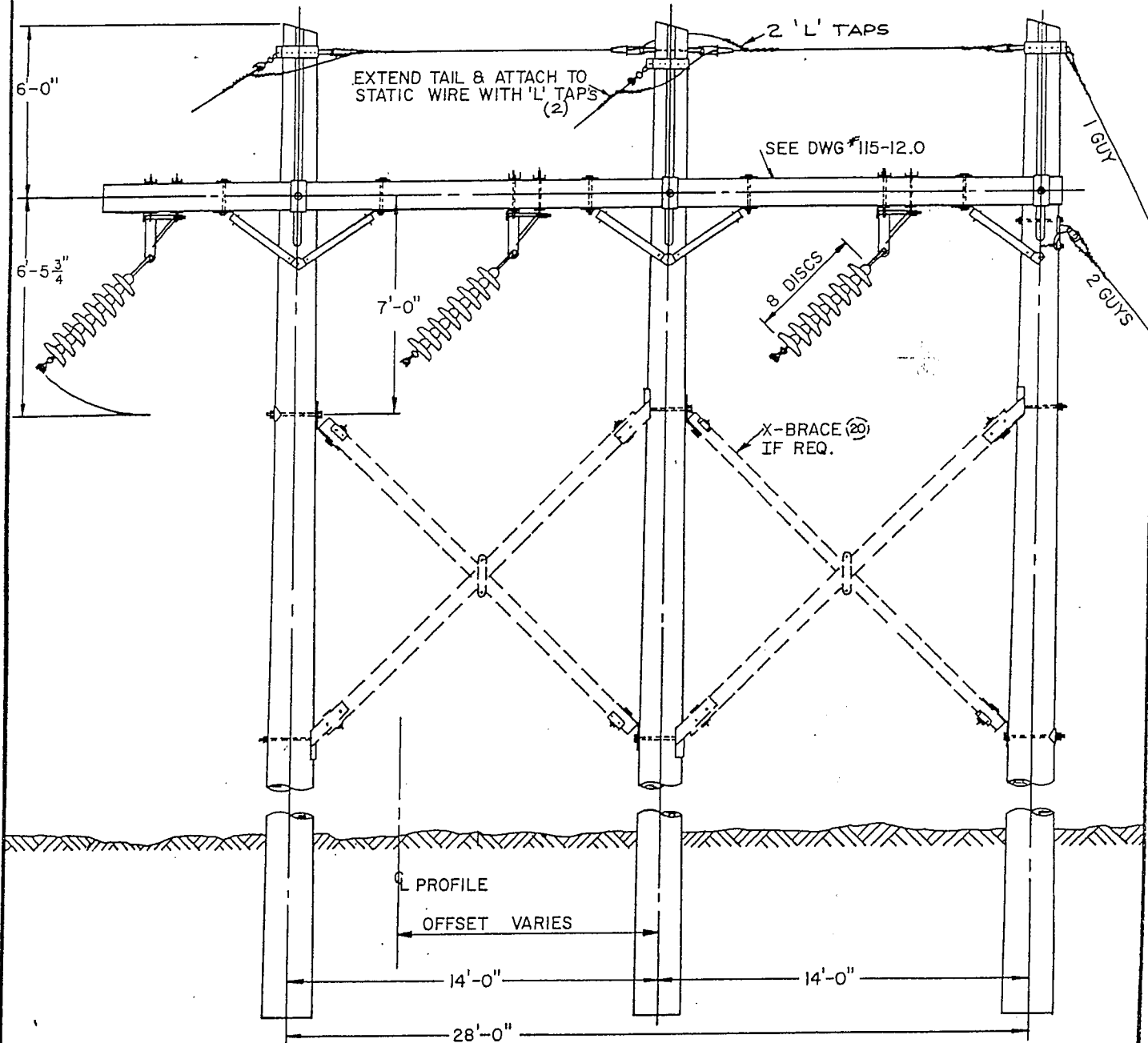
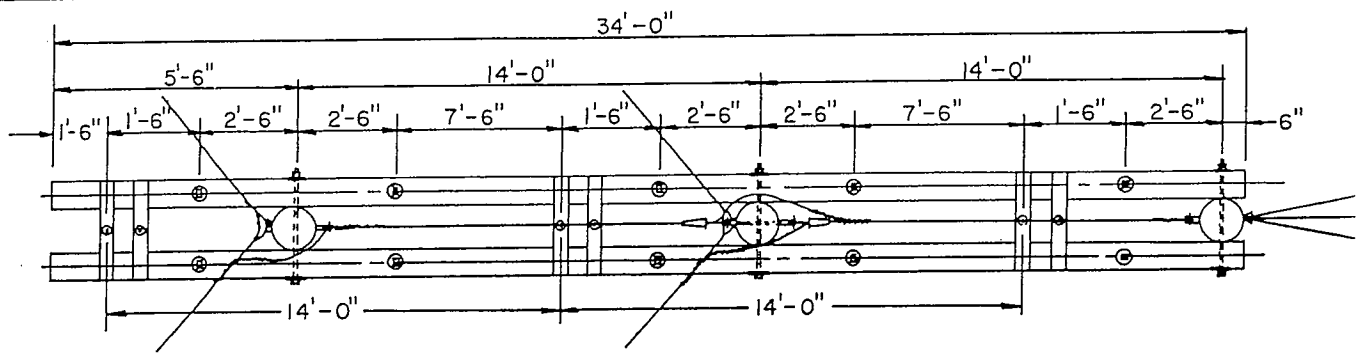
## MATERIAL FOR TYPE B-2 STRUCTURE

115 Kv

Mark	Quant	Description	Manuf.	Cat. No.
47	2	Clamps, suspension w/socket fittings (for S.W)	Lapp Bethea	N95750-S FS 46S
50	3	Clamps, suspension w/socket fittings (for cnnd)	Bethea	ACF 114-26- 30-S
53	5	Washers, coil spring 3/4"		
54	15	Washers, coil spring 5/8"		
55	18	Washers, coil spring 1/2"		
56	10	Washers, square 2" x 2" x 1/8" 9/16" hole	Joslyn	J1073
57	1	Washer, curved 4" x 4" x 1/4" 13/16" hole	Lapp MIF	304082 P144
58	3	Washers, flat, 4" x 4" x 1/4" 7/8 " hole	Joslyn	J 1082
59	8	Washers, round 9/16" hole		
61	3	Guy Guards metal	Oliver	808
62	2	Strandvise	Reliable	5152
63	6	Reinforcement plate	Joslyn	J 4047
66	20'	Cable, 3/8" galv. 3-strd (common grade)		
68	230'	Cable, guying 3/8" EHS galv. steel		
69	35'	Cable, 3/8" galv 3-strd for cross tie EHS		
72	2	Ball eye, long	Lapp BTC	6422 3014
76	5	Sheave wheel (roller)	Joslyn	J6288
77	1	Pole eye plate	Lapp MIF	304021 PX 88
78	1	Guy attachment double sheave	Joslyn	J6274
82	24	Insulators susp. 9" disc (8 per string)	Lapp GE	9000-70 155-409- ASA-70
		<u>When Required</u>		
20	2	Xbraces - w/mounting hardware	Hughes	1042X
73	3	150# Weights	Bethea	ASM 389-150 M-H
74	3 sets	Rods, armor		
79	.	Pole roof, non metallic (used if pole cut in field)	Joslyn	J 2108

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Rev 2/7

Rev. 2/74

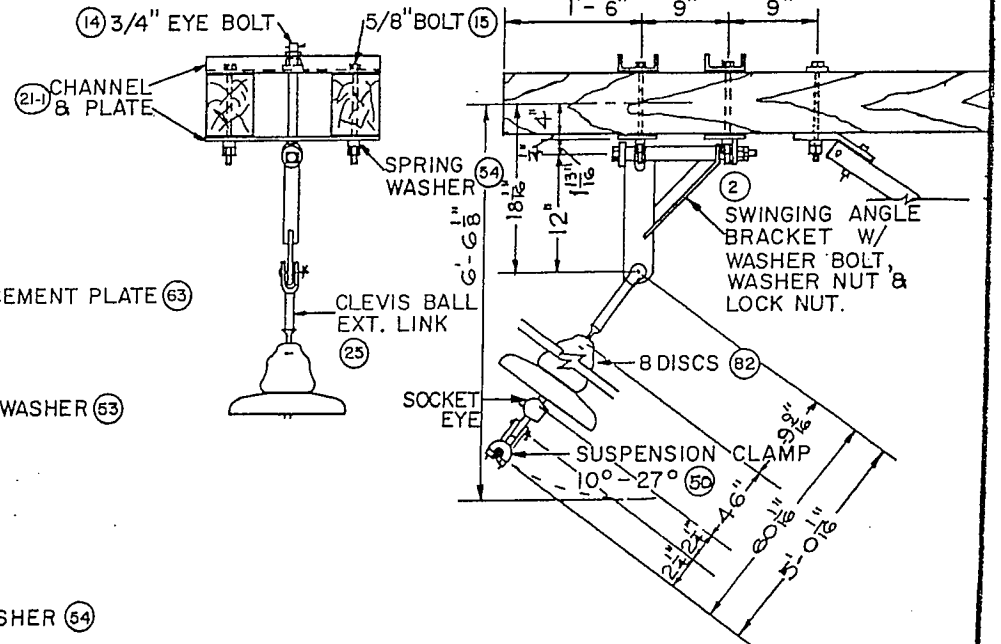
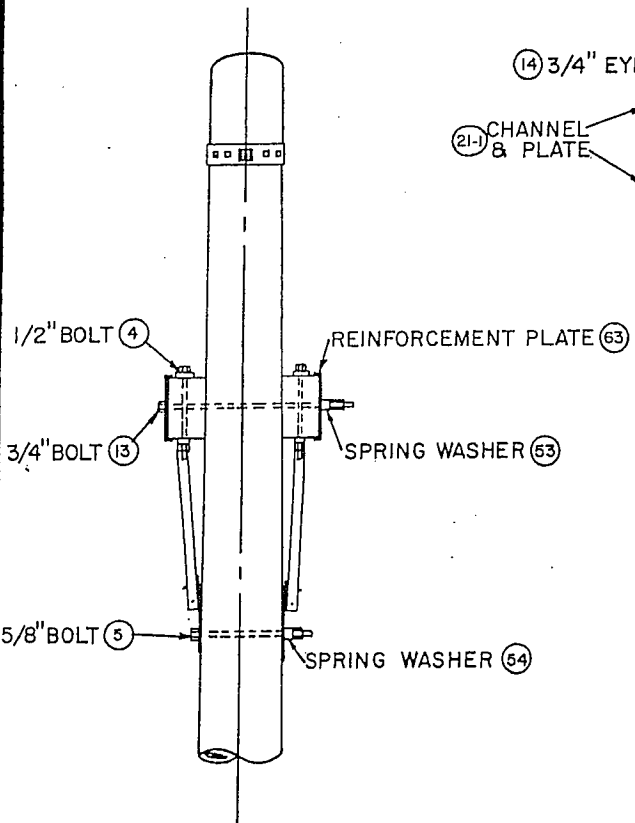
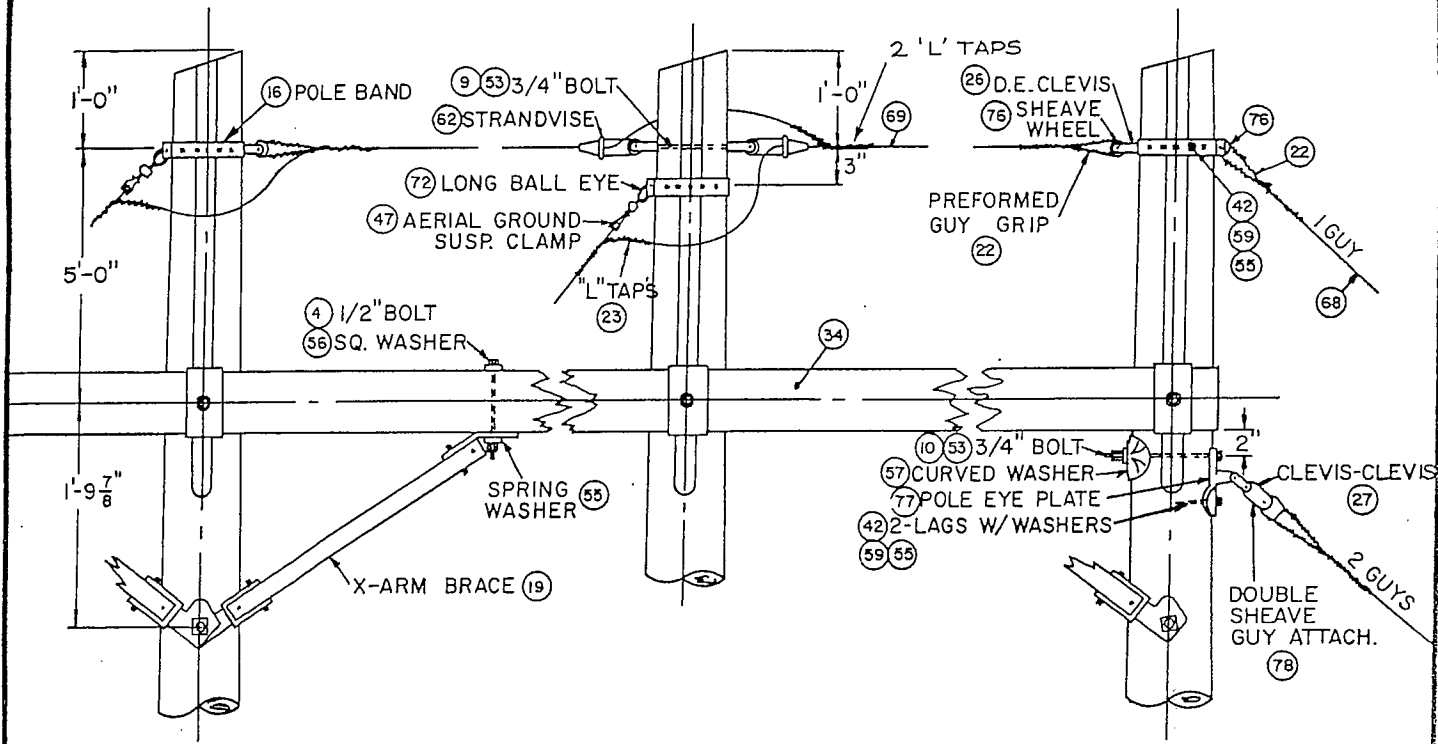
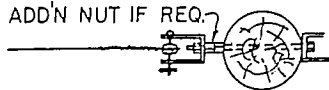


**NOTE:**

1. POLE BANDS TO BE TIGHT & LAGGED WITH 2 LAGS, ROUND WASHERS & SPRING WASHERS.
2. CONE HEAD BOLTS NOT UNDER TENSION TO BE SECURED WITH LOCKNUTS.

		<b>TYPE "B-2" STRUCTURE FOR ANGLES 10°-27° 115 KV CONSTRUCTION</b>	
6/1/77	CROSSING PR	<b>VERMONT ELECTRIC POWER COMPANY, INC.</b>	
3/1/77	22	DRAWN BY <b>JM</b>	CHECKED BY
2/13/74	BK TP 2 LOCATION	DATE <b>3/21/72</b>	
DATE	C'H'K BY	SCALE	APPROVED BY
		<b>NONE</b>	
REVISIONS			<b>DWG #115-6.0</b>





		<b>POLE TOP DETAILS TYPE "B-2" STRUCTURES 115 KV CONSTRUCTION</b>		
9/1/77	CROSSTIE PR	<b>VERMONT ELECTRIC POWER COMPANY, INC.</b>		
3/1/77	JDC			
2/25/74	CHANGE 1 PLATES			
2/13/74	+BKT #2 LOCATION			
DATE	C.H.K BY	DRAWN BY JM	CHECKED BY	DATE 3-15-72
REVISIONS		SCALE	APPROVED BY	DWG # 115-6.1
		NONE		

VERMONT ELECTRIC POWER COMPANY, INC.  
MATERIAL FOR TYPE C STRUCTURE  
115 KV

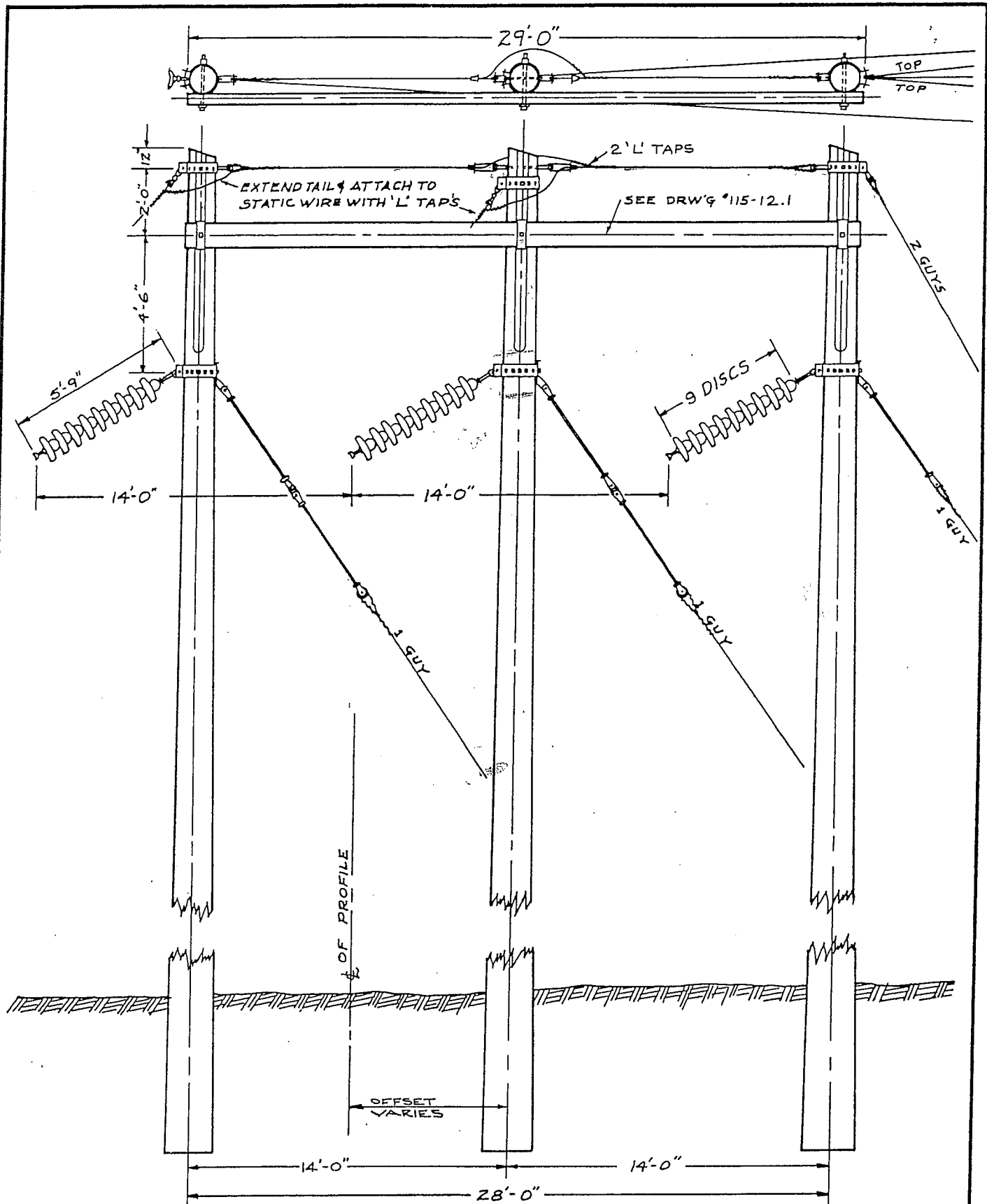
Mark	Quant	Description	Manuf.	Cat. No.
6	12	Bolts, Cone head	Joslyn	J 6277
9	1	Bolt, 3/4" x 10" pole top	Joslyn	J 8910
11	3	Bolts, 3/4" x 16" crossarm	Joslyn	J 8916
16	3	Bands, pole - small	Joslyn	J 6280
17	3	Bands, pole - large	Joslyn	J 6270
18	3	Bands, pole extension	Joslyn	J 6272
22	12	Preformed deadend guy grips	Preformed	GDE 1107
23	6	Preformed "L" taps (for top guy to static)	Preformed	LC-MS-5963
26	4	Clevis - deadend	Joslyn	J 456
29	3	Twist clips for down guys	Joslyn	J 6282A
31	2	Anchor logs 4'	Koppers	
32	1	Anchor log 8'	Koppers	
35	1	Crossarm Type C		
40	5	Rods, anchor 3/4" x 8'	Joslyn	J 7328
40A		Rock anchors	Chance	R 360 R 384 R 372 R 396
41	2	Rods, ground 3/4" x 8'	Joslyn	J 5338
42	12	Lags, screw 1/2" x 4"	Joslyn	8754P
43	1	Insulators, fiberglass strain	Anderson	GSI 3-54-1P
43A	4	Insulators, fiberglass strain	Anderson	GSI 3-78-1P
44	2	Clamps, ground rod connector	L M	DNL4G1
45	2	Clamp, guy ground	Joslyn	J 1050
47	2	Clamps, suspension-static wire w/socket ftg	Lapp Bethea	N95750 FS-46-S
50	3	Clamps, suspension conductor- w/socket eye	Bethea	ACFS 114- 26-30S
52	2	Chain Links	BTC	3082
53	4	Washers, coil spring 3/4"		
55	12	Washers, coil spring 1/2"		

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VERMONT ELECTRIC POWER COMPANY, INC.  
MATERIAL FOR TYPE C STRUCTURE  
115 KV

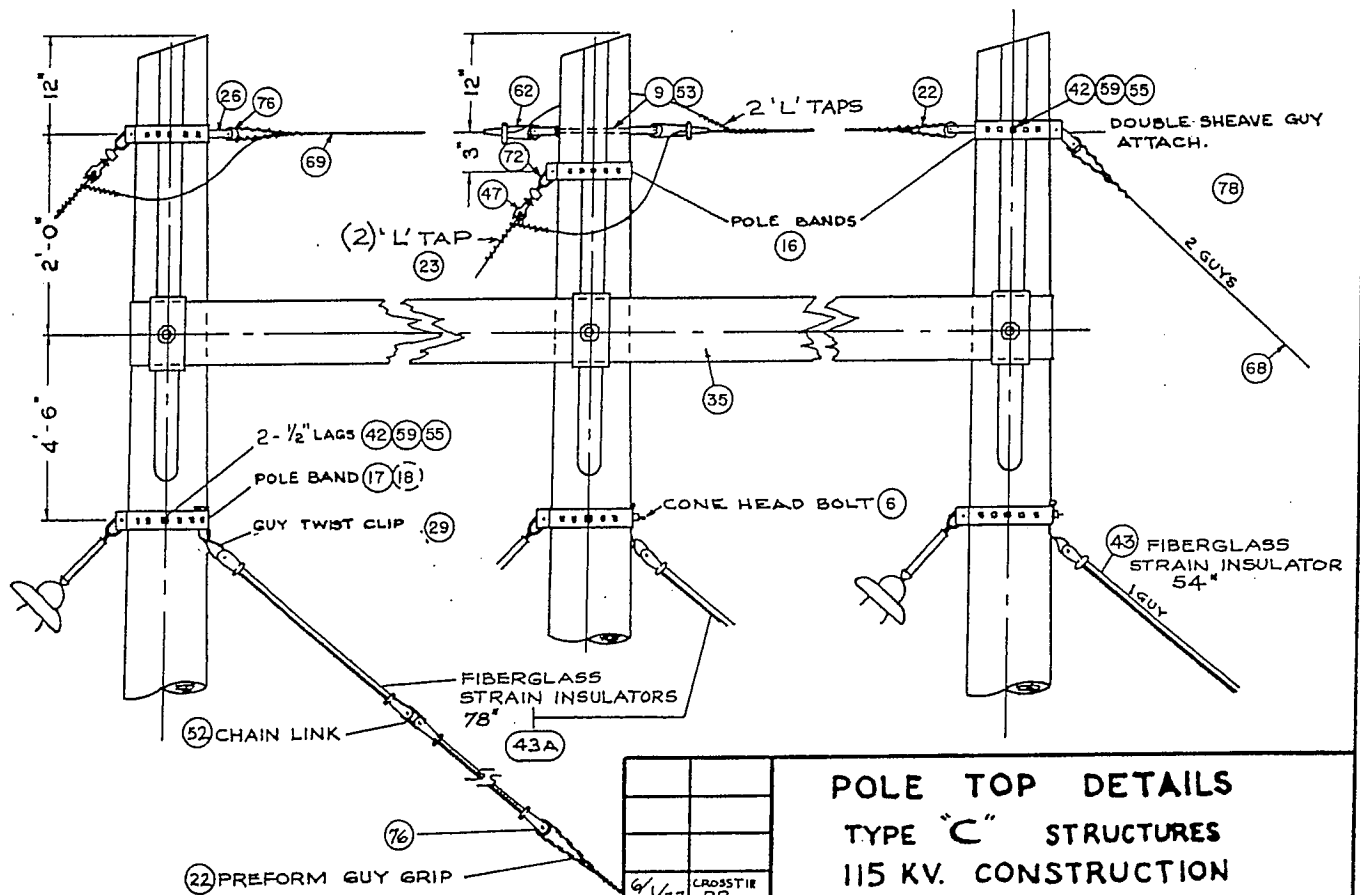
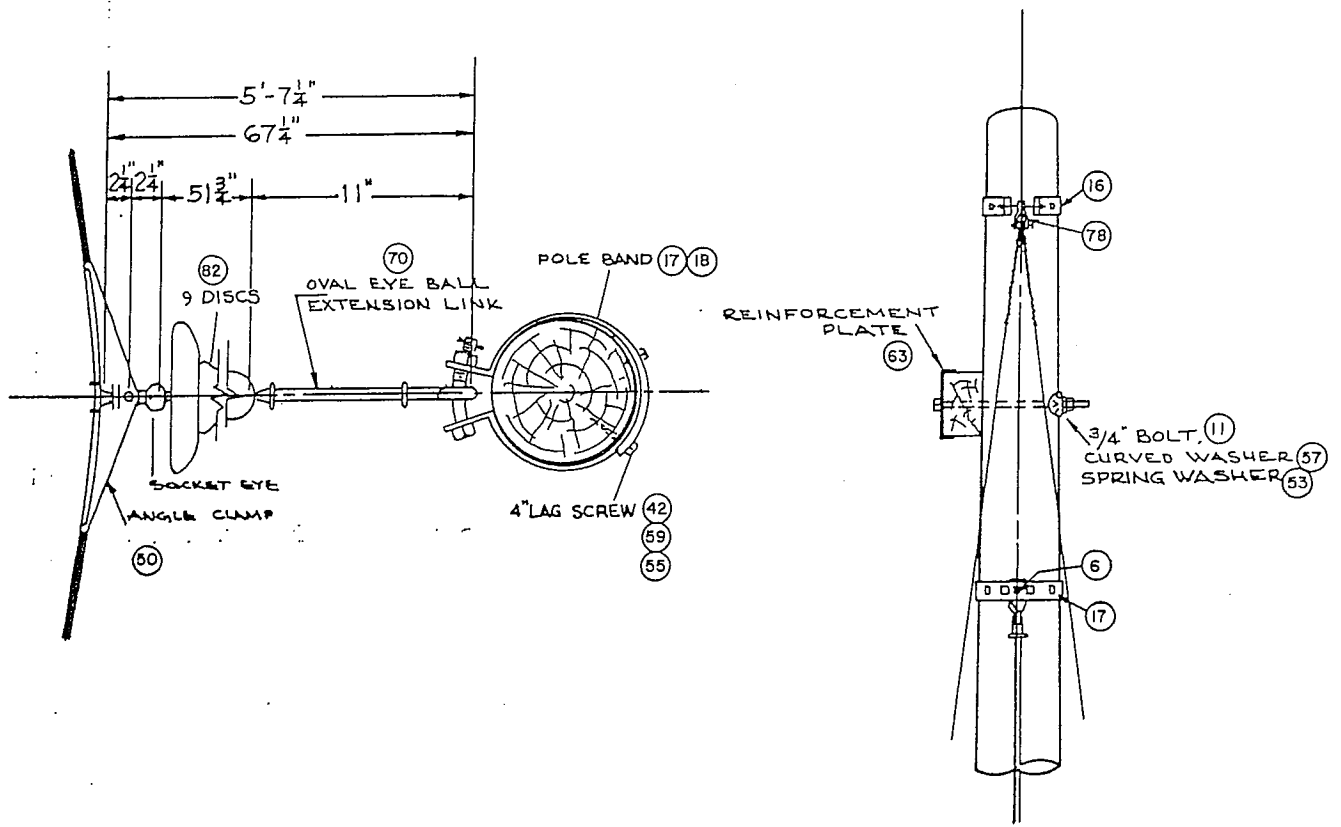
Mark	Quant	Description	Manuf.	Cat. No.
57	3	Washers, curved 4" x 4" x 1/4" 13/16" hole	Lapp MIF	804082 P 144
58	5	Washers, square 4" x 4" x 1/4" 7 / 8 hole	Joslvn	J 1082
59	12	Washers, round 1/2"		
61	5	Guy guards - metal	Oliver	808
62	2	Strandvise for span guys	Reliable	5152
63	3	Reinforcement plates	Joslyn	4047
66	20'	Cable, buried grd. 3/8" Galv. 3-strd	(common grade)	
68	300'	Cable, guying 3/8" EHS galv. steel		
69	35'	Cable, cross tie 3/8" galv. 3-strd. EHS		
70	3	Oval eye ball extension links	Lapp BTC	300024 3004HT
72	2	Ball eye - long	Lapp BTC	6422 3014
76	7	Roller eye	Joslyn	J 6288
78	1	Guy attachment double sheave	Joslyn	J 6274
82	27	Insulators, suspension 9" disc (9 per string)	Lapp GE	9000-70 155-409- ASA-70
		<u>When Required</u>		
73	3	150# Weights	Bethea	ASM 389-150 M-H
74	3 sets	Armor rods		
79		Pole roof, non-metallic (used if pole cut off in field)	Joslyn	J 2108

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**NOTE:**  
 1. POLE BANDS TO BE TIGHT AND LAGGED WITH 2 LAGS, ROUND WASHERS & SPRING WASHERS.  
 2. CONE HEAD BOLTS NOT UNDER TENSION TO BE SECURED WITH LOCKNUT.

<b>TYPE-C STRUCTURE</b>			
ANGLES 27° TO 50°			
115 KV CONSTRUCTION			
VERMONT ELECTRIC POWER COMPANY, INC.			
9/1/77	CROSS TIB PR	DRAWN BY JM	DATE 4/7/72
8/1/77	JLP	SCALE	DWG #
DATE 2/13/74		NONE	115-7.0



POLE TOP DETAILS			
TYPE "C" STRUCTURES			
115 KV. CONSTRUCTION			
6/1/77	CROSSTIE PR	VERMONT ELECTRIC POWER COMPANY, INC.	
2/1/77	Jc	DRAWN BY P.D.A. CHECKED BY DATE 4/7/72	
2/13/77	FIBER- GLASS INSULATOR	APPROVED BY	
DATE	CHK BY	SCALE	DWG #115-71
		NONE	

VERMONT ELECTRIC POWER COMPANY, INC.  
MATERIAL FOR TYPE D STRUCTURE  
115 KV

Mark	Quant	Description	Manuf.	Cat. No.
1	2	Bayonets, complete w/plate, filler washer, w/bolts, nuts, washers (2" x 5/8" and 2 1/2" x 5/8")	L M	DN 3B2
3	4	Bolts, machine 5/8" x 10" (12") for bayonet	Joslyn	J8810,8812
4	8	Bolts, brace 1/2" x 10"	Joslyn	J 8710
5	2	Bolts, machine 5/8" x 12" for cross brace	Joslyn	J 8812
13	2	Bolts, machine 3/4" x 24" (26") (28")	Joslyn	J8924,8926 J8928
14	3	Bolts, eye 3/4" x 10" -forged shoulder w/ cotter pin or dbl. nut and lock washer	Joslyn	J 2180
15	6	Bolts, 5/8" x 10" for plate & channel	L M	DF 3B10
19	4 pr	Brace wood xarms	Hughes	2000CC
20	1	Xbrace w/mounting hardware	Hughes	1042X
21	3	Channel & Plate	L M	66D901M1 DP23A3
22	2	Preformed guy grips - deadend	Preformed	GDE 1107
23	4	Preformed "L" taps	Preformed	LC-MS-5963
26	2	Clevis - deadend	Joslyn	J 456
28	6	Clevis - ball	Lapp OB	6227 70689
30	6	Plates - yoke 18"	Chance	C904-0329
36	2	Crossarms Type D		
39A	6	Socket clevis	Lapp BTC	6228 3040
41	2	Rods, ground 3/4" x 8'	Joslyn	J 5338
44	2	Clamps, ground rod 3/4"	L M	DN 14G1
46	2	Clamps, suspension for s/w	Lapp Bethea	N95750 FS-46
48	3	Clamps, suspension w/clevis for cond.	Bethea	ACFS 114-19 -25C
53	2	Washers, coil spring 3/4"		
54	12	Washers, coil spring 5/8"		
55	8	Washers, coil spring 1/2"		

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VERMONT ELECTRIC POWER COMPANY, INC.  
MATERIAL FOR TYPE D STRUCTURE  
115 KV

Mark	Quant	Description	Manuf.	Cat. No.
56	8	Washers, 2" x 2" x 1/8" - 9/16" hole square	Joslyn	J 1073
63	4	Reinforcement plate for Xarms	Joslyn	J 4047
64	75	Staples 3/8" x 1-3/4"	Joslyn	J 173
67	120'	Down lead 3/8" galv. 3-strd - common grade		
69	14'	Static wire 3/8" galv. cross tie		Common Grade
75	3	Shackle - anchor	BTC	3023
76	2	Sheave wheel (roller eye)	Joslyn	J 6288
82	48	Insulators, Discs 9" (8 per string)	Lapp GE	9000-70 155-409- ASA-70
		<u>When Required</u>		
73	3	150# Weights	Bethea	ASM 389-150 M-H
74	3 sets	Armor rods		
79		Pole Roof, non-metalic(used if pole cut in field)	Joslyn	J 2108
		<u>Line Guys - When Required</u>		
10	2	Bolts, thru 3/4" x 12"	Joslyn	J 8912
10A	2	Bolts, thru 3/4" x 14"	Joslyn	J 8914
22	8	Preformed Guy grips - deadend	Preformed	GDE 1107
24	4	Thimble Clevis	Lapp MIF	304056 PA 271
31	4	Anchor logs 4 ft.	Koppers	
40A		Rock anchors	Chance	R360, 372 R384 396
45	4	Clamp, ground guy	Joslyn	J 1050
53	4	Washers, coil spring 3/4"		
58	4	Washers, 4" x 4" x 1/4" w/ 7/8 " hole Flat	Joslyn	J1082
40	4	Rods, anchor 3/4" x 8'	Joslyn	J 7328

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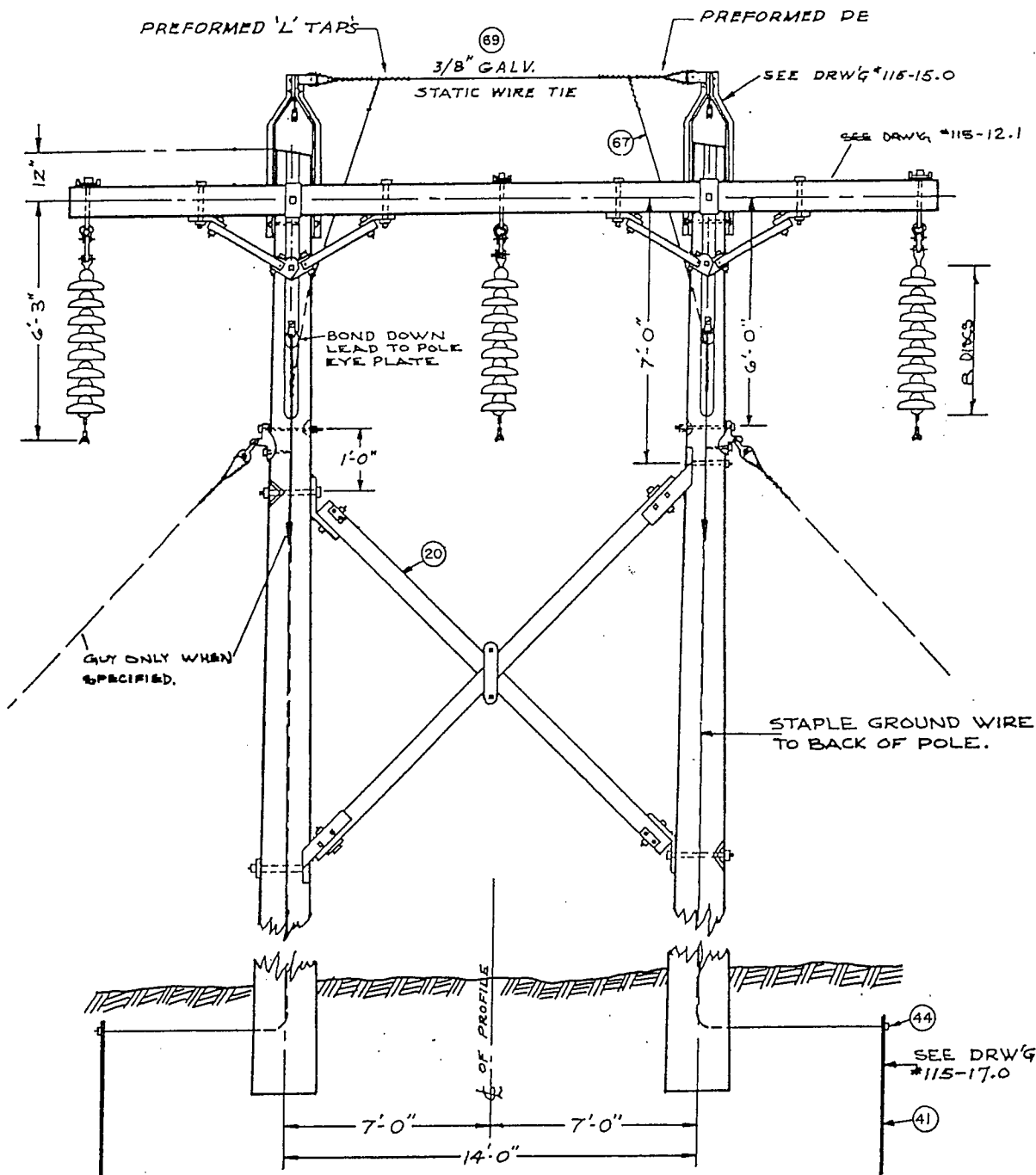
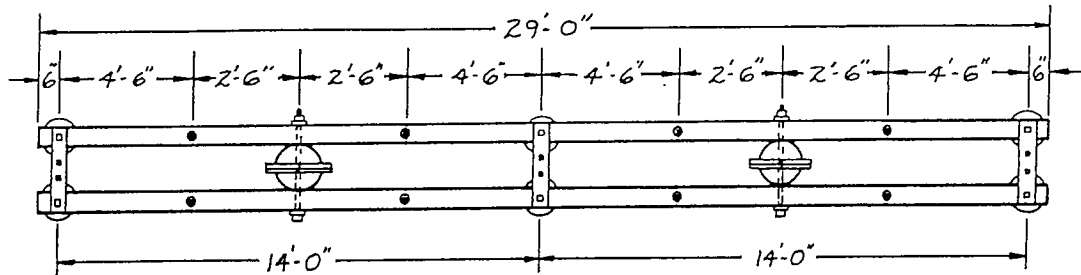
VERMONT ELECTRIC POWER COMPANY, INC.  
MATERIAL FOR TYPE D STRUCTURE  
115 KV

Mark	Quant	Description	Manuf.	Cat. No.
61	4	Guy guards - metal	Oliver	808
66	230'	Cable, 3/8" galv. 3-strd.(common grade)		
68	275'	Cable, guying 3/8" EHS Galv. Steel		
77	4	Pole eye plate	Lapp MIF	304021 PX 88
<u>Side Guys - When Required</u> Refer to Side Guy Materials for Type "A"				

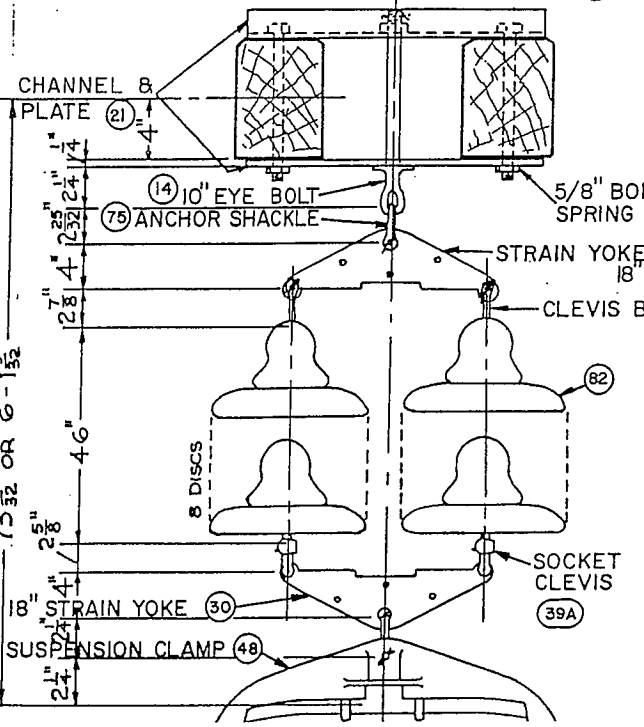
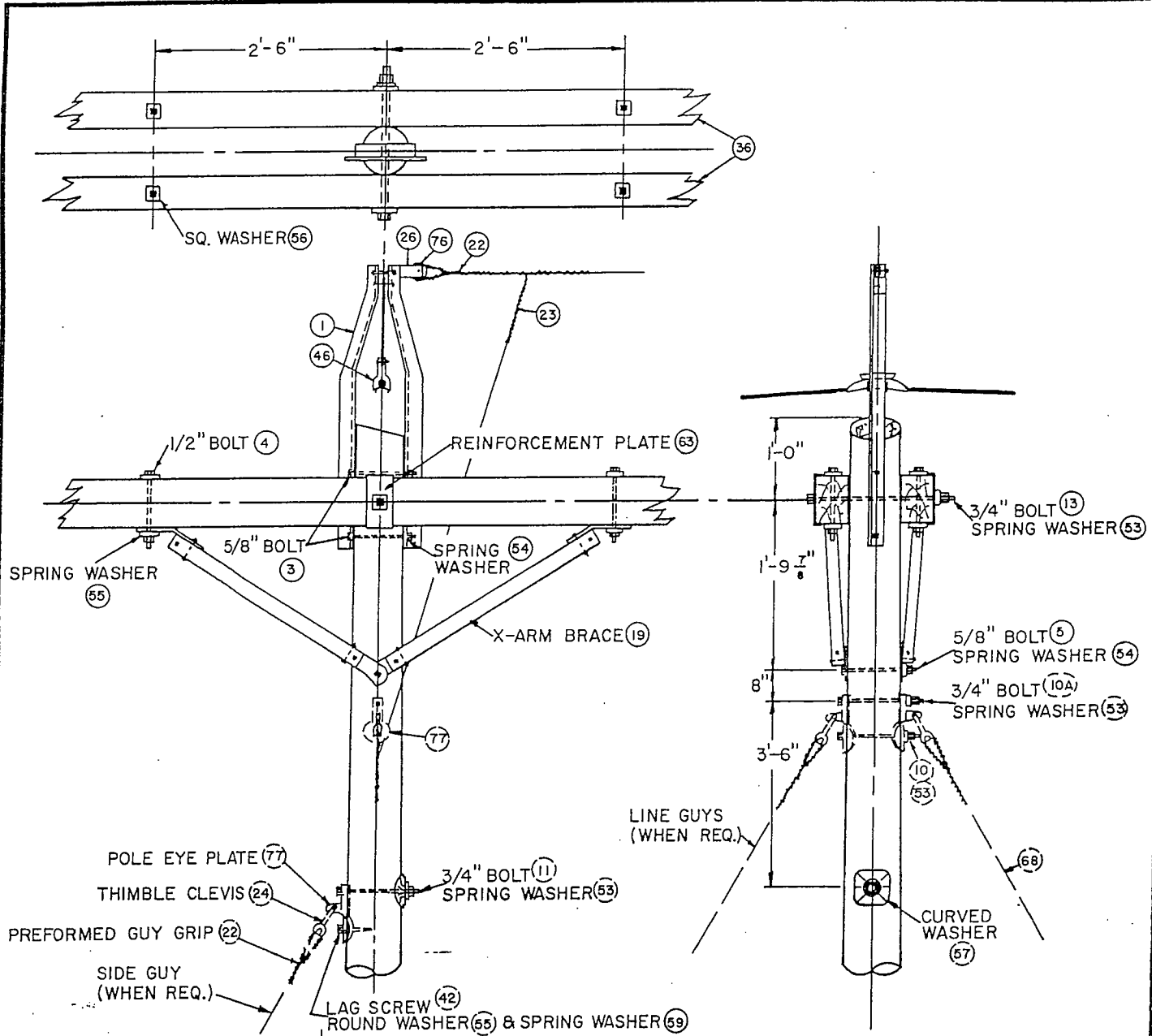
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<b>TYPE - D</b>			
<b>HWY &amp; RAILROAD X-INGS</b>			
<b>115 KV CONSTRUCTION</b>			
VERMONT ELECTRIC POWER COMPANY, INC.			
3/1/77	JM	DRAWN BY	DATE 4/19/72
DATE		SCALE	DWG#
REVISIONS	NONE		115-8.0



<p style="text-align: center;"><b>POLE TOP DETAILS TYPE "D" STRUCTURES 115 KV CONSTRUCTION</b></p>			
<p style="text-align: center;"><b>VERMONT ELECTRIC POWER COMPANY, INC.</b></p>			
<p>3/1/77</p>	<p>✓</p>	<p>DRAWN BY JM</p>	<p>CHECKED BY</p>
<p>DATE</p>	<p>C'H'K BY</p>	<p>SCALE</p>	<p>APPROVED BY</p>
<p>REVISIONS</p>		<p>NONE</p>	<p>DATE 4/19/72</p>
<p>DWG # 115-8.1</p>			<p>82</p>

## VERMONT ELECTRIC POWER COMPANY, INC.

## MATERIAL FOR TYPE DA STRUCTURE

115 KV

Mark	Quant	Description	Manuf.	Cat. No.
6	18	Bolts, cone head	Joslyn	J 6277
7	3	Bolts, Xarm clamp 3/4"	Joslyn	J 8908
9	1	Bolt, thru 3/4" x 10"	Joslyn	J 8910
11	3	Bolts, thru 3/4" x 16"	Joslyn	J 8916
16	3	Bands, pole - small	Joslyn	J 6280
17	6	Bands, pole - large,	Joslyn	J 6270
18	6	Bands, extensions pole	Joslyn	J 6272
20	2	Xbrace w/mounting hardware	Hughes	1042X
22	22	Preformed Guy grips-deadend	Preformed	GDE 1107
23	8	Preformed "L" taps	Preformed	LC MS 5963
24	3	Thimble clevis	Lapp MIF	304056 PA 271
26	4	Clevis - deadend	Joslyn	J 456
29	10	Clips- twist type for guys	Joslyn	J6282A
31	6	Anchor logs -4 ft.	Koppers	
32	1	Anchor logs -8 ft.	Koppers	
37	1	Crossarm-Type DA		
38	2	Adjustable Compression DE-static wire	Alcoa	4620-12
39	6	Adjustable Compression DE- conductor	Alcoa	AC-9300 7534-122HV 5134-122HV
40	7	Rods, anchor 3/4" x 8'	Joslyn	J 7328
40A		Rock anchors	Chance	R360,372 R384,396
41	2	Rods, ground 3/4" x 8'	Joslyn	J5338
42	18	Lags, screw 1/2" x 4"		8754-P
43	7	Fiberglass strain insulators	Anderson	GS I-3-54-1P
44	2	Clamp, ground rod 3/4"	L M	DN 14G1
45	3	Clamp, guy ground	Joslyn	J 1050
47	1	Clamp, suspension w/socket for S.W.	Bethea	FS 46-S

Rev 6/77  
Rev 2/77

Rev 2/74

VERMONT ELECTRIC POWER COMPANY, INC.  
MATERIAL FOR TYPE DA STRUCTURE

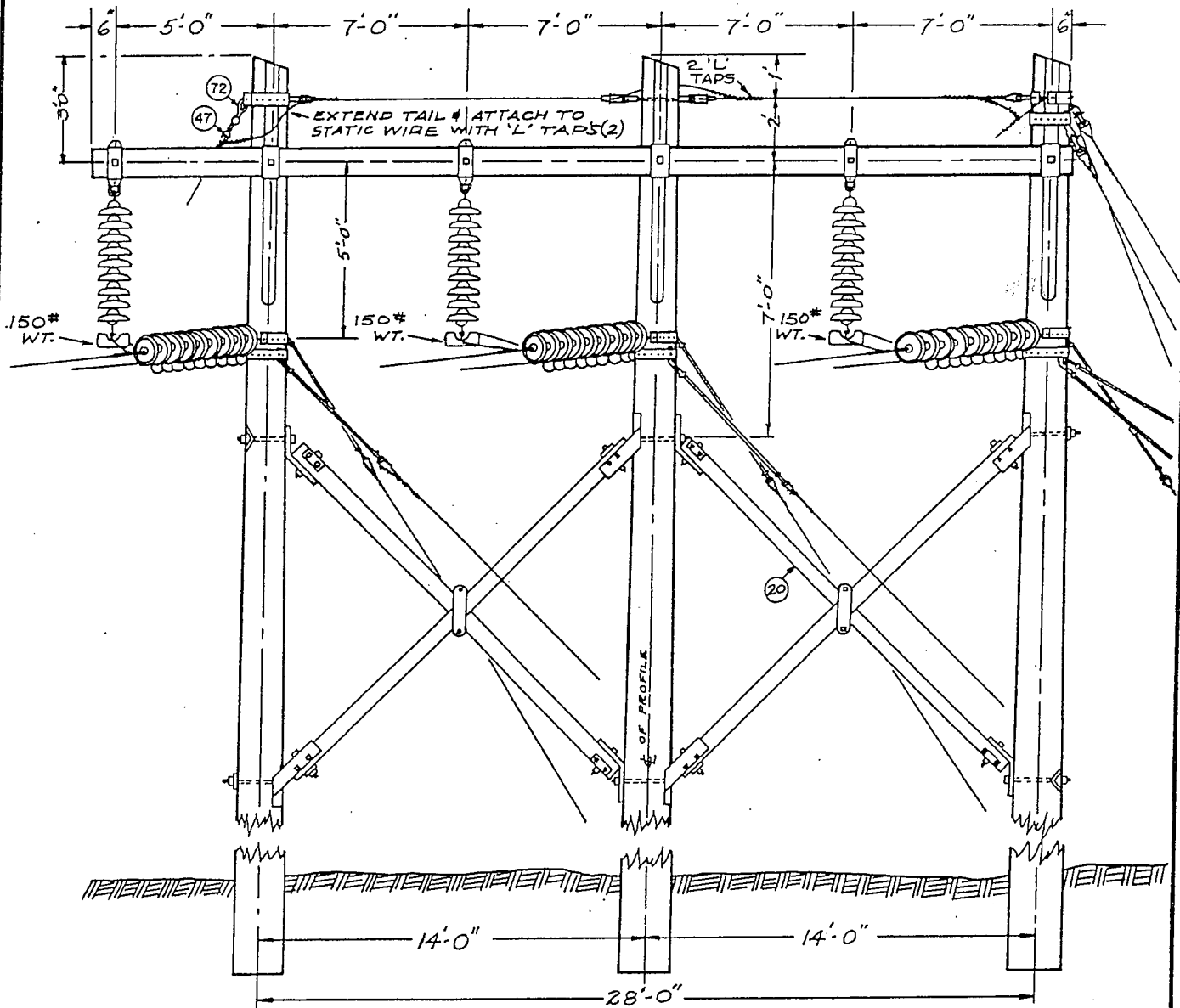
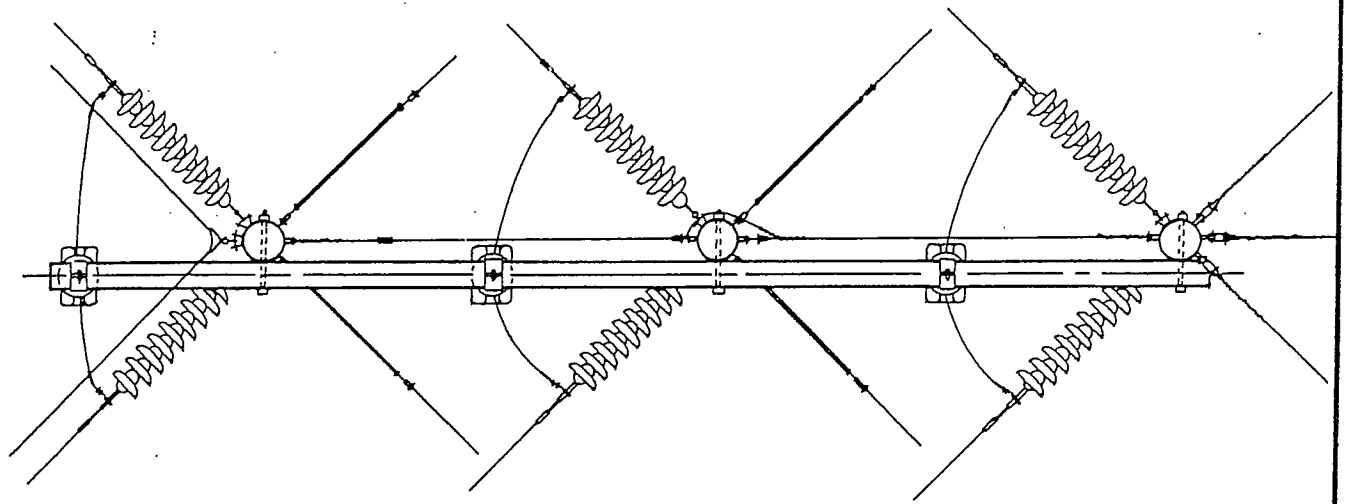
115 KV

Mark	Quant	Description	Manuf.	Cat. No.
49	3	Clamp, suspension w/socket for conductor	Bethea	ACFS-114- 19-25S
51	3	Clamp, crossarm	Joslyn	J 1820
52	2	Chain Link	BTC	3082
53	7	Washers, coil spring 3/4"		
55	18	Washers, coil spring 1/2"		
57	3	Washers, 4" x 4" x 1/4" 13/16" curved	Lapp MIF	304082 P 144
58	7	Washers, 4" x 4" x 1/4" 7/8 " flat	Joslyn	J 1082
59	18	Washers, round 9/16"		
61	7	Guards, guy- metal	Oliver	808
62	2	Strandwise for span guys	Reliable	5152
63	3	Reinforcement plate for xarms	Joslyn	4047
66	100'	Cable, 3/8" galv. 3-strd. (common grade)		
68	550'	Cable, guying 3/8" EHS galv. steel		
69	35'	Static wire - cross tie 3/8" galv. EHS		
70	6	Oval eye ball extension link	Lapp BTC	300024 3004-HT
71	6	Socket eye extension link	Lapp BTC	93161B 4314B
72	4	Ball eye - long	Lapp BTC	6422 3014
73	3	150# Weights	Bethea	ASM 389-150- M-H
76	11	Sheave wheel	Joslyn	J 6288
82	78	Insulators Discs 9" 3 strings of 8 (Idler) 6 strings of 9	GE Lapp	155-409- ASA-70 9000-70
		<u>When Required</u>		
79		Pole roof, non-metalic (used if pole cut in field)	Joslyn	J 2108
40	2	<u>S.W. DE guys under 50°</u> Rods, anchor 3/4" x 8'	Joslyn	J7328
31	2	Logs, anchor 4'	Koppers	
58	2	Washers 4" x 4" x 1/4" 13/16" flat	Hughes	SW-4-70

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Rev 2/77

Rev. 2/74

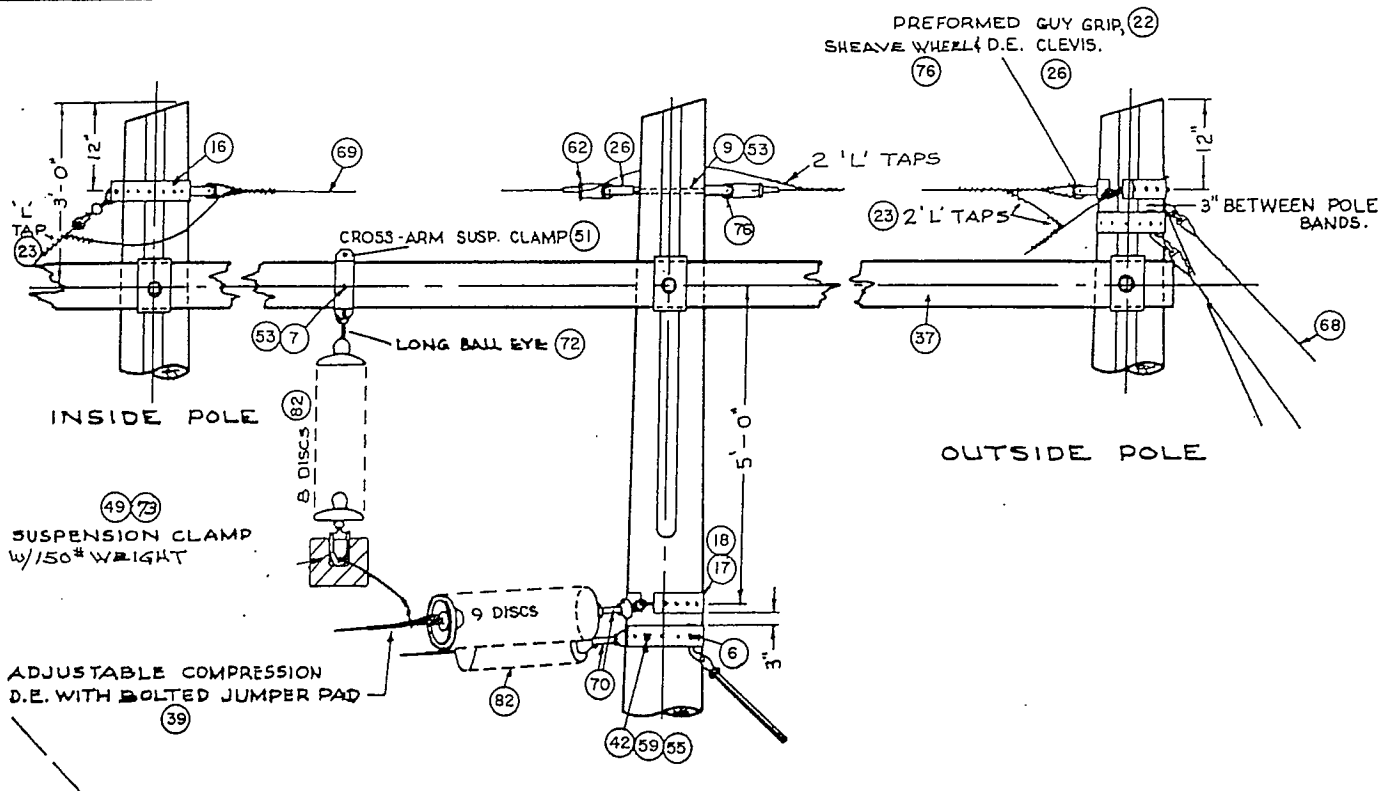


**NOTE:**

1. POLE BANDS TO BE TIGHT & LAGGED WITH 2 LAGS, ROUND WASHERS & SPRING WASHERS.
2. CONE HEAD BOLTS NOT UNDER TENSION TO BE SECURED WITH LOCKNUTS.
3. FOR ANGLES LESS THAN 50° SEE DRAWING #115-18.2

**TYPE DA STRUCTURE  
FOR ANGLES OVER 50°  
115 KV. CONSTRUCTION**

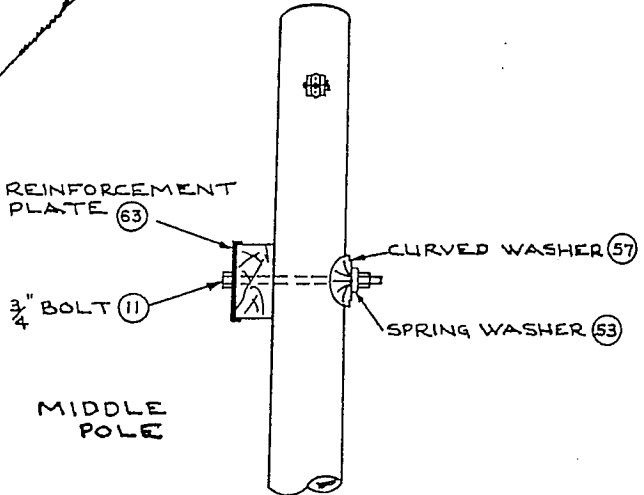
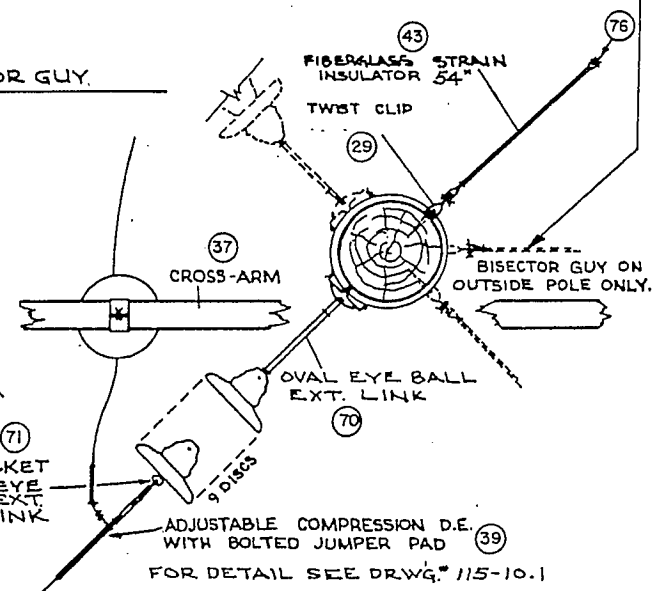
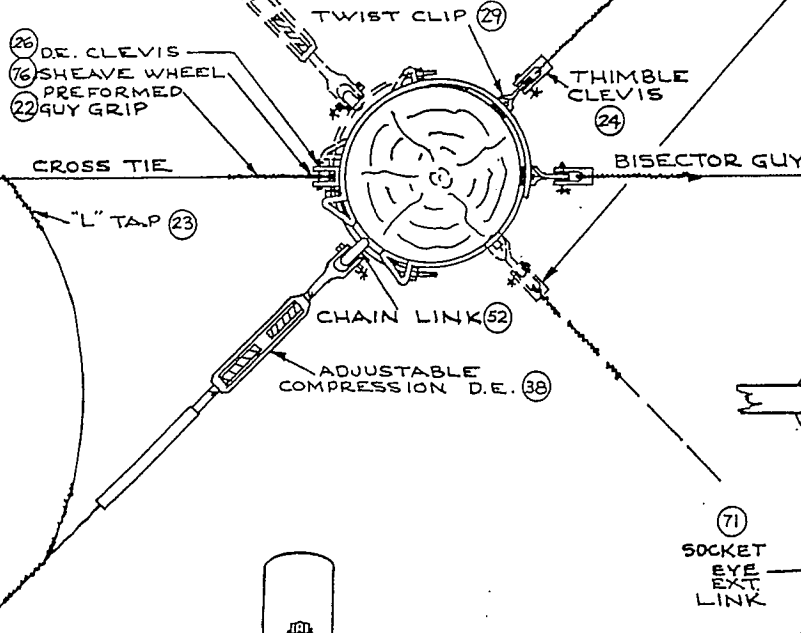
		VERMONT ELECTRIC POWER COMPANY, INC.	
9/1/77	CROSSTIE PR	DRAWN BY JM	CHECKED BY
3/1/77	30	SCALE	DATE 4/20/72
DATE	CHK'D BY	APPROVED BY	DWG # 115-9.0
REVISIONS		NONE	



**STATIC WIRE ATTACHMENTS**  
OUTSIDE POLE DETAILS

-NOTE-  
DASHED LINES INDICATE HARDWARE ON LOWER POLE BAND.

**CONDUCTOR ATTACHMENTS**



		<b>POLE TOP DETAILS</b>		
		<b>TYPE "DA" STRUCTURES</b>		
		<b>115 KV. CONSTRUCTION</b>		
6/1/77	CRASSTIE PR	<b>VERMONT ELECTRIC POWER COMPANY, INC.</b>		
3/1/77	JD			
7/18/72	ADD #52 CHAIN LINK			
DATE	CHK BY	SCALE	APPROVED BY	DATE 4-21-72
REVISIONS		NONE		DWG # 115-9.1

VERMONT ELECTRIC POWER COMPANY, INC.  
MATERIAL FOR TYPE E STRUCTURE  
115 KV

Mark	Quant	Description	Manuf.	Cat. No.
4	8	Bolts, brace 1/2" x 10'	Joslyn	J 8710
5	2	Bolts, machine 5/8" x 12"	Joslyn	J 8812
8	3	Bolts, DA 3/4" x 24" (26") (28")	Joslyn	J 8894,8896 J 8897
9	2	Bolts, thru 3/4" x 10"	Joslyn	J 8910
10	4	Bolts, thru 3/4" x 12"	Joslyn	J 8912
10A	4	Bolts, thru 3/4" x 14"	Joslyn	J 8914
13	2	Bolts, thru 3/4" x 24" (26") (28")	Joslyn	J8924,8926 J8928
19	4pr	Brace wood xarm 60"	Hughes	2000CC
20	1	X-brace w/mounting hardware	Hughes	1042X
22	8	Preformed Guy grips - deadend	Preformed	GDE 1107
23	20	Preformed "L" taps	Preformed	LC MS-5963
24	4	Thimble clevis	Lapp MIF	304056 PA 271
26	6	Clevis - deadend	Joslyn	J 456
31	4	Anchor logs 4 ft.	Koppers	
33	2	Crossarms - Type A		
38	4	Adjustable Compression DE-static wire	Alcoa	4620-12
39	6	Adjustable Compression DE-conductor	Alcoa	AC 9300 7534-122HV 5134-122HV
40A		Rock anchors	Chance	R360,372 R384,396
40	4	Rods, anchor 3/4" x 8'	Joslyn	J 7328
41	2	Rods, ground 3/4" x 8'	Joslyn	J 5338
44	4	Clamp, ground rod 3/4"	L M	DN 14G1
45	4	Clamp, guy ground	Joslyn	J 1050
51	6	Clamp, crossarm	Joslyn	J 1820
53	16	Washers, coil spring 3/4"		

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VERMONT ELECTRIC POWER COMPANY, INC.  
MATERIAL FOR TYPE E STRUCTURE

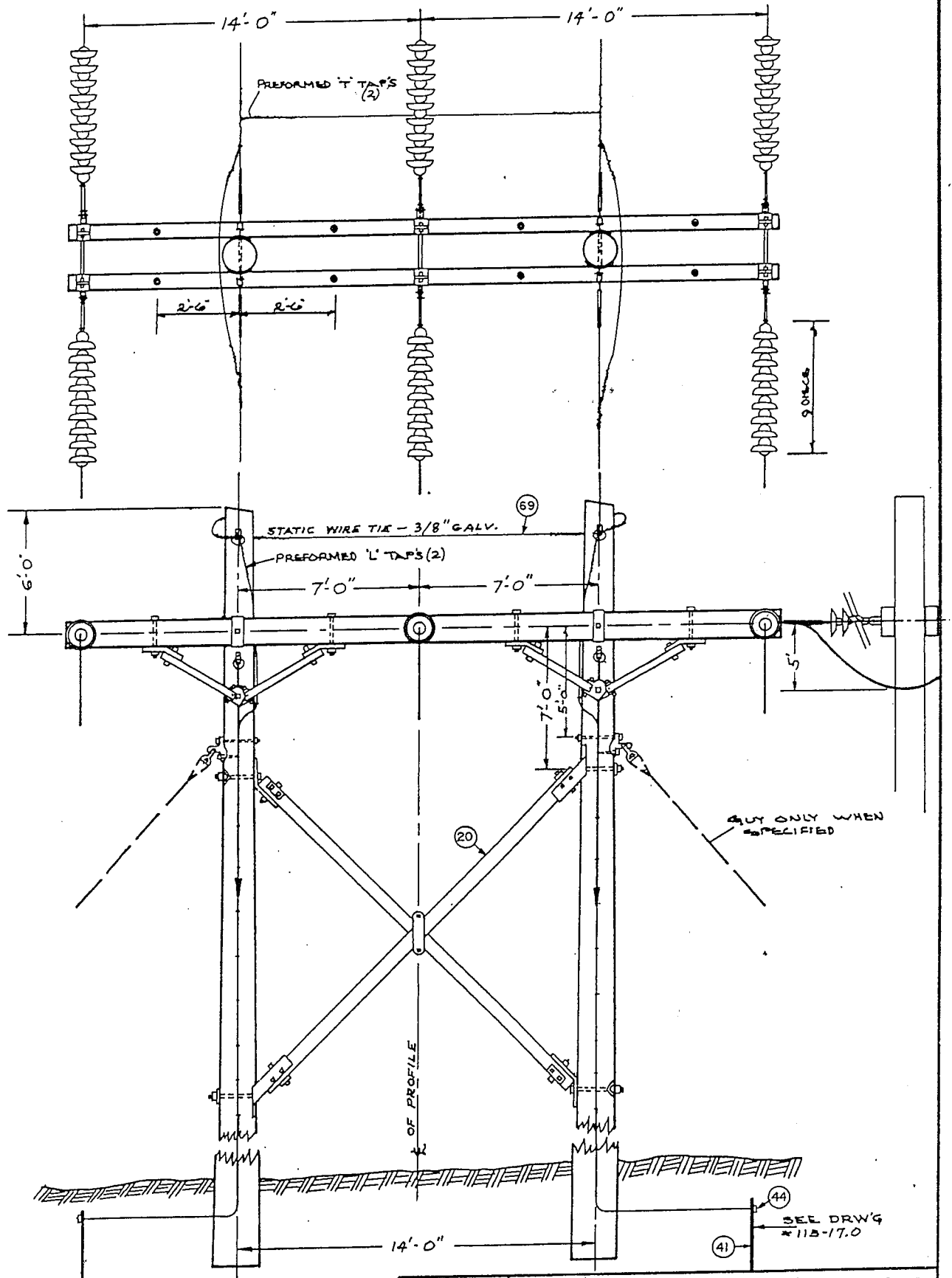
115 KV

Mark	Quant	Description	Manuf.	Cat. No.
54	2	Washers, coil spring 5/8		
55	8	Washers, coil spring 1/2"		
56	8	Washers, 2" x 2" x 1/8" w/9/16" hole square	Joslyn	J 1073
58	4	Washers, 4" x 4" x 1/4" w/ 7/8" hole flat	Joslyn	J 1082
61	4	Guards - guy metal	Oliver	808
63	4	Reinforcement plate for xarms	Joslyn	J 4047
64	75	Staples, 3/8" x 1-3/4"	Joslyn	J 173
66	230'	Cable, 3/8" galv. 3-strd (common grade)		
67	120'	Down lead 3/8" galv. 3 strd. (common grade)		
68	275'	Cable, guying 3/8" EHS. Galv. Steel		
69	14'	Static wire - cross tie 3/8" galv.		Common Grade
70	6	Oval eye ball extension link	Lapp BTC	300024 3004HT
71	6	Socket eye extension link	Lapp BTC	93161B 4314B
77	8	Pole eye plate	Lapp MIF	304021 PX 88
82	54	Insulators, discs 9" (9 per string)	Lapp GE	9000-70 155-409- ASA-70
		<u>When Required</u>		
79		Pole roof, non-metalic (used if pole cut in field)	Joslyn	J 2108
		<u>Side Guys - When Required</u>  Refer to Side Guy Material for Type "A"		

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Rev 2/77

Rev. 2/74

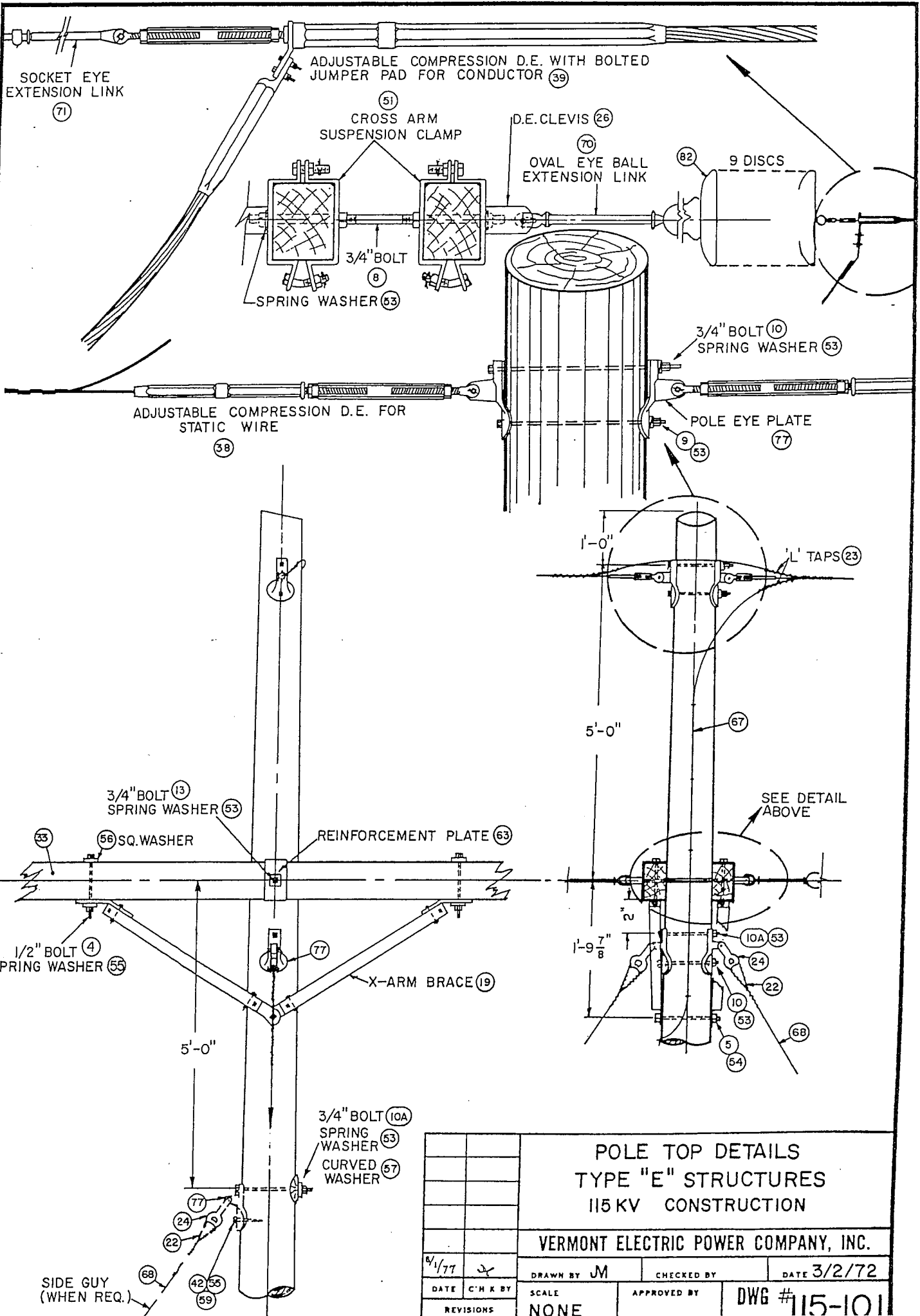




**NOTE:**

1. WHEN USED FOR ANGLES ATTACH GUY 6" BELOW X-ARM.
2. WHEN STRINGING CONDUCTOR USE ADDITIONAL TEMPORARY GUYS TO HOLD X-ARM FROM BENDING.

<b>TYPE - E STRUCTURE DEAD - END 115 KV CONSTRUCTION</b>			
VERMONT ELECTRIC POWER COMPANY, INC.			
3/1/77	22	DRAWN BY <i>JM</i>	CHECKED BY
DATE	SCALE	APPROVED BY	DATE 3/3/72
REVISIONS	NONE	DWG # 115-10.0	



POLE TOP DETAILS  
 TYPE "E" STRUCTURES  
 115 KV CONSTRUCTION

VERMONT ELECTRIC POWER COMPANY, INC.

DATE	C'H K BY	SCALE	APPROVED BY	DWG #
4/1/77	JM	NONE		115-1011
DRAWN BY		CHECKED BY		DATE
JM				3/2/72

VERMONT ELECTRIC POWER COMPANY, INC.  
MATERIALS FOR TYPE DA-T  
115 Kv

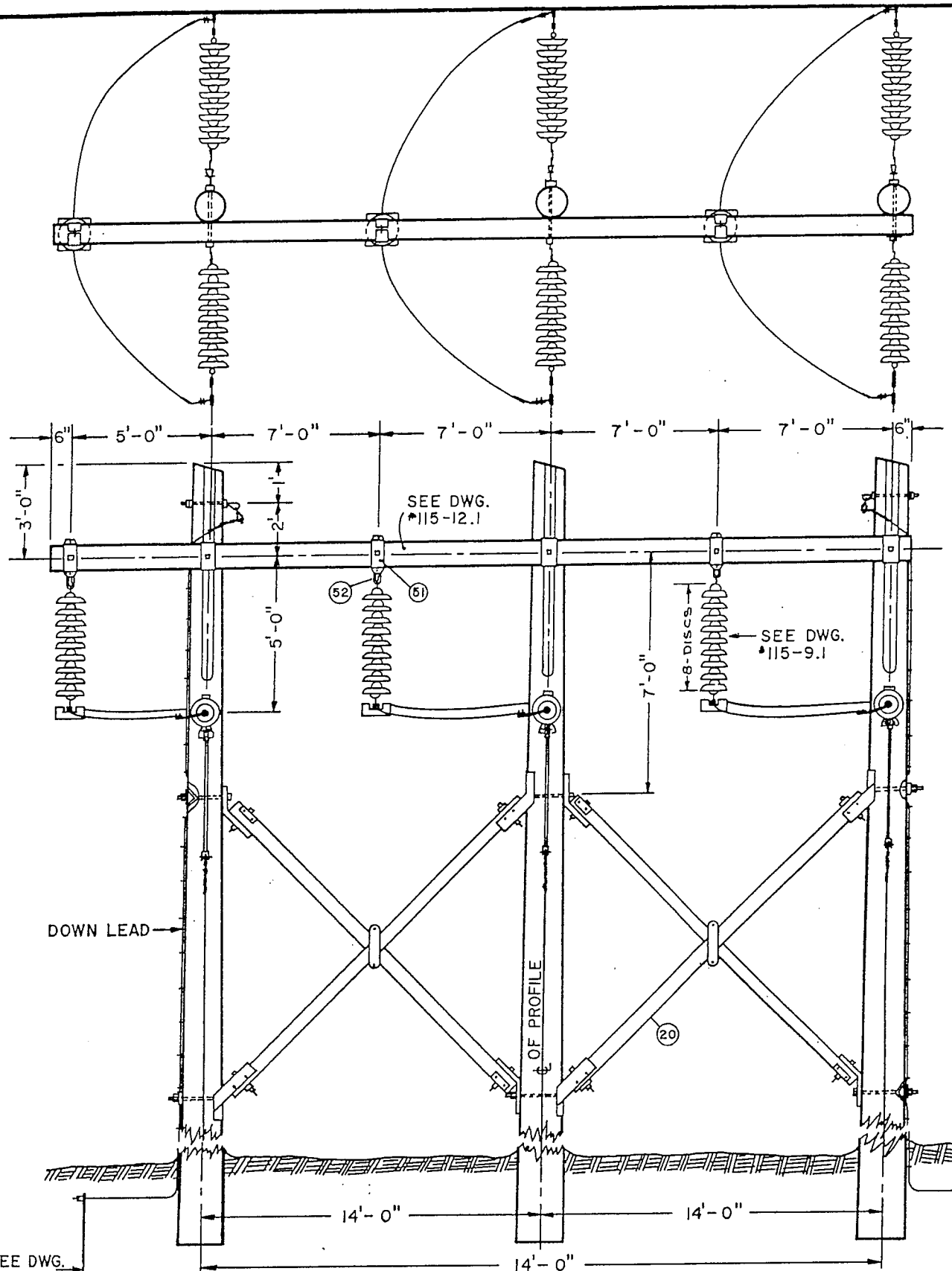
7	3	Bolts, Xarm clamp 3/4"	Joslyn	J 6277
11	3	Bolts, thru 3/4" x 16"	Joslyn	J 8916
13A	6	Bolts, thru 7/8" x 16" 14" 12"	Joslyn	J 9064
14A	2	Static wire support	Hughes	2854
20	2	Xbrace w/mounting hardware	Hughes	1042X
22A	12	Preformed guy grips deadend 1/2"	Preformed	BG 2-115
23	4	Preformed 'L' tap	Preformed	LC-MS-5963
28A	6	'Y' Clevis ball extension link	BTC	3091
31	6	Anchor logs 4'	Koppers	
37	1	Crossarm Type DA-T		
39	6	Adjustable Compression DE -conductor	Alcoa	AC-9300 7534-122HV 5134-122HV
40	6	Rods, anchor 3/4" x 8'	Joslyn	J 7328
40A	6	Rock Anchors	Chance	R360,372 R384,396
41	2	Rods, ground 3/4" x 8'	Joslyn	J 5338
43	12	Fiberglass Strain Insulators	Anderson	GSI-3-54-1E
44	2	Ground rod clamps	LM	DN 14G1
47	2	Clamp, suspension w/clevis for s w	Bethea	FS-46C
49	3	Clamp, suspension w/socket for conductor	Bethea	ACFS-108- 19-25S
51	3	Clamp, crossarm	Joslyn	J1820
52	6	Chain link	BTC	3082
53	6	Washers, coil spring 3/4"	Eaton	
53A	8	Washers, coil spring 7/8"	Eaton	
56A	2	Washer, curved 4" x 4" x 1/4" w/15/16" hole	MIF	Pl44-B
57	3	Washer, curved 4" x 4" x 1/4" w/13/16" hole	MIF	Pl44
58	6	Washer, flat 4" x 4" x 1/4" w/7/8" hole for anchor	Joslyn	J. 1082
61	6	Guy Guards	Oliver	808

Rev 1/7

## VERMONT ELECTRIC POWER COMPANY, INC.

MATERIALS FOR TYPE DA-T  
115 KV

Item	Quant		Manuf.	Cat. No.
63	3	Reinforcement plate for Xarm	Joslyn	4047
67	120'	Cable, 3/8" galv. 3-strd (common grade)		
68A	400'	Cable, guying 1/2" EHS galv steel		
71	3	Socket eye extension link	BTC	4314B
72	3	Ball eye-long	BTC	3014
73	3	Weights - 150#	Bethea	ASM 389- 150-E-H
75	6	Anchor shackle	BTC	3023
76	6	Sheave wheel	Joslyn	J 6288
77A	6	Deadend Tee	MIF	PX 41
82	78	Insulator disc 9" (3 strings of 8 -idler) (6 strings of 9)	GE	155-409 ASA-70
79		<u>When Required</u> Pole Roof - non-metallic (used if pole cut in field)	Joslyn	J 2108



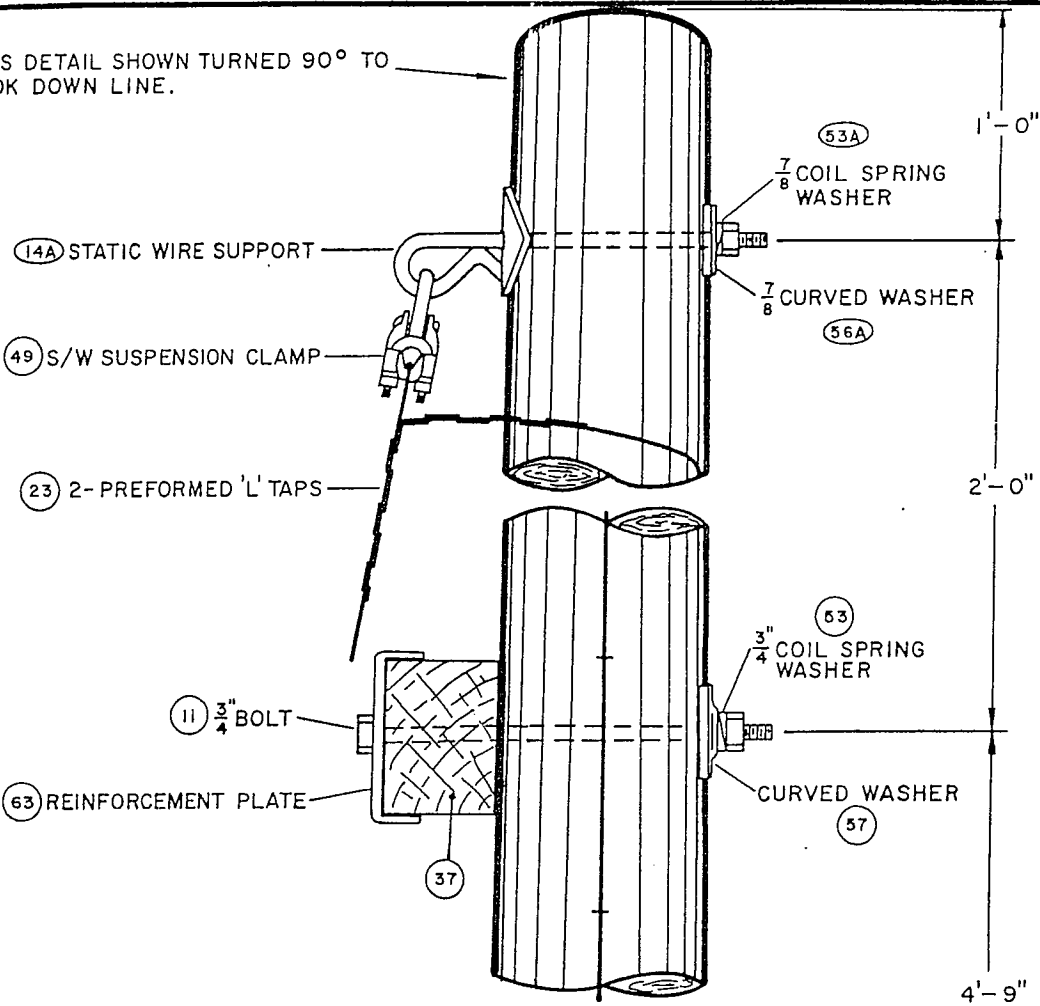
SEE DWG. #115-17.0

**TYPE DA-T STRUCTURE  
STRAIGHT LINE DEADEND  
115KV CONSTRUCTION**

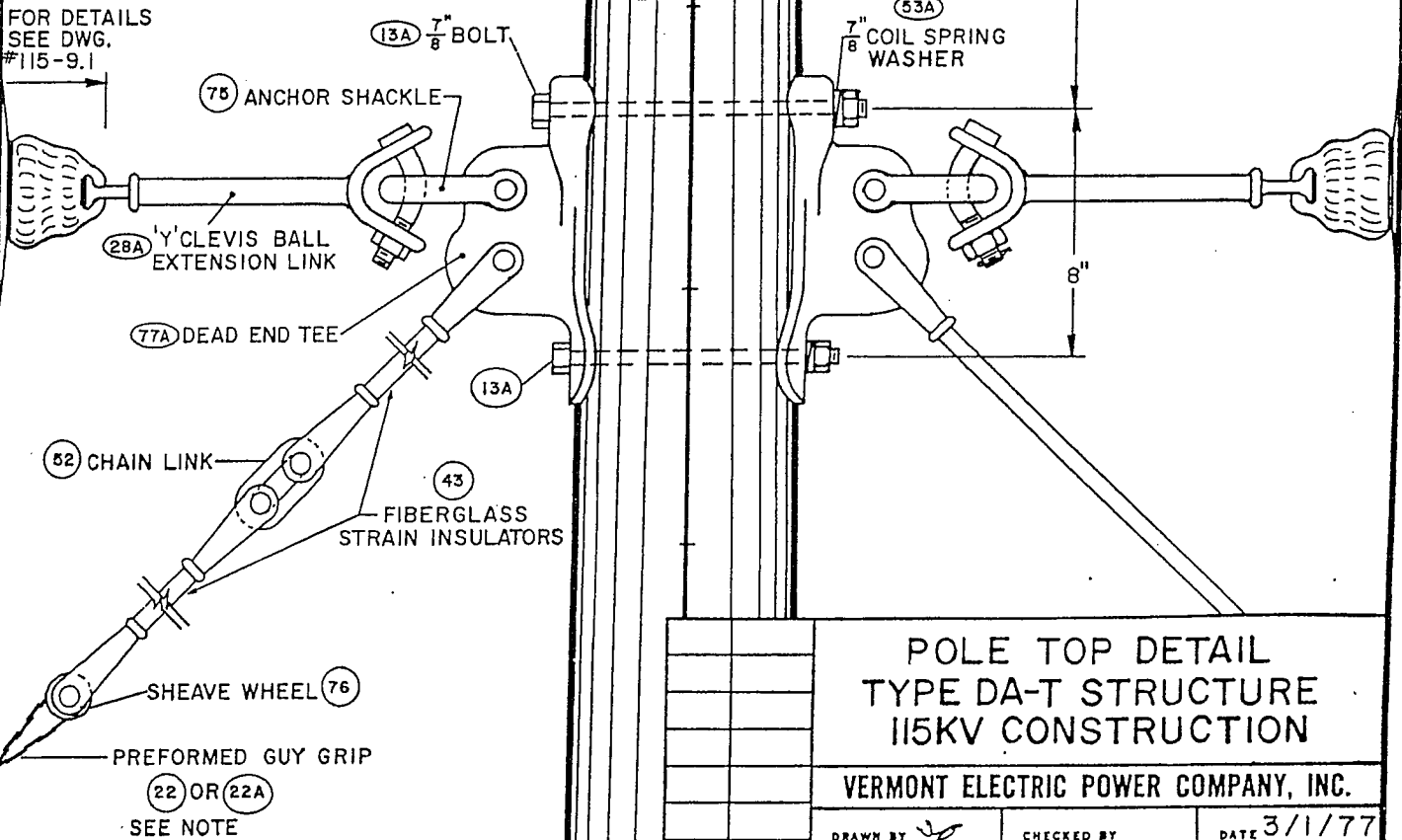
VERMONT ELECTRIC POWER COMPANY, INC.

DATE		DRAWN BY		CHECKED BY		DATE 3/1/77	
C'H'X BY		SCALE		APPROVED BY		DWG # 115-11.0	
REVISIONS		NONE					

NOTE:  
THIS DETAIL SHOWN TURNED 90° TO  
LOOK DOWN LINE.



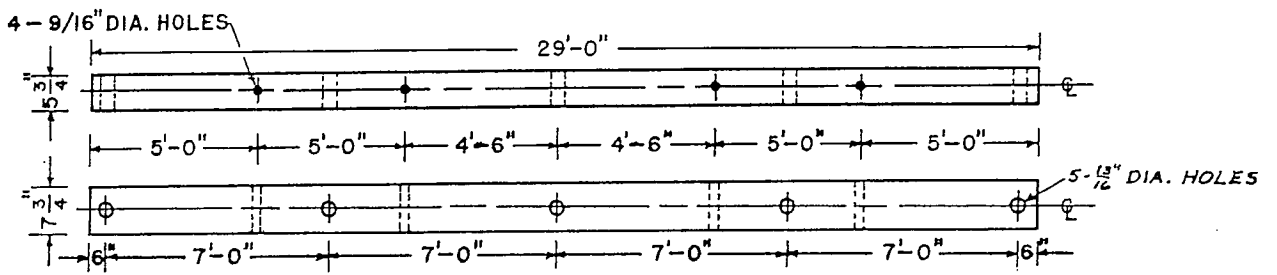
FOR DETAILS  
SEE DWG.  
#115-9.1



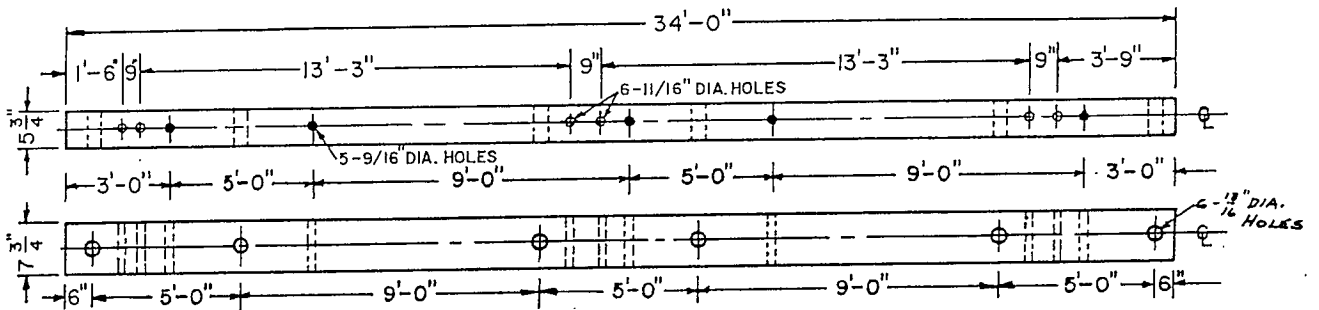
POLE TOP DETAIL  
TYPE DA-T STRUCTURE  
115KV CONSTRUCTION

VERMONT ELECTRIC POWER COMPANY, INC.

DATE	C'H'K BY	SCALE	APPROVED BY	DATE
		NONE		3/1/77
REVISIONS			DWG # 115-11.1	

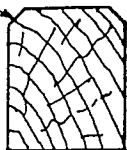


TYPE A (A & E STRUCTURE)  
 (33)



TYPE B (B & B-2 STRUCTURE)  
 (34)

3/8" CHAMFER TOP EDGES

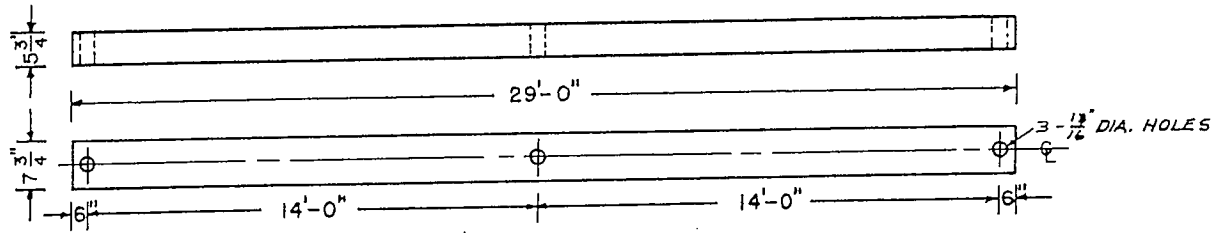


1/8" EASED BOTTOM EDGES

# DETAIL OF CROSSARMS A & B

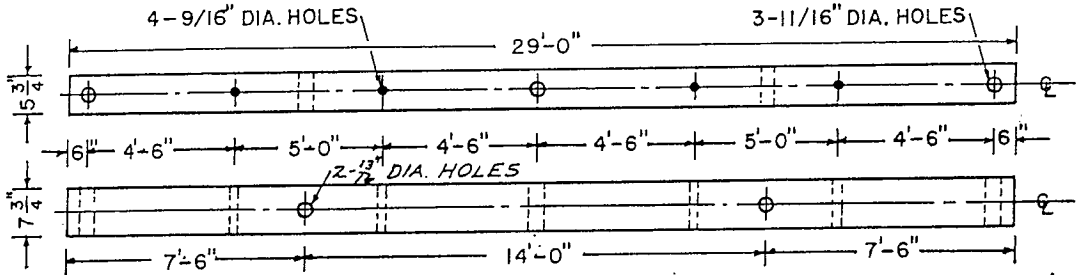
VERMONT ELECTRIC POWER COMPANY, INC.

2/19/74	TYPE "B-2"	DRAWN BY JM	CHECKED BY	DATE 4/19/72
DATE	CH. K. BY	SCALE	APPROVED BY	DWG # 115-12.0
REVISIONS		NONE		



TYPE C (C & F STRUCTURE)

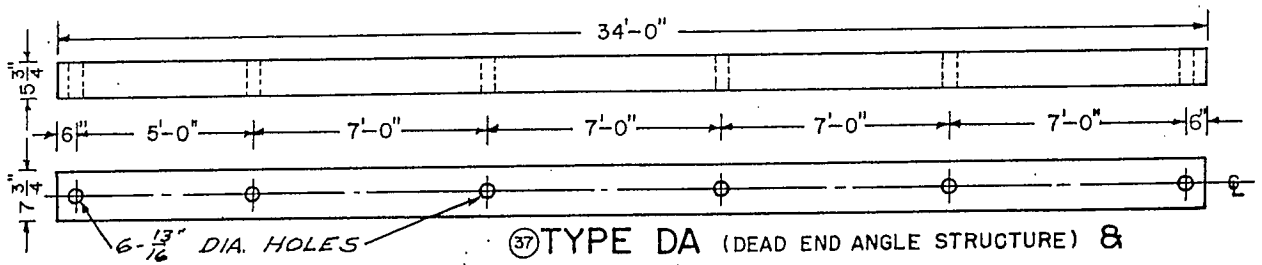
33



TYPE D (D STRUCTURE)

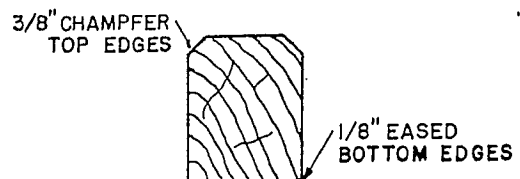
35

A2 & D 4-2-



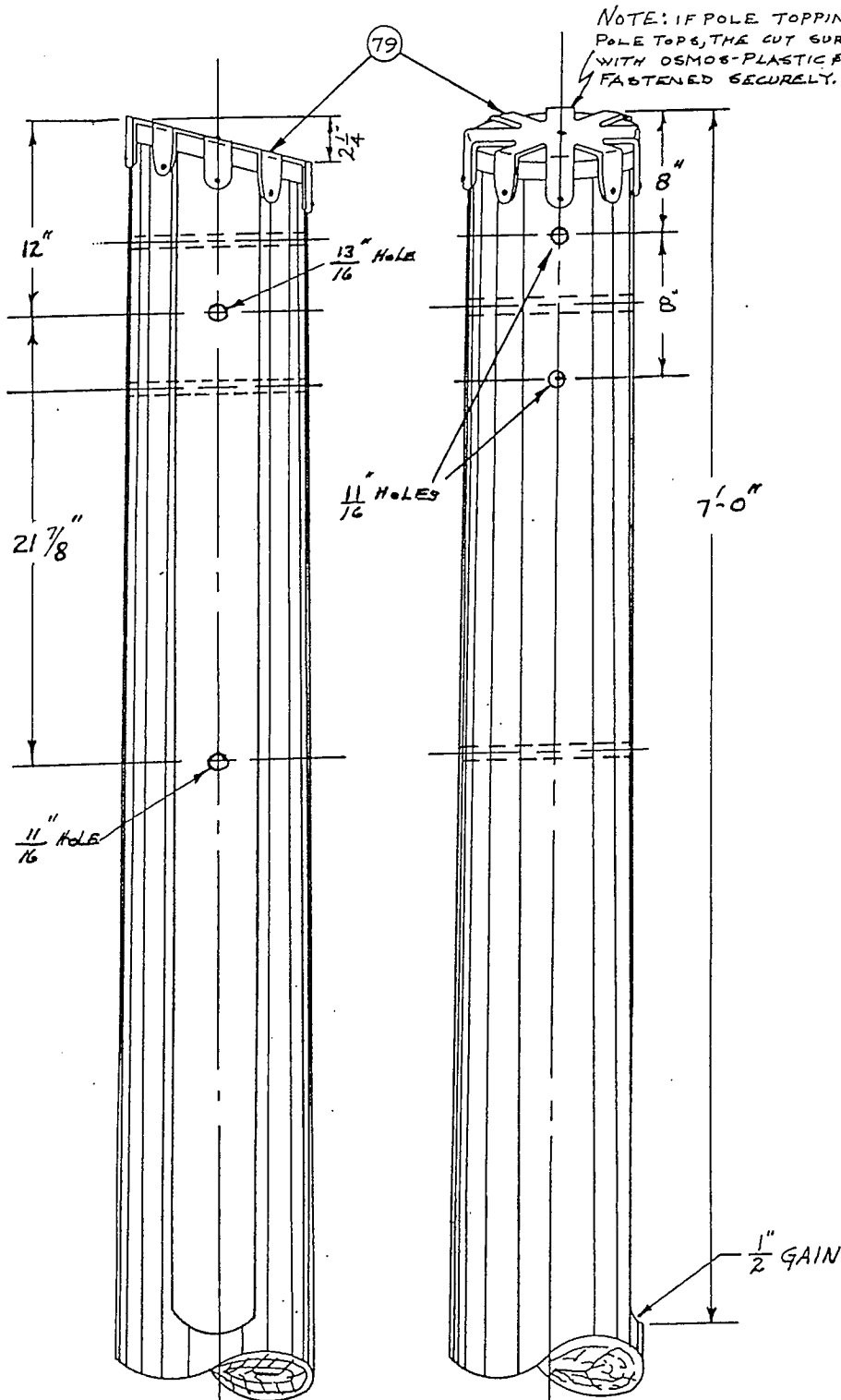
TYPE DA (DEAD END ANGLE STRUCTURE) &  
TYPE DA-T (DEAD END STRAIGHT LINE STRUCTURE)

37

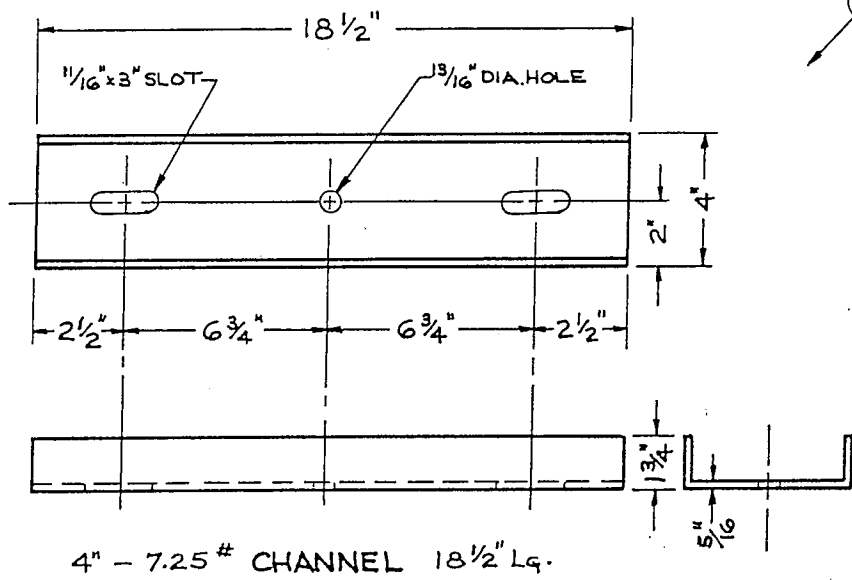
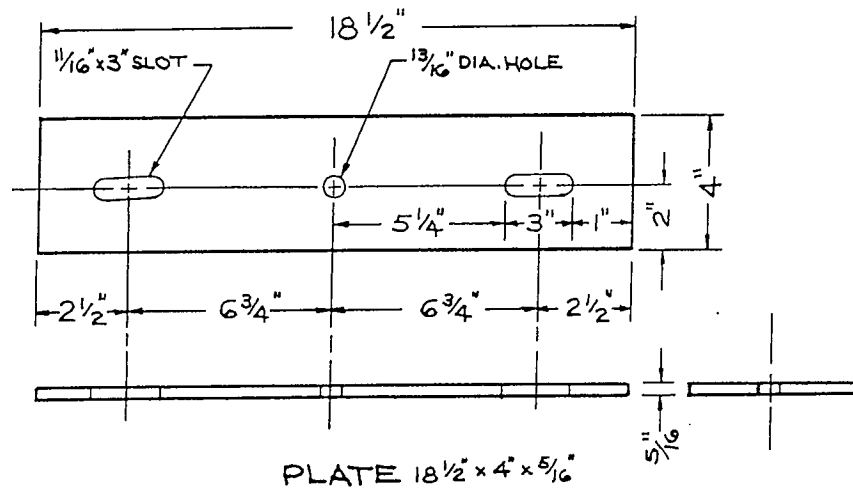


DETAIL OF CROSSARMS C, D, DA				VERMONT ELECTRIC POWER COMPANY, INC.			
				DATE 3/1/77	C'H K BY Jce	SCALE NONE	APPROVED BY
REVISIONS				NONE			





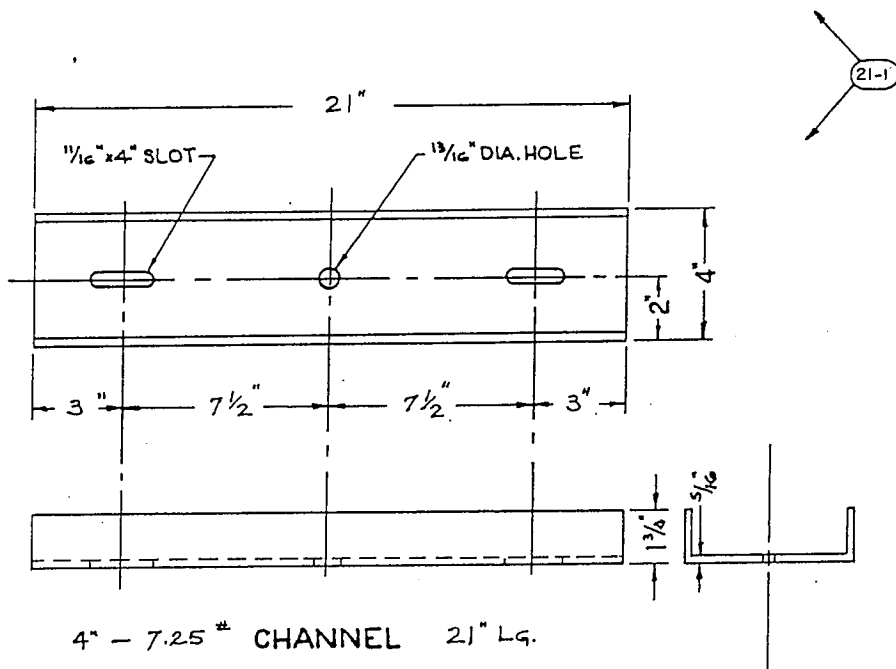
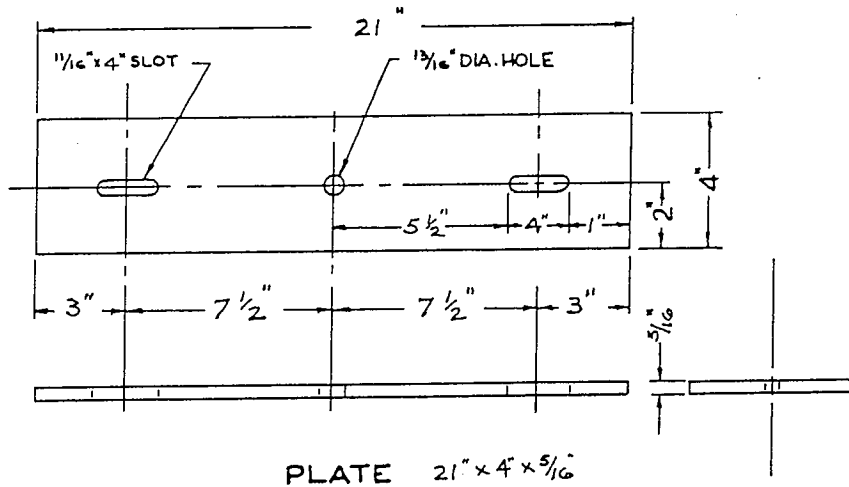
				DETAILS OF BORING, GAINING & POLE ROOF			
				VERMONT ELECTRIC POWER COMPANY, INC.			
		DRAWN BY <i>RJ</i>		CHECKED BY		DATE 4-6-72	
DATE	C'H'X BY	SCALE		APPROVED BY		DWG # 115-13.0	
REVISIONS		<i>No 17C</i>					



(21)

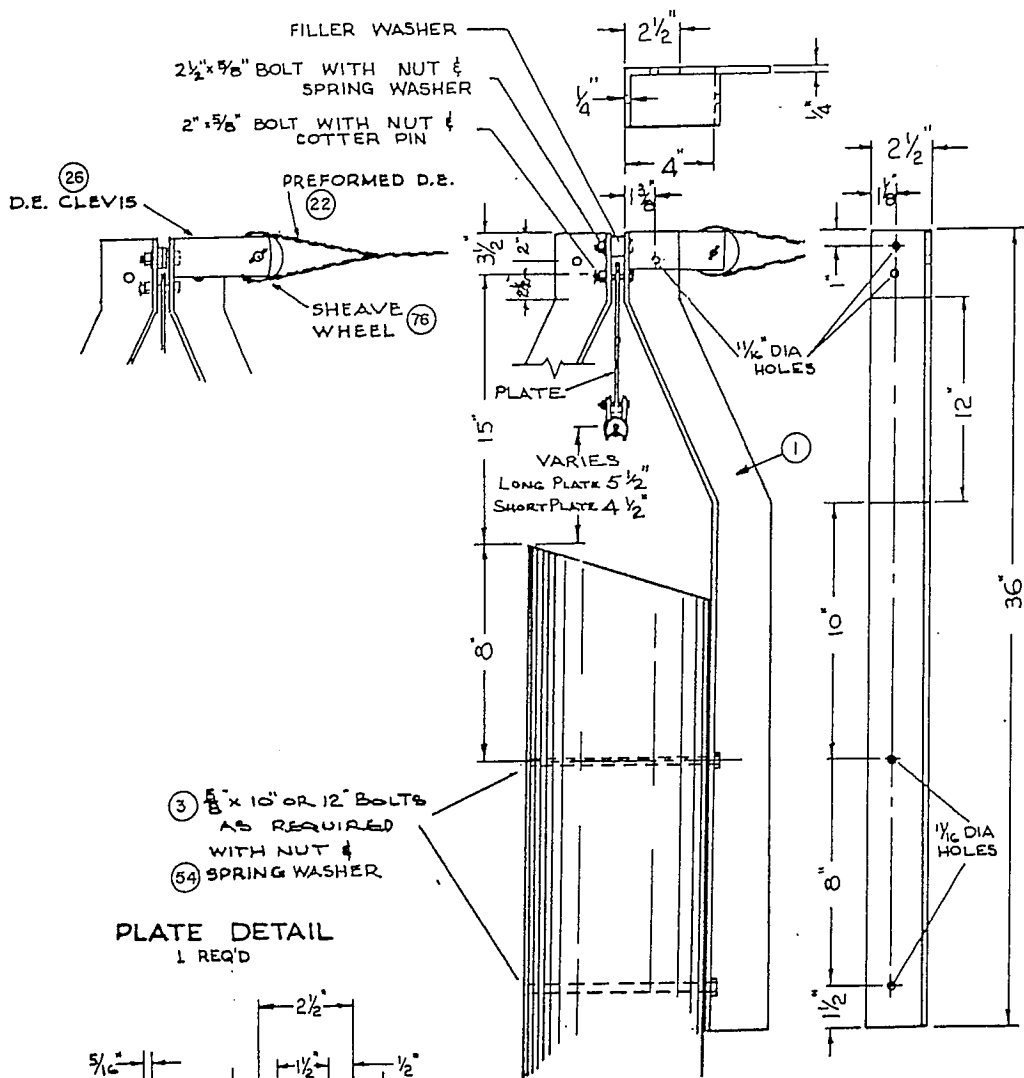
- NOTE -  
 PLATE & CHANNEL  
 HOT DIP GALVANIZED

		PLATE & CHANNEL DETAIL	
		115 KV CONSTRUCTION	
		VERMONT ELECTRIC POWER COMPANY, INC.	
		DRAWN BY <i>SG</i>	CHECKED BY
		DATE 3-1-77	
DATE	C.H.K. BY	SCALE	APPROVED BY
		NONE	
REVISIONS		DWG # 115-14.0	



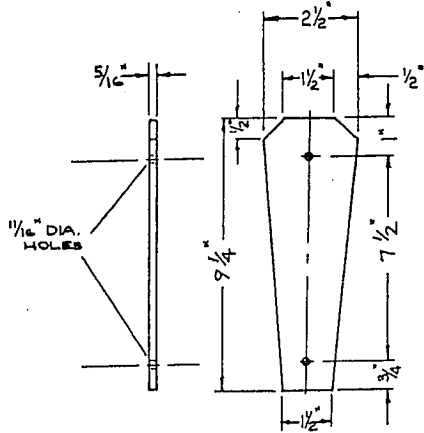
- NOTE -  
 PLATE & CHANNEL  
 HOT DIP GALVANIZED

PLATE & CHANNEL DETAIL			
115 KV. CONSTRUCTION			
VERMONT ELECTRIC POWER COMPANY, INC.			
DATE	CHK BY	SCALE	APPROVED BY
			DWG #15-141
			DATE 4-25-74
			CHECKED BY
			DRAWN BY P.D.A.

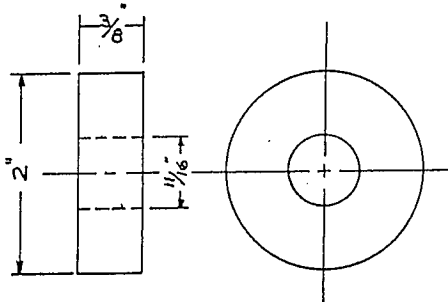


- ③  $\frac{5}{8}$  x 10" OR 12" BOLTS AS REQUIRED WITH NUT & SPRING WASHER
- ⑤4 SPRING WASHER

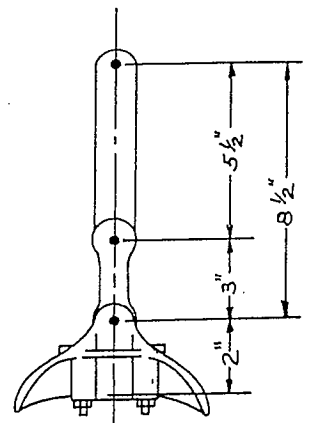
**PLATE DETAIL**  
1 REQ'D



**BAYONET DETAIL**  
2 REQ'D 1 RIGHT 1 LEFT

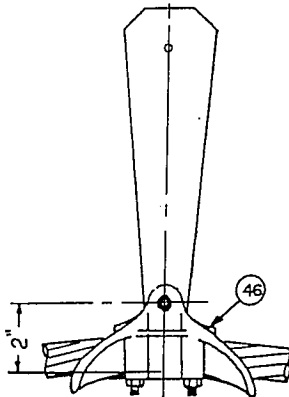


**FILLER WASHER**



**SHORT PLATE, CLEVIS-EYE & SUSPENSION CLAMP**

NOTE ALL HARDWARE GALVANIZED



**LONG PLATE & SUSPENSION CLAMP ASSEMBLY**

		<b>BAYONET DETAIL</b>	
		<b>115 KV. CONSTRUCTION</b>	
VERMONT ELECTRIC POWER COMPANY, INC.			
3/1/77	JC	DRAWN BY PDA	CHECKED BY
DATE CH-K BY		SCALE NONE	APPROVED BY
REVISIONS		DWG # 115-15.0	
		DATE 4-7-72	

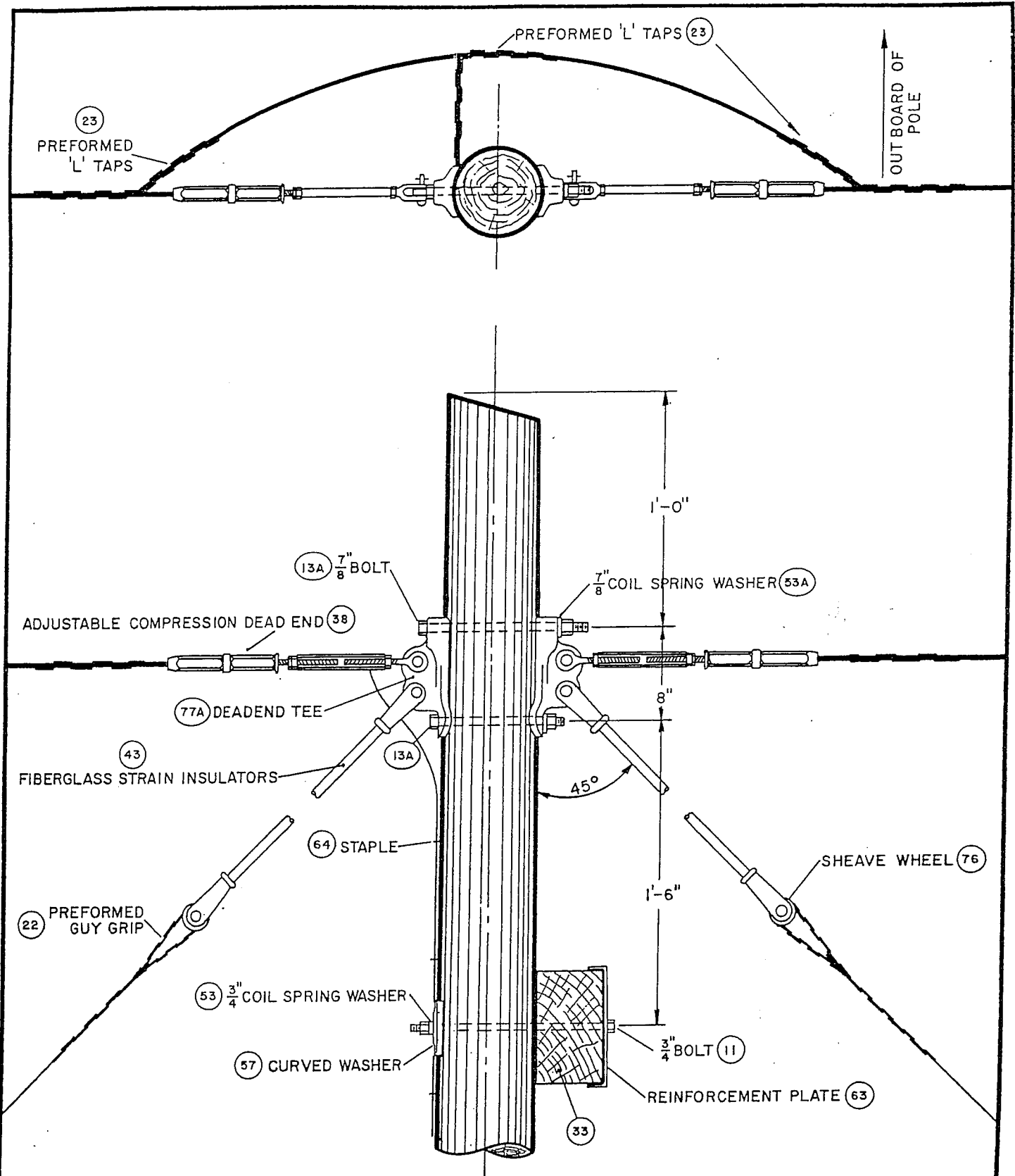
VERMONT ELECTRIC POWER COMPANY, INC.  
Material for Special Type A Structure  
w/Shield Wire Deadended

Mark	Quant.	Description	Manuf.	Cat. No.
4	4	Bolts, brace 1/2" x 10"	Joslyn	J8710
5	2	Bolts, 5/8" x 12" (xarm brace)	Joslyn	J8812
7	3	Bolts, Xarm Clamps 3/4" x 8"	Joslyn	J8908
11	2	Bolts, machine 3/4" x 16" (Xarm)	Joslyn	J8916
13A	4	Bolts, thru 7/8" x 12" 14" 16" (345 Kv material)	Joslyn	
19	2 prs	Brace wood - 60" Xarm	Hughes	2000cc
22	8	Preformed guy grips DE	Preformed	GDE 1107
23	12	Preformed "L" taps	Preformed	LC-MS 5963
31	4	Anchor logs 4'	Kopper	
33	1	Crossarm Type A	Haley	
38	4	Adjustable Compression DE for Static Wire	Alcoa	4620-12
40	4	Rods, anchor 3/4" x 8'	Joslyn	J7328
40A		Rock anchors	Chance	R360, R384 R372, R396
43	4	Fiberglass Strain Insulators	Anderson	GSI 3-54-1P
44	2	Clamps, ground rod	LM	DN14G1
49	3	Clamps, suspension conductor w/socket fitting	Bethea	ACFS 114-19 25S
51	3	Clamps, crossarm	Joslyn	J1820
53	5	Washer, coil spring 3/4"	Eaton	
53A	4	Washer, coil spring 7/8"	Eaton	
54	6	Washer, coil spring 5/8"	Eaton	
55	4	Washers, coil spring 1/2"	Eaton	
56	4	Washer 2" x 2" x 1/8" w/9/16" hole square	Joslyn	J1073
57	2	Washer 4" x 4" x 1/4" w/3/16" hole curved	Lapp MIF	304082 P144

VERMONT ELECTRIC POWER COMPANY, INC.  
 Material for Special Type A Structure  
 w/Shield Wire Deadended

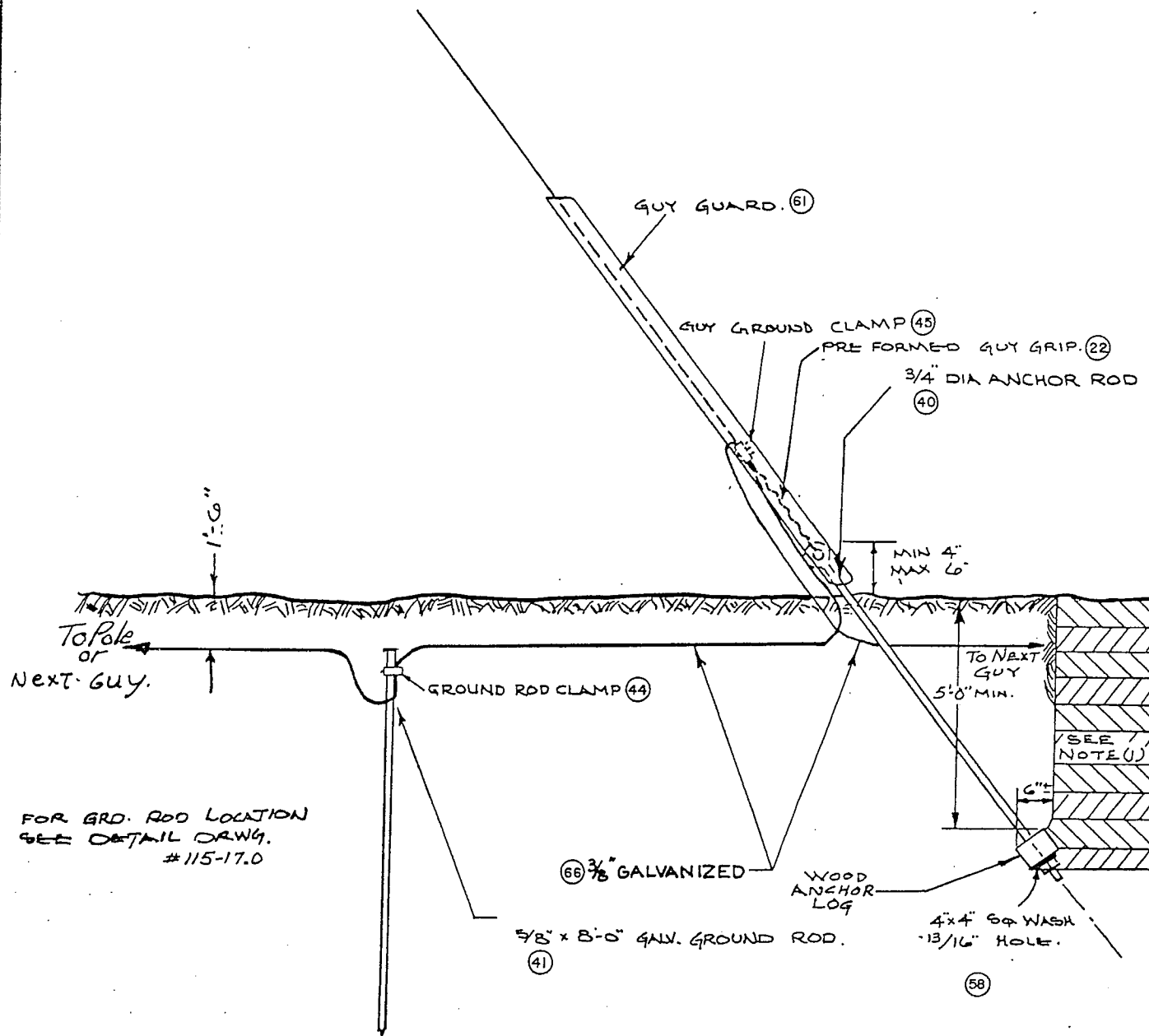
Mark	Quant.	Description	Manuf.	Cat. No.
58	4	Washers, 4" x 4" x 1/4" w/ 7/8" hole square	Joslyn	J 1082
60	2	Washers, 3" x 3" x 3/16" w/11/16"hole curved	Lapp MIF	304078 P143
61	4	Guy guards, metal	Oliver	808
63	2	Plate, reinforcement for Xarms	Joslyn	J4047
64	75	Staples 3/8" x 1-3/4" (down lead)	Joslyn	J173
67	120'	Down Lead 3/8" galv. 3-strd-common		
68	275'	Cable, guying 3/8" EHS galv steel		
72	3	Ball eye - long	BTC Lapp	3014 6422
77A	4	Deadend Tee - (345Kv material)	MIF	PX41
76	4	Sheave wheel	Joslyn	J6288
41	2	Rods, ground 3/4" x 8'	Joslyn	J5338
82	21	Insulators 9" disc	Lapp GE	9000-70 155409- ASA-70
		<u>When Required</u>		
20	1	Xbrace w/mounting hardware	Hughes	1042X
73	3	150# Weights	Bethea	ASM 389-150 M-H
79		Pole Roof, non-metalic (used if pole cut in fld)	Joslyn	J 2108

6/77  
 REV 1/78

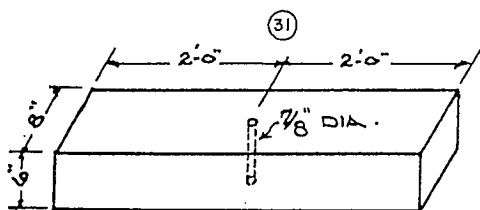


NOTE:  
 STANDARD 'A' STRUCTURE WITH X-ARM LOWERED 2'-2"  
 AND SHIELD WIRE DEAD ENDED.  
 NO CROSS TIE.

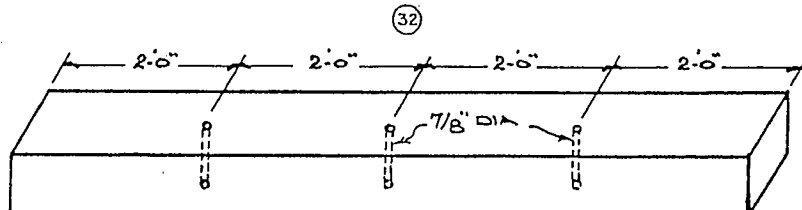
				POLE TOP DETAIL 115KV TYPE "A" STRUCTURE WITH SHIELD WIRE DEAD END			
		DRAWN BY <i>JG</i>		CHECKED BY		DATE 3/1/77	
DATE		C'H'K BY		SCALE		APPROVED BY	
REVISIONS				NONE		DWG # 115-15.1	



FOR GRO. ROD LOCATION  
SEE DETAIL DRAWG.  
#115-17.0



4'-0" x 6" x 8"



8'-0" x 6" x 8"

**WOOD ANCHOR LOGS**

**NOTE:**

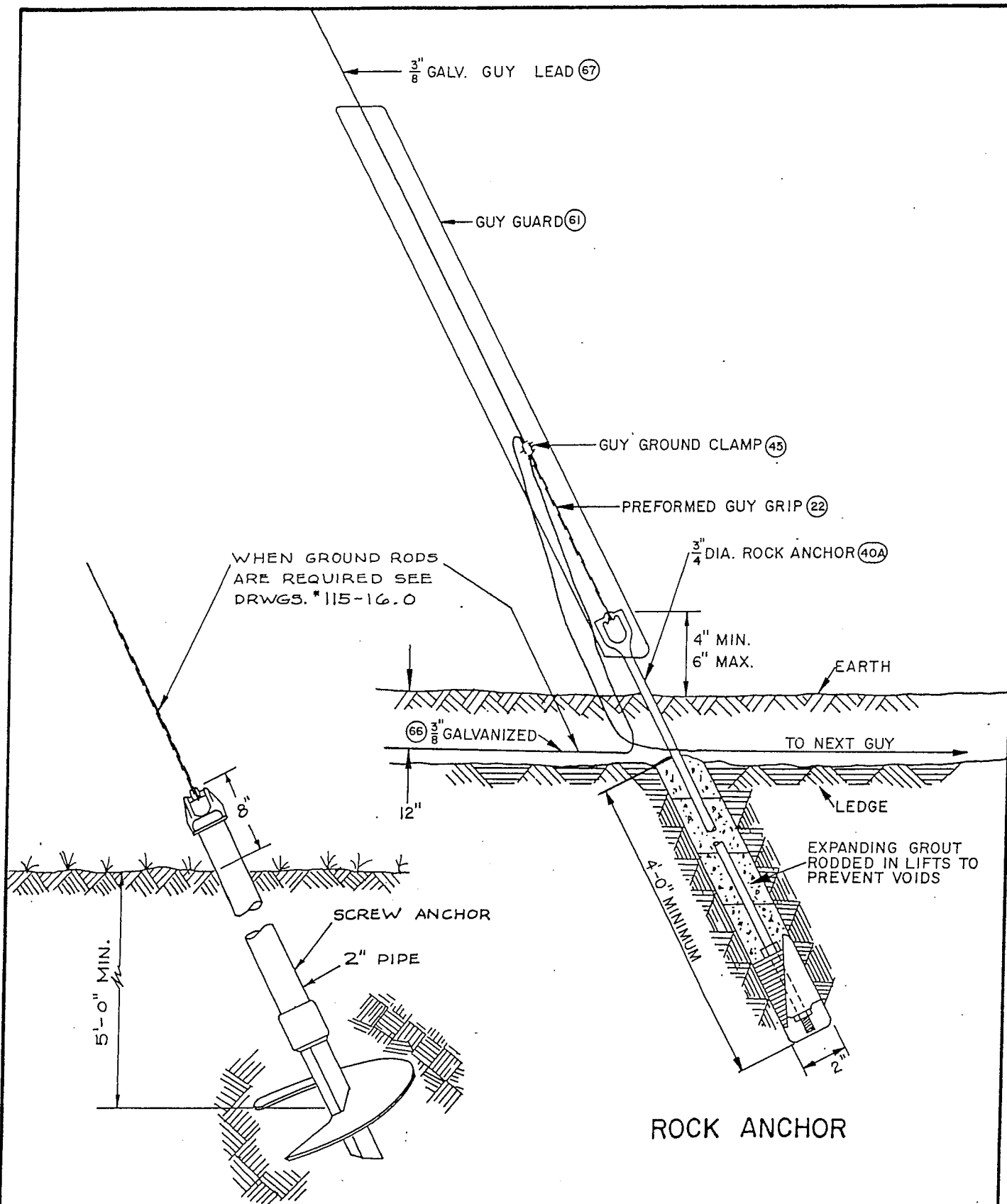
1. SET ANCHOR LOG FIRMLY AGAINST UNDER CUT SOIL AND COMPACT IN 8" LIFTS TO 90% SURROUNDING EARTH.
2. WHEN BACKFILLING ANCHOR HOLES, 1000 LB. TENSION SHALL BE MAINTAINED ON THE ANCHOR ROD DURING THE BACKFILLING OPERATION.
3. WHEREVER POSSIBLE, THE GROUND WIRE SHALL BE MADE CONTINUOUS THRU JOINTS.

**DETAIL OF GUY GROUNDING AND ANCHORS**

VERMONT ELECTRIC POWER COMPANY, INC.

DATE		C'H'K BY		DRAWN BY R.G.		CHECKED BY		DATE 4-7-72	
REVISIONS		SCALE		APPROVED BY		DWG #115-16.0			
				NONE					





**SWAMP ANCHOR**

SWAMP ANCHORS TO BE INSTALLED BY HAND & USED FOR STRUCTURE STABILIZATION ONLY.

**DETAIL OF ROCK AND SWAMP ANCHOR**

VERMONT ELECTRIC POWER COMPANY, INC

DATE	CH'K BY	DRAWN BY JM	CHECKED BY	DATE 4/8/72
REVISIONS		SCALE	APPROVED BY	DWG # 115-16.1
		NONE		

LINE OF STRUCTURE

STAPLE TO BACK OR INSIDE  
EDGE OF POLE AS SPECIFIED  
ON STRUCTURE DRAWINGS

67 3/16" GALV. ST.

24" APART TO TOP

8'-0" STAPLES 12" APART 64

1'-6" MIN.

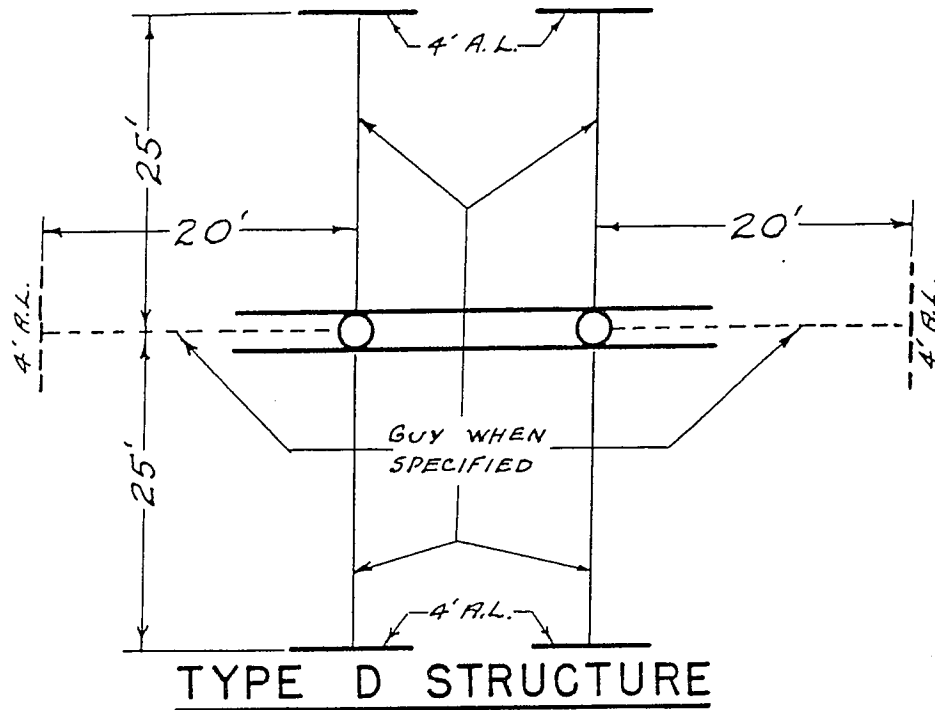
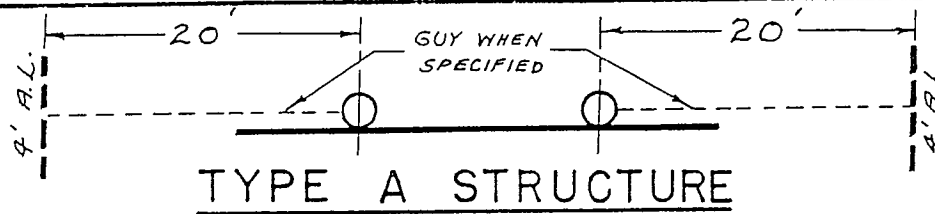
44 GROUND ROD CLAMP

41 8'-0" GROUND ROD

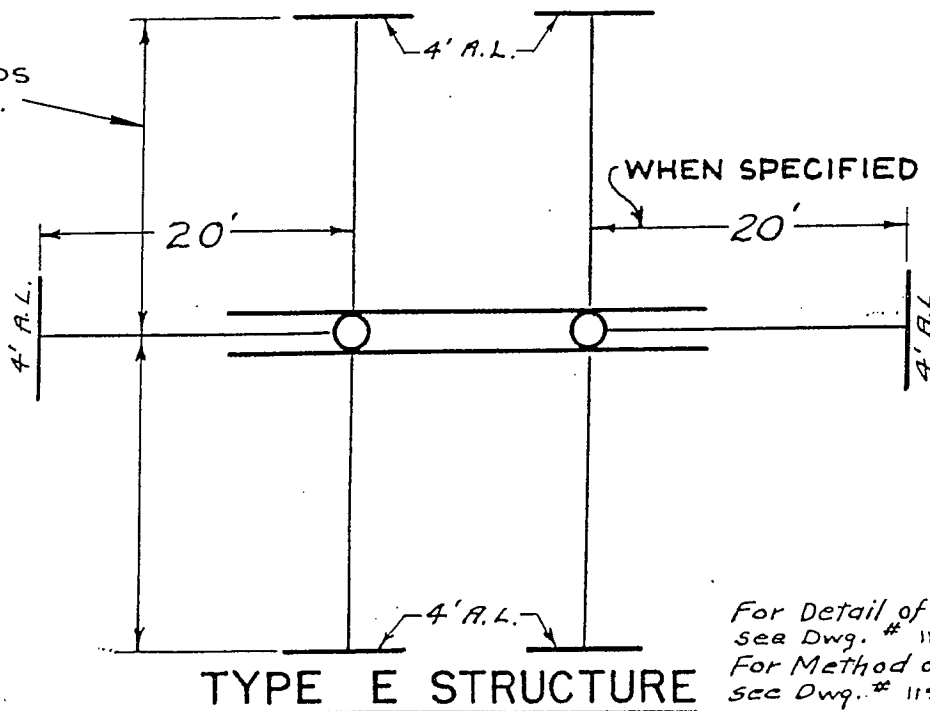
7'-0"

5'-0" MIN. TYPICAL

				<b>GROUND ROD DETAIL</b>			
				VERMONT ELECTRIC POWER COMPANY, INC.			
		DRAWN BY JM		CHECKED BY		DATE 4/8/72	
DATE	CH'K BY					DWG # 115-170	
REVISIONS		SCALE NONE		APPROVED BY			

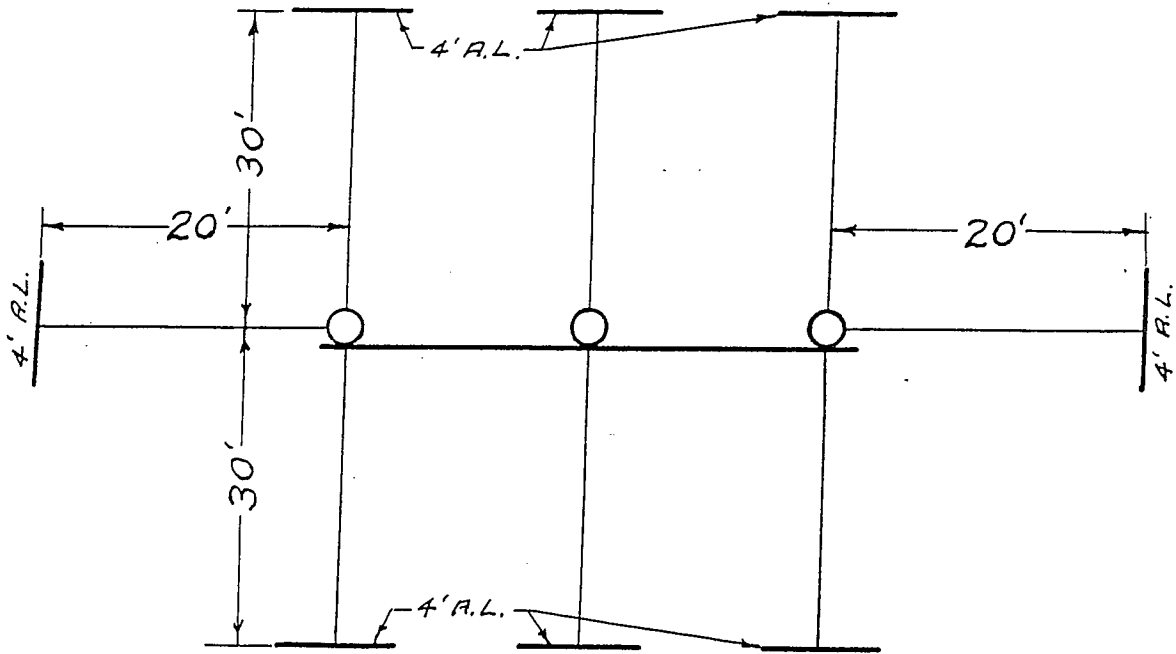
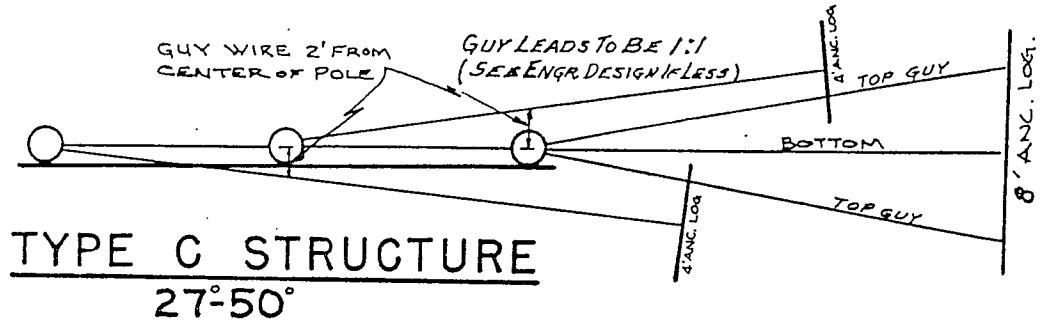
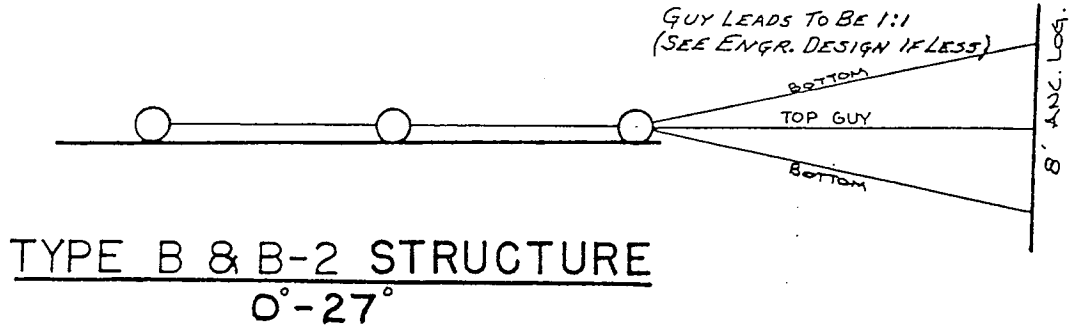


NOTE:  
GUY LEADS  
TO BE 1:1.



For Detail of Anchor Logs,  
See Dwg. # 115-16.0  
For Method of Guy Grounding,  
See Dwg. # 115-16.1

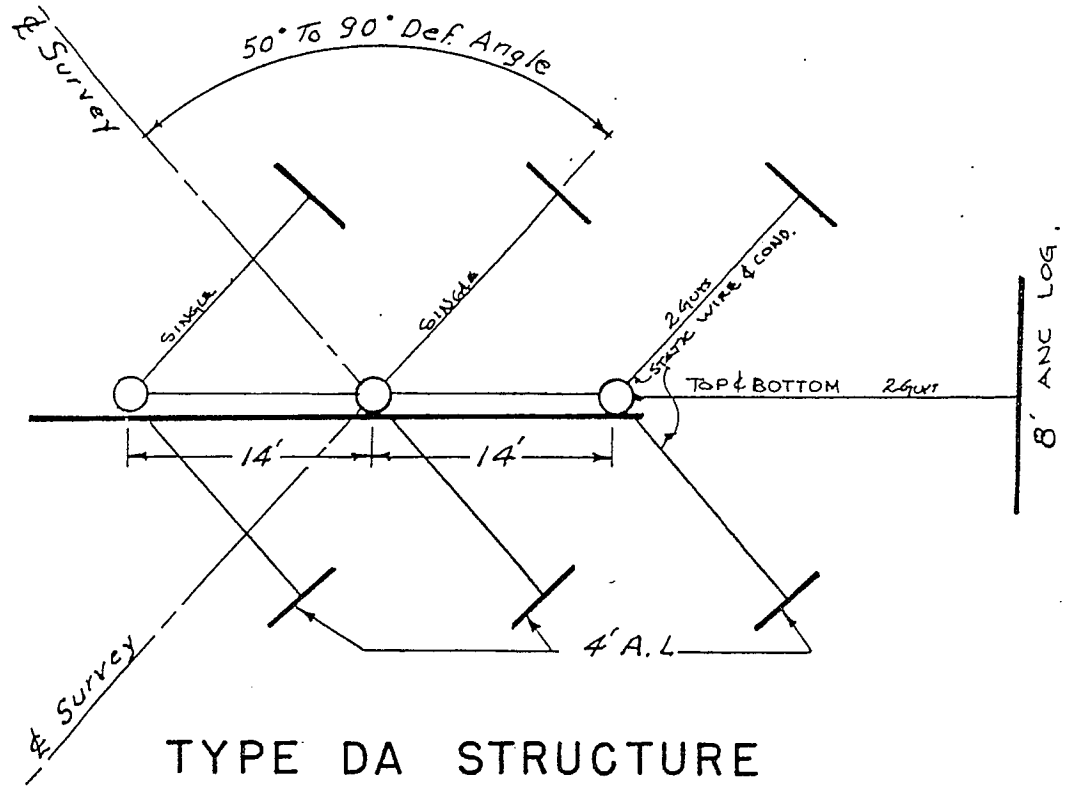
		<b>METHODS OF POLE GUYING</b>	
		VERMONT ELECTRIC POWER COMPANY, INC.	
		DRAWN BY <i>R.G.</i>	CHECKED BY
		DATE	4-10-72
		SCALE	APPROVED BY
		REVISIONS	<i>None</i>
		DWG #115-18.0	



For Detail of Anchor Logs,  
see Dwg. # 115-16.0  
For Method of Guy Grounding,  
see Dwg. # 115-16.1

		<b>METHODS OF POLE GUYING</b>	
		VERMONT ELECTRIC POWER COMPANY, INC.	
DATE	CHECK BY	DRAWN BY <i>R. B.</i>	CHECKED BY
		SCALE	APPROVED BY
REVISIONS		<i>NONE</i>	DWG # <b>115-18.1</b>
			DATE <b>4-10-72</b>

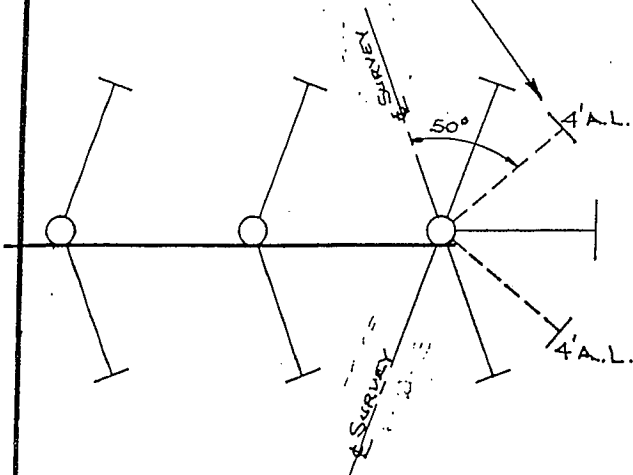
NOTE: GUY LEADS TO BE 1:1.  
(SEE ENGR. DESIGN IF LESS.)



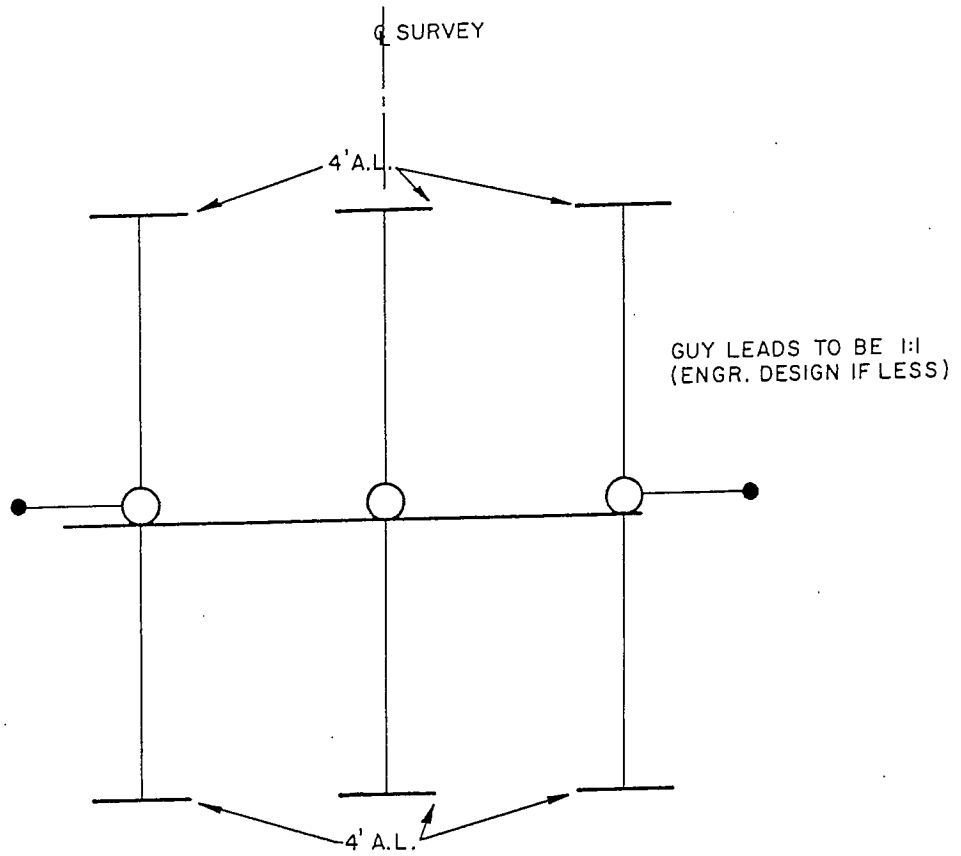
**TYPE DA STRUCTURE**  
**50°-UP**

FOR LINE ANGLES LESS THAN 50°, SHIELD WIRE DE. GUYS WILL GO TO ADDITIONAL 4' ANCHOR LOGS AT 50° DEFLECTION ANGLE FROM OUTSIDE PHASE.

For Detail of Anchor Logs see Dwg. 115-16.0  
For Method of Guy Grounding see Dwg. 115-16.1



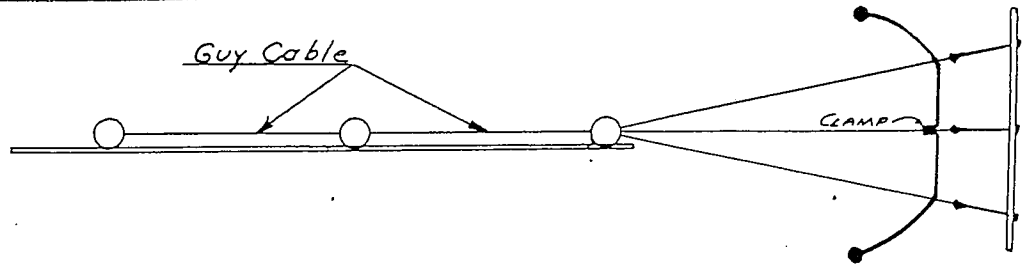
<b>METHODS OF POLE GUYING</b>			
VERMONT ELECTRIC POWER COMPANY, INC.			
3/1/72	de	DRAWN BY <i>R.G.</i>	CHECKED BY
DATE	C'K' BY	SCALE	DATE 4-10-72
REVISIONS	None.		APPROVED BY
			DWG # 115-18.2



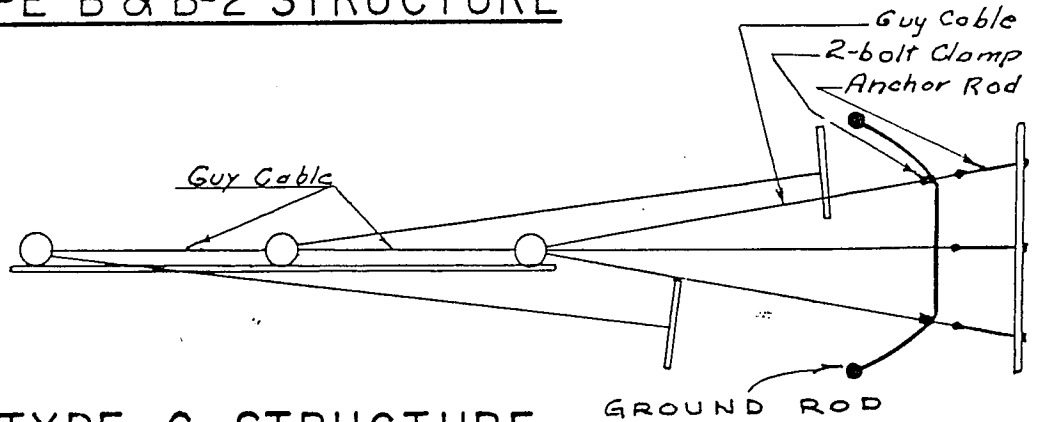
**TYPE DA-T STRUCTURE**  
 FOR LONG SPAN AND/OR DIFFERENTIAL  
 CONDUCTOR TENSIONS

NOTE:  
 FOR DETAIL OF ANCHOR LOGS SEE DRWG. #115-16.0  
 FOR DETAIL OF GROUNDING SEE DRWG. #115-17.0

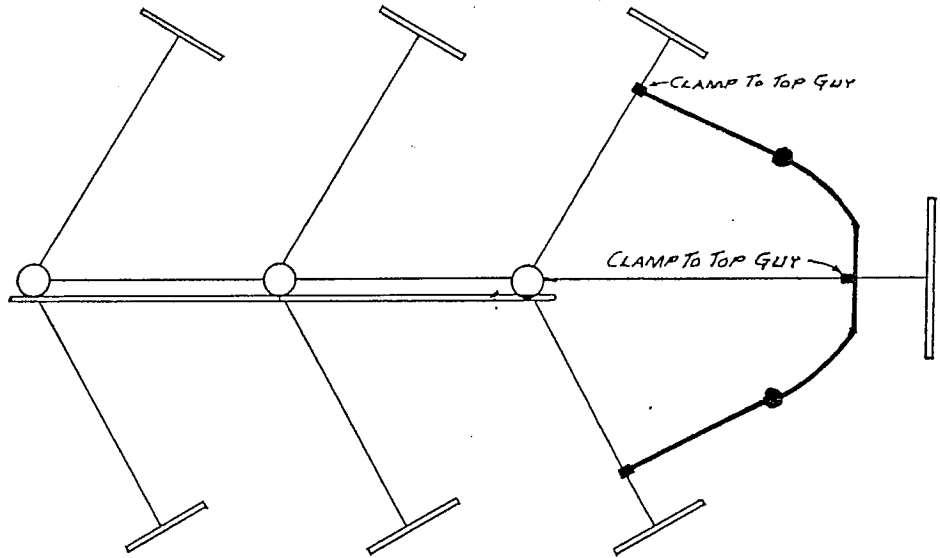
		<b>METHODS OF POLE GUYING</b>	
		<b>VERMONT ELECTRIC POWER COMPANY, INC.</b>	
		DRAWN BY <i>JG</i>	CHECKED BY
			DATE 3/1/77
DATE	CHECK BY	SCALE	APPROVED BY
		NONE	DWG # 115-18.3
REVISIONS			



TYPE B & B-2 STRUCTURE



TYPE C STRUCTURE



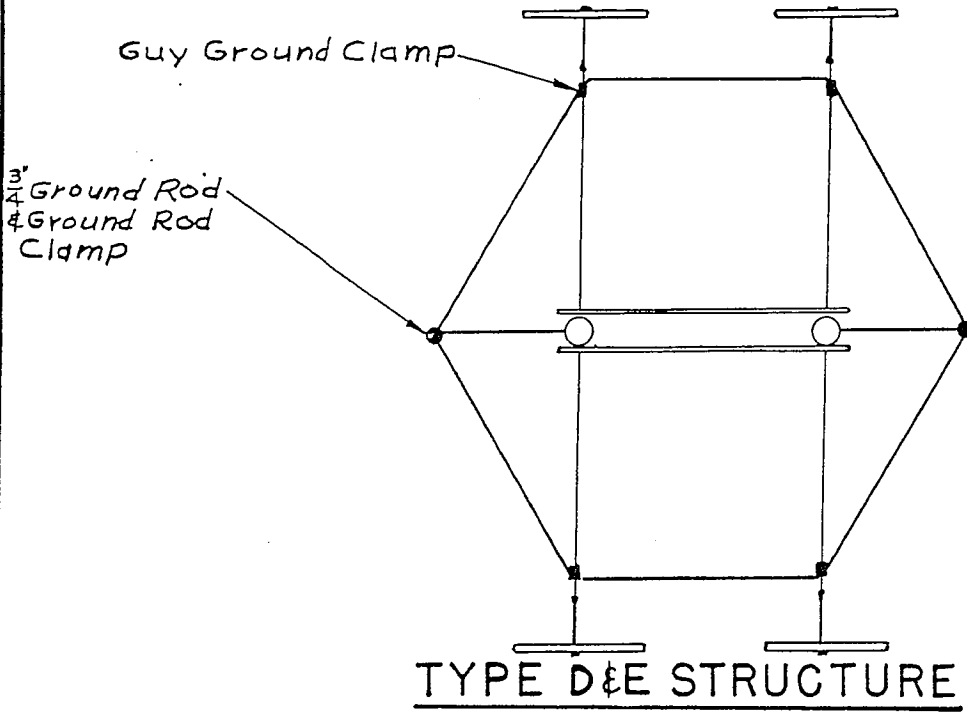
TYPE DA STRUCTURE

NOTE:

All Ground Rods to have a minimum distance of 5' from Poles.

For Pole Ground Detail, see Dwg. 115-16.0  
 For Method of Guying, see Dwg. 115-18.1 & 115-18.2

			<b>METHODS OF POLE &amp; GUY GROUNDING 3-POLE STRUCTURE</b>		
			VERMONT ELECTRIC POWER COMPANY, INC.		
DATE		C'K' BY	DRAWN BY <i>R.G.</i>	CHECKED BY	DATE <i>4-11-72</i>
REVISIONS		SCALE		APPROVED BY	DWG # <i>115-19.0</i>
		NONE			

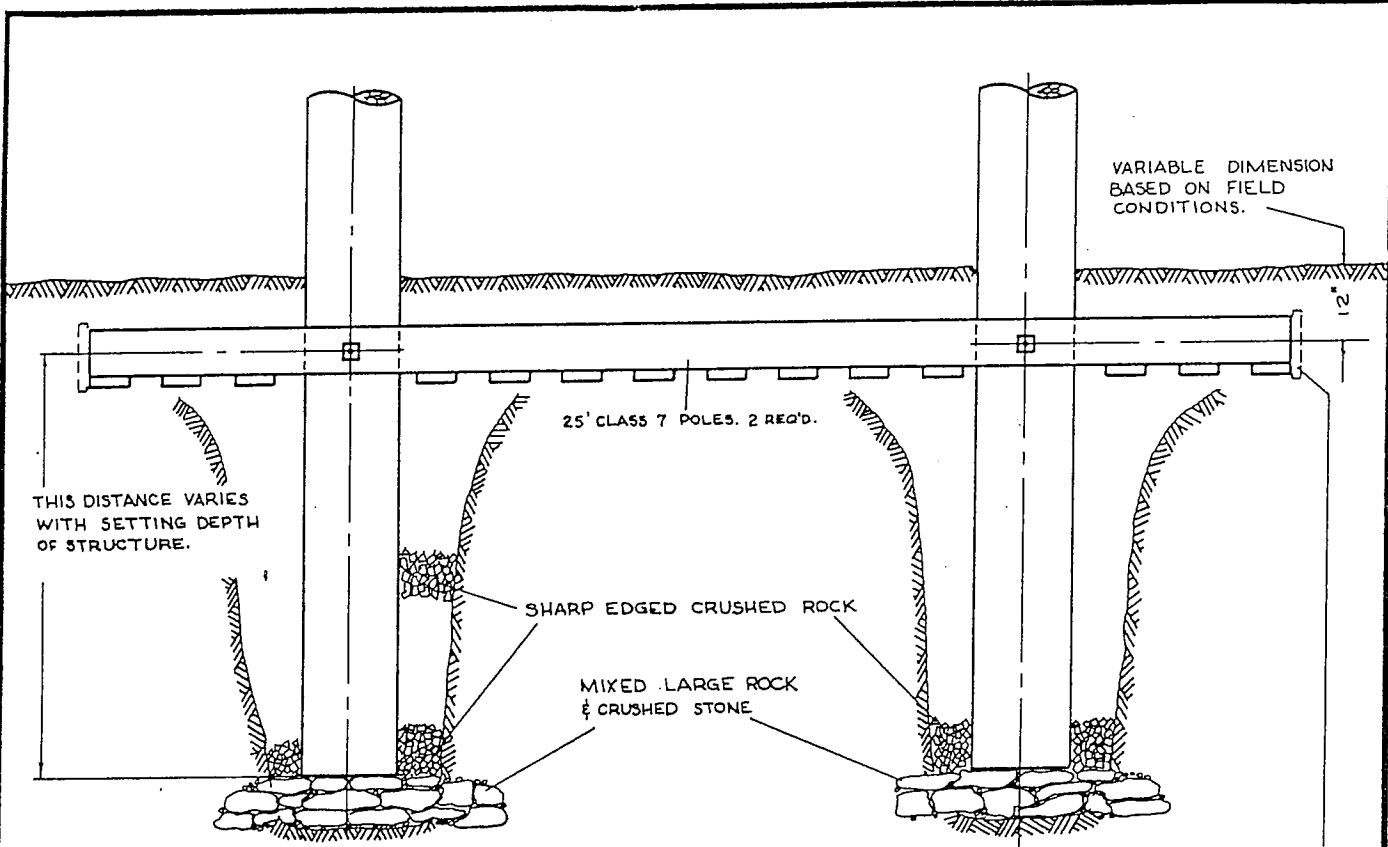


TYPE D&E STRUCTURE

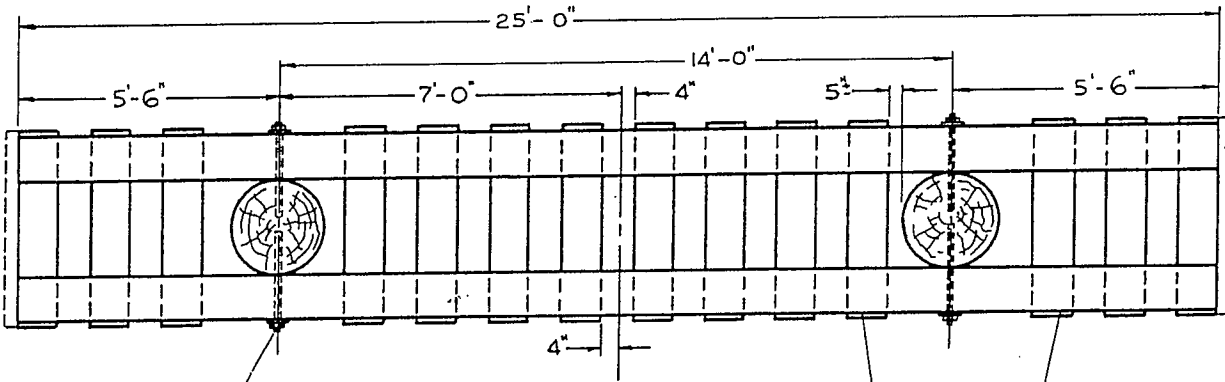
For Pole Ground Detail,  
see Dwg # 115-16.0  
For Method of Guying,  
see Dwg # 115-18.2

METHODS OF POLE & GUY GROUNDING 2-POLE STRUCTURE				
				VERMONT ELECTRIC POWER COMPANY, INC.
DRAWN BY R.C.		CHECKED BY	DATE 4-11-72	
DATE	C'K' BY	SCALE	APPROVED BY	DWG # 115-19.1
REVISIONS		NONE		





LAG 2"x10"x4" PLANK TO BUTT WHEN REQUIRED.



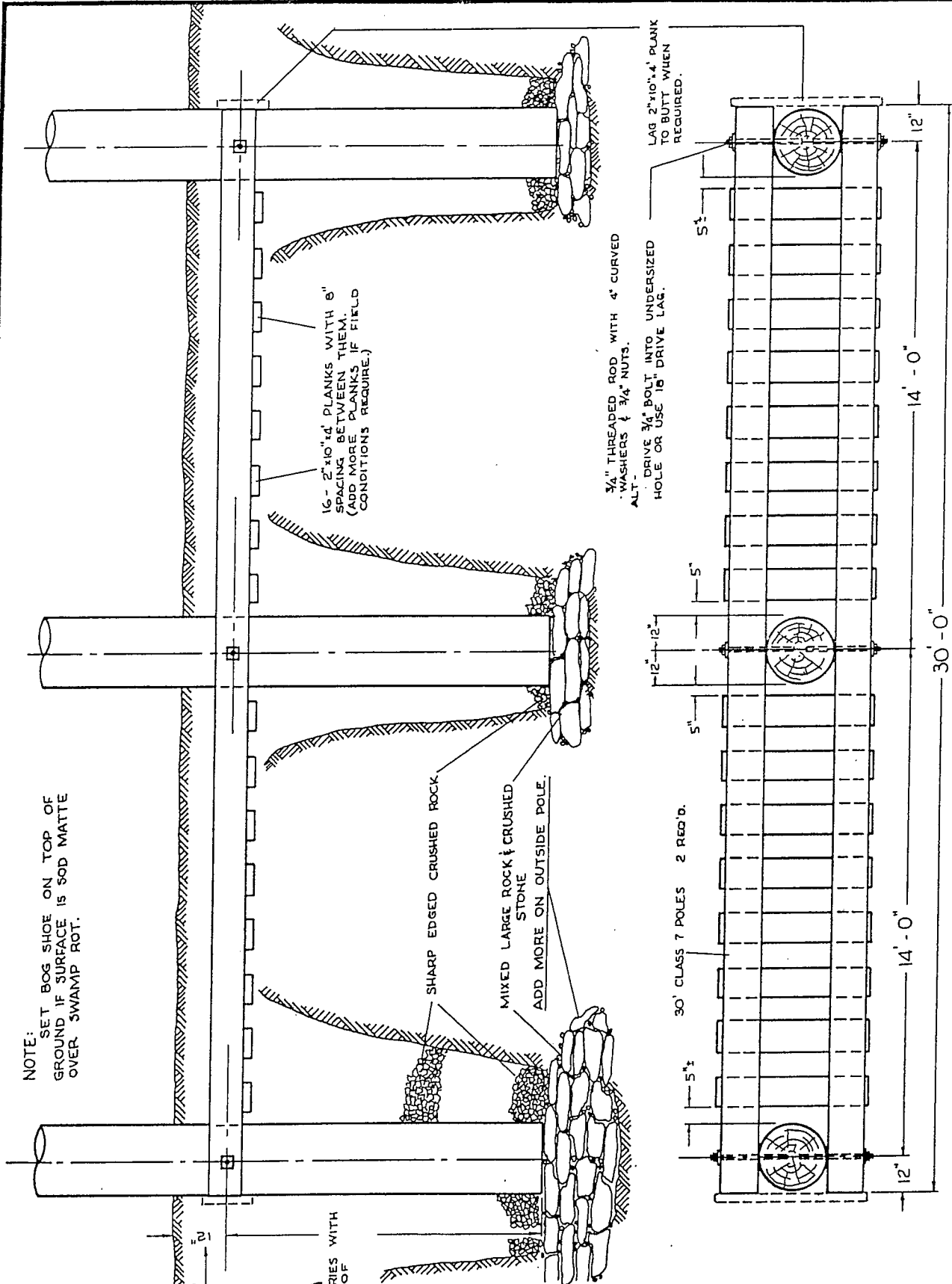
3/4" THREADED ROD WITH 4" CURVED WASHERS & 3/4" NUTS.  
 ALT- DRIVE 3/4" BOLT INTO UNDERSIZED HOLE, OR USE 1 1/2" DRIVE LAG.

14 - 2"x10"x4" PLANKS WITH 8" SPACING BETWEEN THEM.  
 (ADD MORE PLANKS IF FIELD CONDITIONS REQUIRE.)

NOTE:  
 SET BOG SHOE ON TOP OF GROUND IF SURFACE IS SOD MATTE OVER SWAMP ROT.

<b>BOG SHOE DETAIL                  TANGENT "A" STRUCTURE                  115 KV. CONSTRUCTION</b>			
VERMONT ELECTRIC POWER COMPANY, INC.			
DRAWN BY PDA		CHECKED BY	DATE 4-12-72
DATE	CHK BY	SCALE 1"=4'	APPROVED BY
REVISIONS			DWG# 115-20.0

NOTE: SET BOG SHOE ON TOP OF GROUND IF SURFACE IS SOD MATTE OVER SWAMP ROT.



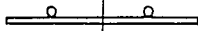
VARIABLE DIMENSION BASED ON FIELD CONDITIONS.

THIS DISTANCE VARIES WITH SETTING DEPTH OF STRUCTURE.

**BOG SHOE DETAIL  
FOR 3 POLE ANGLE STRUCTURES  
115 KV. CONSTRUCTION**

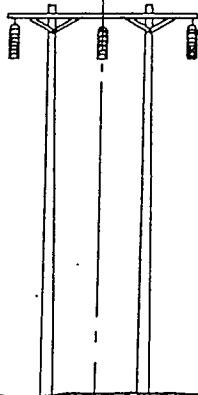
VERMONT ELECTRIC POWER COMPANY, INC.

DATE		CH'K BY	SCALE	APPROVED BY	DWG#
REVISIONS			1" = 4'		115-20.1
DRAWN BY PDA.			CHECKED BY	DATE 4-12-72	



TOP VIEW

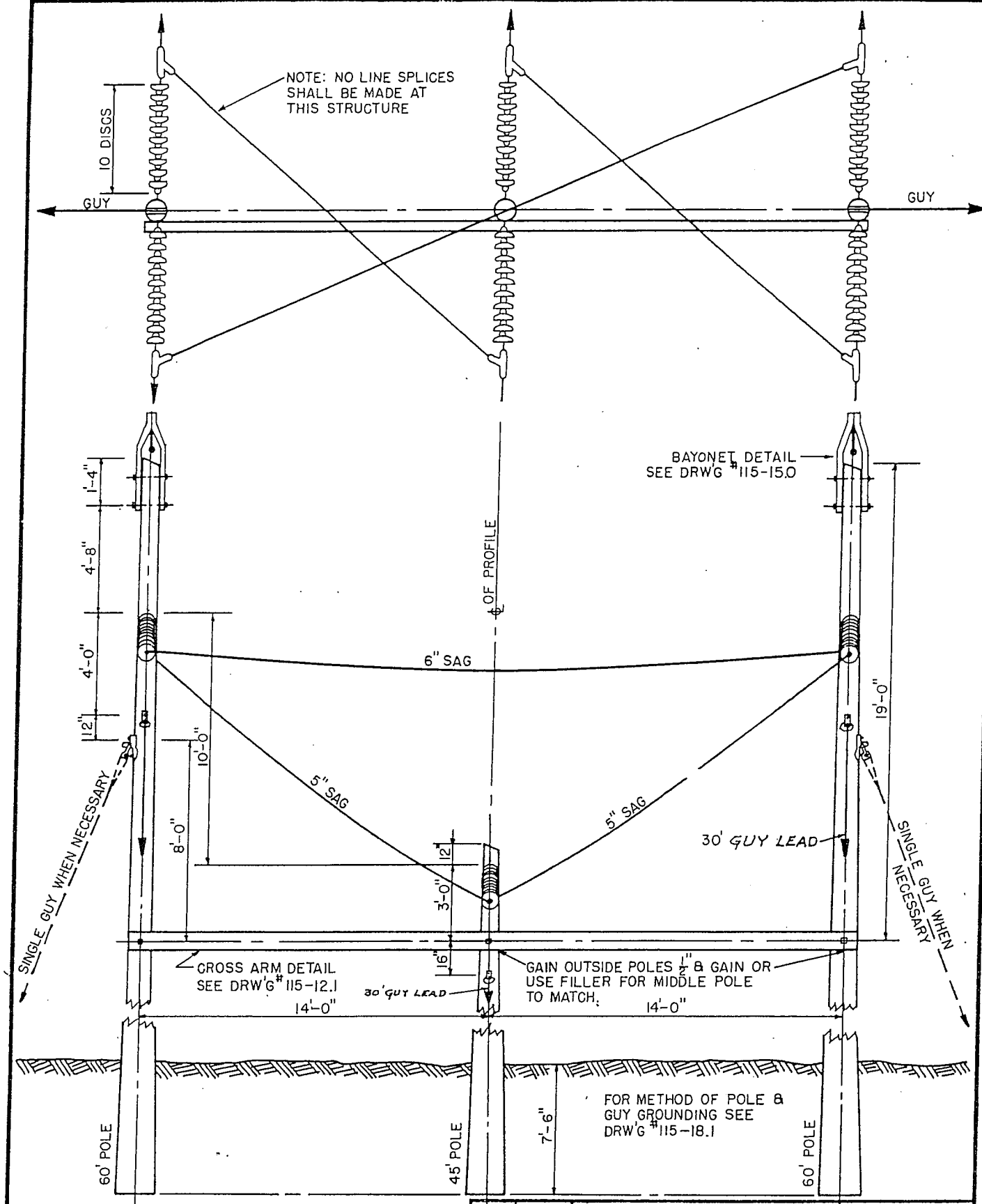
LINE OF PROFILE



75'-0"

150'-0"

		<b>GENERAL PLAN</b>	
		FOR PILING WOOD & BRUSH	
		150' RIGHT OF WAY	
		VERMONT ELECTRIC POWER COMPANY, INC.	
		DRAWN BY JM	CHECKED BY
			DATE 4/13/72
DATE	CHK BY	*SCALE	APPROVED BY
		NONE	DWG # 115-21.0

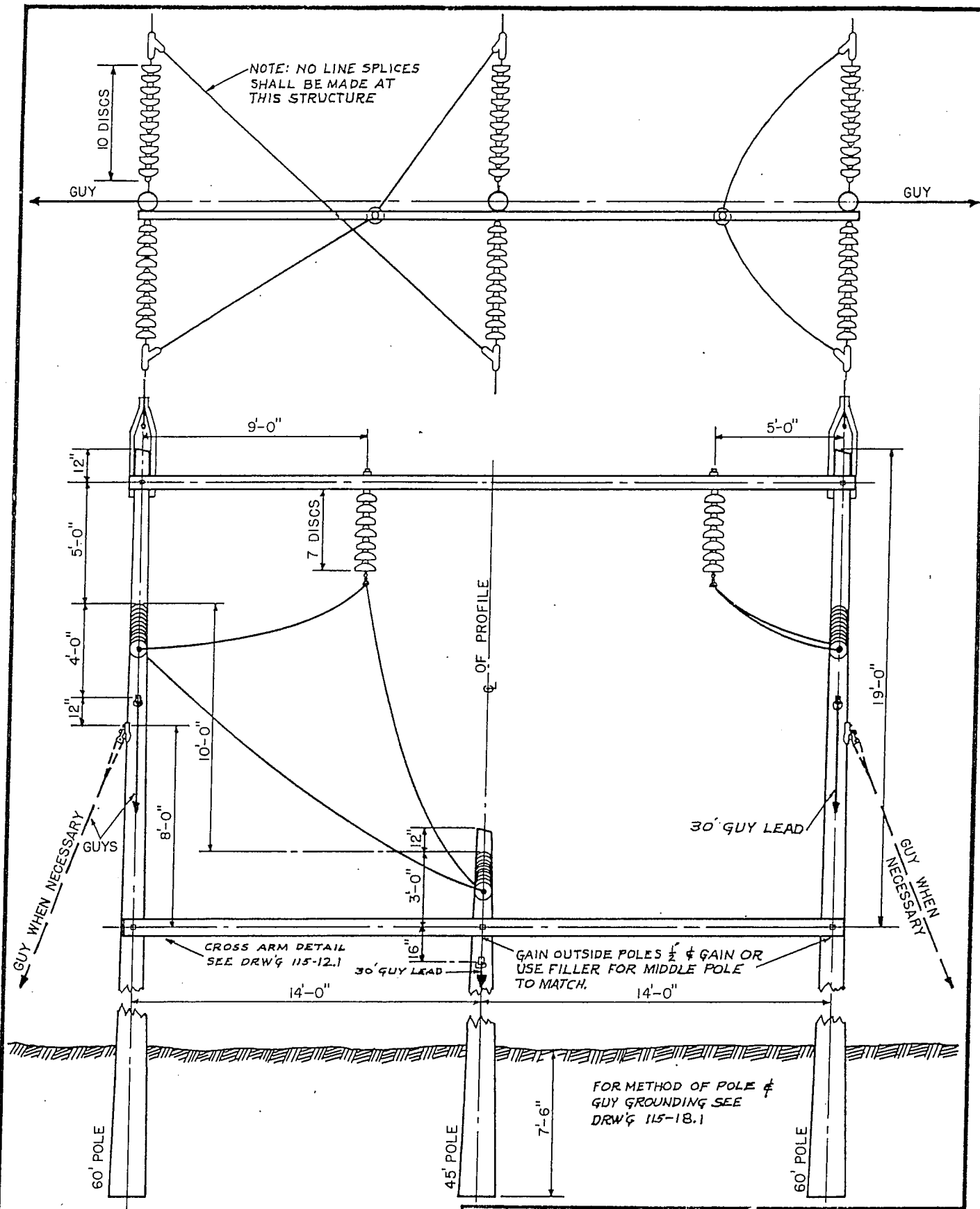


NOTE:  
FOR STRUCTURAL DETAILS SEE DRWG 115-11.2

**TYPE F STRUCTURE  
TRANSPPOSITION  
115 KV CONSTRUCTION**

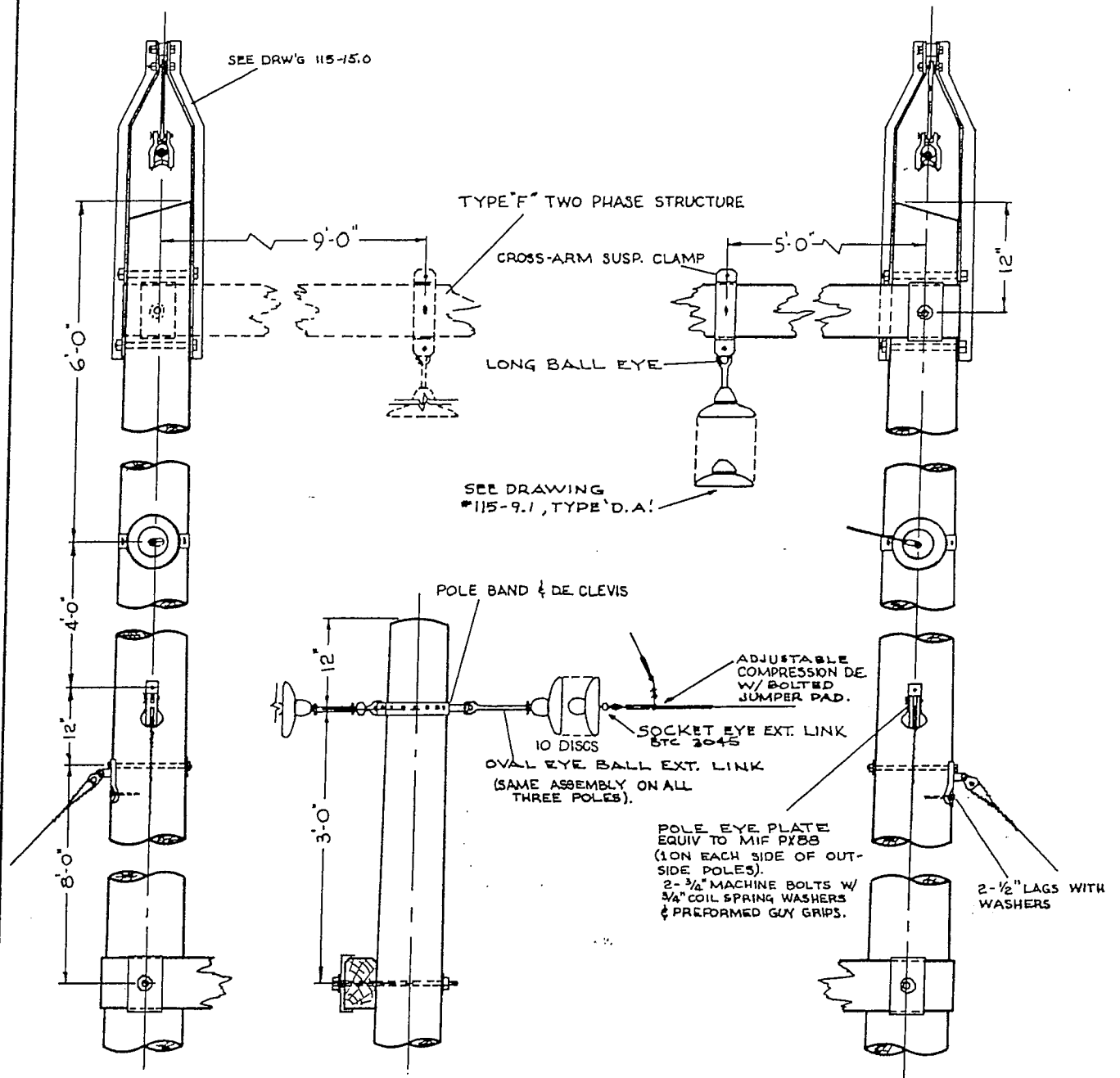
VERMONT ELECTRIC POWER COMPANY, INC.

3/1/77	✓	DRAWN BY JM	CHECKED BY	DATE 4/22/72
DATE	CHK BY	SCALE	APPROVED BY	DWG# 115-22.0
REVISIONS		NONE		



NOTE: FOR STRUCTURAL DETAILS  
SEE DRWG. 115-11.2

<b>TYPE F SPECIAL TWO PHASE TRANSPOSITION 115KV CONSTRUCTION</b>			
VERMONT ELECTRIC POWER COMPANY, INC.			
3/1/77	DRAWN BY JM	CHECKED BY	DATE 4/22/72
DATE	CHK BY	SCALE	APPROVED BY
REVISIONS	NONE		
			DWG # 115-22.1



3 PHASE TRANSPOSITION STRUCTURE

2 PHASE TRANSPOSITION STRUCTURE

(ALL DIMENSIONS, EXCEPT THOSE NOTED, ARE SAME AS THREE PHASE STRUCTURE).

NOTE:  
OUTSIDE POLES 60'  
MIDDLE POLE 45'

POLE TOP DETAILS TYPE "F" 2 & 3 PHASE TRANSPOSITION STRUCTURES 115 KV. CONSTRUCTION			
VERMONT ELECTRIC POWER COMPANY, INC.			
3/1/77	DP	DRAWN BY PDA	CHECKED BY
DATE	CHK BY	SCALE	APPROVED BY
REVISIONS		NONE	
			DATE 4/22/72
			DWG# 115-22.2



# West Rutland-New Haven


Burns & McDonnell Project No. 40240

## 345KV STRUCTURE DRAWING INDEX

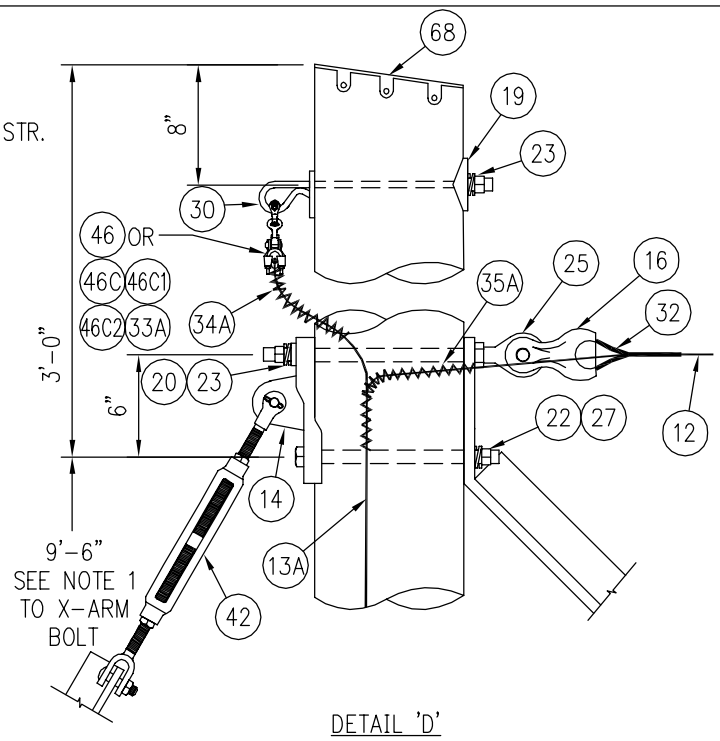
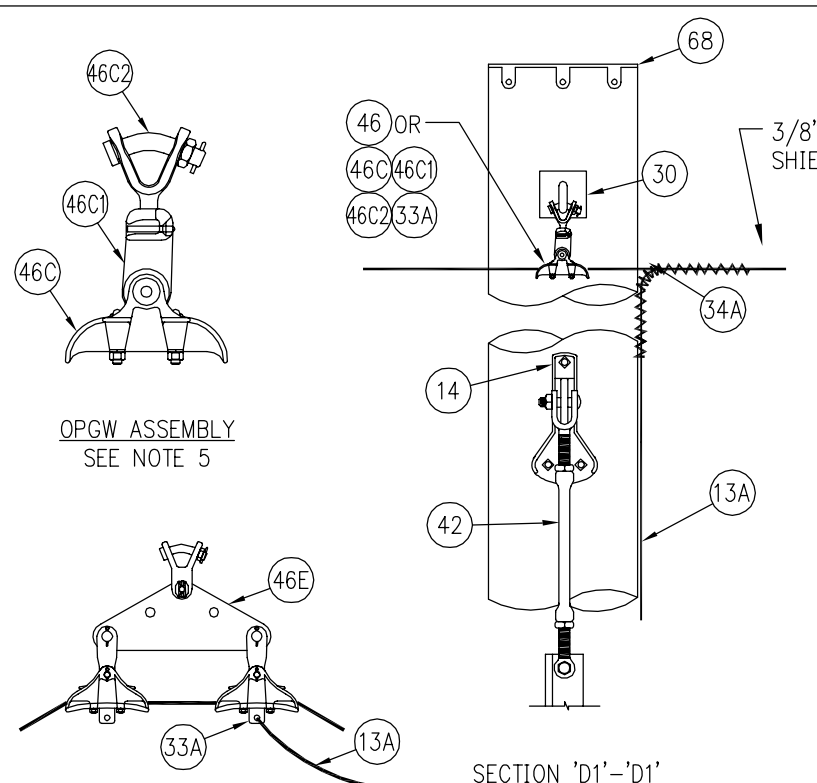
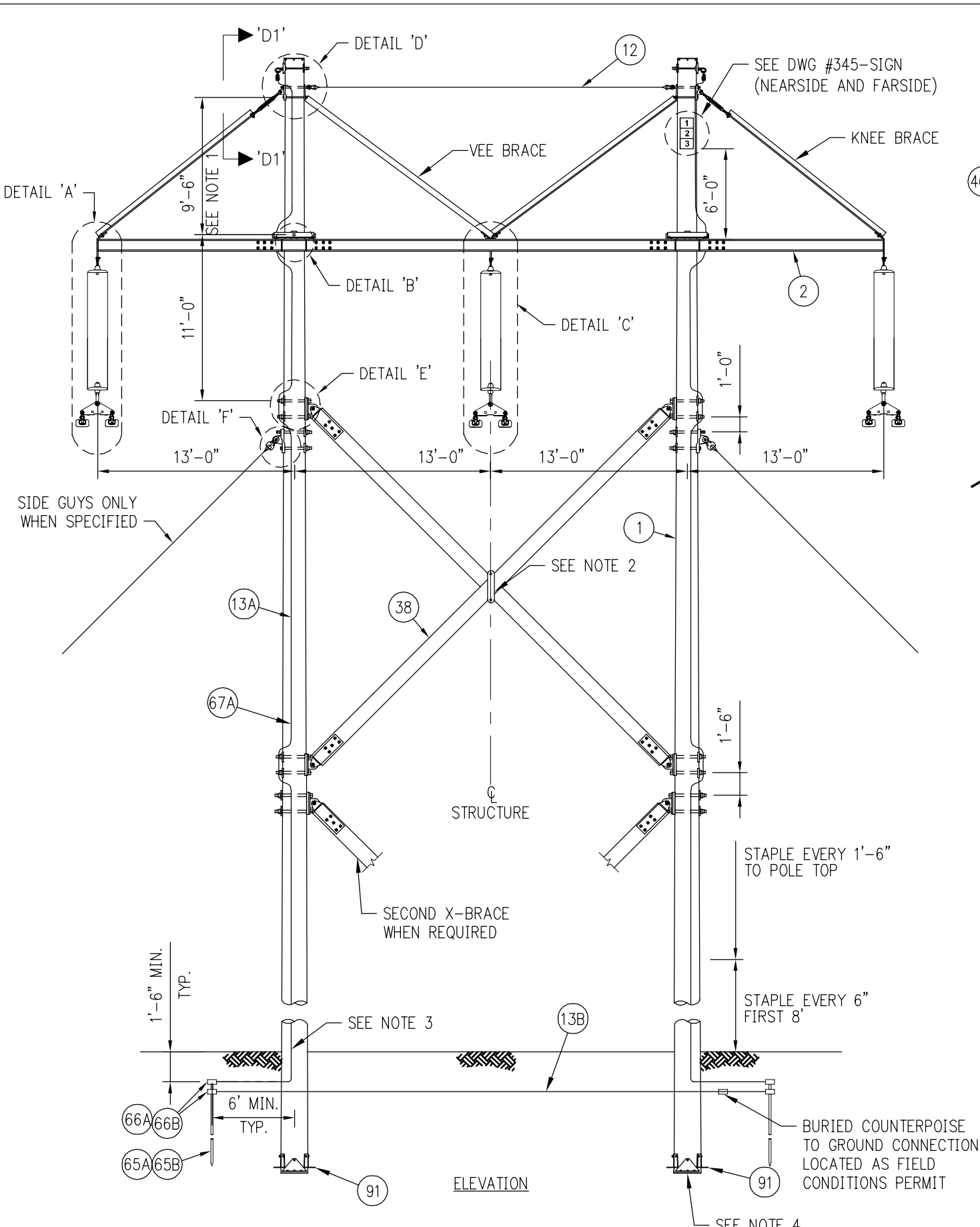
DRAWING NO.	TITLE	DRAWING NO.	TITLE	DRAWING NO.	TITLE
345-0.0	345KV CONSTRUCTION INDEX TO DRAWINGS	345-5.3	STRAIGHT LINE DEAD END POLE TOP DETAILS-TIMBER CONNECTIONS TYPE 'DE1'	345-9.0	CROSSARM DETAILS
345-1.0	TANGENT SUSPENSION STRUCTURE TYPE 'A'	345-5.4	STRAIGHT LINE DEAD END POLE TOP DETAILS-COND. & GUY ATTACH. TYPE 'DE1'	345-9.1	CROSSARM DETAILS
345-1.1	TANGENT SUSPENSION POLE TOP DETAILS TYPE 'A'	345-5.5	STRAIGHT LINE DEAD END BILL OF MATERIALS TYPE 'DE1'	345-10.0	ANCHOR AND GUY GROUNDING DETAILS
345-1.2	TANGENT SUSPENSION BILL OF MATERIALS TYPE 'A'	345-6.0	ANGLE DEAD END STRUCTURE TYPE 'DE2' (35° TO 55°)	345-10.1	ROCK ANCHOR DETAILS
345-1.3	SHIELD WIRE DEAD END ATTACHMENT TYPE 'A' STRUCTURE	345-6.1	ANGLE DEAD END POLE TOP DETAILS TYPE 'DE2' (35° TO 55°)	345-10.2	METHOD OF POLE GUYING
345-1.4	OPTICAL WIRE DEAD END ATTACHMENT TYPE 'A' STRUCTURE	345-6.2	ANGLE DEAD END POLE TOP DETAILS-COND. & GUY ATTACH. TYPE 'DE2' (35° TO 55°)	345-11.0	2-POLE GROUNDING DETAILS TYPE A, B & C
345-3.0	SUSPENSION ANGLE STRUCTURE TYPE 'SA2' (12° TO 22°)	345-6.3	ANGLE DEAD END BILL OF MATERIALS TYPE 'DE2' (35° TO 55°)	345-11.1	METHOD OF POLE AND GUY GROUNDING
345-3.1	SUSPENSION ANGLE POLE TOP DETAILS TYPE 'SA2' (12° TO 22°)	345-7.0	ANGLE DEAD END STRUCTURE TYPE 'DE3' (55° TO 75°)	345-13.0	FOUNDATIONS AND BOG SHOE PLATFORM FOR 2 POLE STRUCTURE
345-3.2	SUSPENSION ANGLE BILL OF MATERIALS TYPE 'SA2' (12° TO 22°)	345-7.1	ANGLE DEAD END POLE TOP DETAILS TYPE 'DE3' (55° TO 75°)	345-14.0	BOG SHOE PLATFORM FOR 3 POLE STRUCTURE 29'-0" & 29'-6" POLE SPACING
345-4.0	SUSPENSION ANGLE STRUCTURE TYPE 'SA3' (22° TO 35°)	345-7.2	ANGLE DEAD END POLE TOP DETAILS-COND. & GUY ATTACH. TYPE 'DE3' (55° TO 75°)	345-14.1	BOG SHOE PLATFORM FOR 3 POLE STRUCTURE 29'-0" & 29'-6" POLE SPACING
345-4.1	SUSPENSION ANGLE POLE TOP DETAILS TYPE 'SA3' (22° TO 35°)	345-7.3	ANGLE DEAD END BILL OF MATERIALS TYPE 'DE3' (55° TO 75°)	345-DG	345KV STRUCTURE POLE DRILLING GUIDE TYPE "A"
345-4.2	SUSPENSION ANGLE BILL OF MATERIALS TYPE 'SA3' (22° TO 35°)			345-SIGN	AERIAL PATROL AND STRUCTURE NUMBER SIGNS
345-5.0	STRAIGHT LINE DEAD END STRUCTURE TYPE 'DE1'				
345-5.1	STRAIGHT LINE DEAD END SHIELD WIRE DEAD END TYPE 'DE1'				
345-5.2	STRAIGHT LINE DEAD END OPTICAL WIRE DEAD END TYPE 'DE1'				


**CONFORMED TO CONSTRUCTION RECORDS**  
 The revision dated 01.01.08 supercedes all revisions with an earlier revision date

**PROPRIETARY**  
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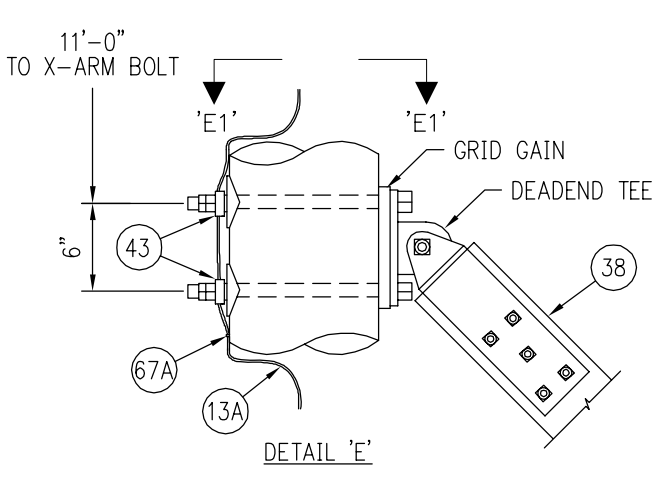
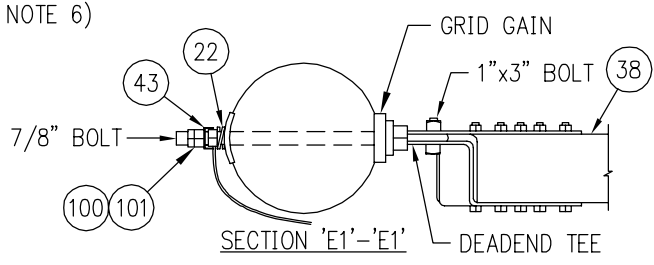
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0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION
REV	DATE	DR	CK	DESCRIPTION
				<b>VERMONT ELECTRIC POWER CO., INC.</b> RUTLAND, VERMONT WEST RUTLAND - NEW HAVEN 345KV
<b>345KV CONSTRUCTION INDEX TO DRAWINGS</b>				
SCALE: NONE		DRAWN BY: BMcD		APPROVED BY:
DATE: 11/05		CHECKED BY: KAW		DATE
DRAWING NUMBER: 345-0.0				1
PLOT: 1=1				REV.

N:\velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-00.dwg 09-20-2005 16:27 6



NOTES:

1. DIMENSION INCREASED TO 10'-0" ON APPROXIMATELY HALF OF STRUCTURES INSTALLED TO ALLOW USE OF LARGER STATIC WIRE RUNNING BLOCK.
2. BRACKET INSTALLED HORIZONTALLY ON APPROXIMATELY HALF OF STRUCTURES INSTALLED; HORIZONTAL INSTALLATION WAS APPROVED BY HUGHES.
3. AN ADDITIONAL PARALLEL GROOVE CONNECTOR AND GROUND WIRE WAS EXTENDED TO CONNECT TO GROUND LUG ON MARK 91 IN AREAS OF HIGH SOIL RESISTANCE.
4. FOUR SECTION PLATES WERE USED IN POOR SOILS; TWO SECTION PLATES WERE TYPICALLY INSTALLED.
5. PENETROX GREASE REQUIRED AT CONNECTION OF MARK 33A AND 46C.
6. USE DOUBLE OPTICAL WIRE SUSPENSION ASSEMBLY WHEN VERTICAL ANGLE EXCEEDS 30 DEGREES.



**Burns & McDonnell**  
SINCE 1892

**CONFORMED TO CONSTRUCTION RECORDS**

The revision dated 01.01.08 supercedes all revisions with an earlier revision date

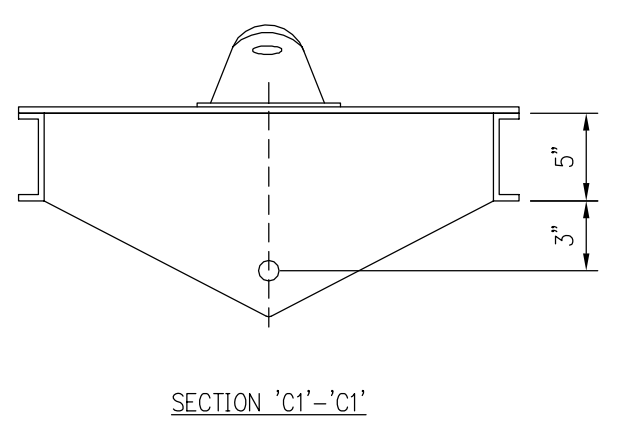
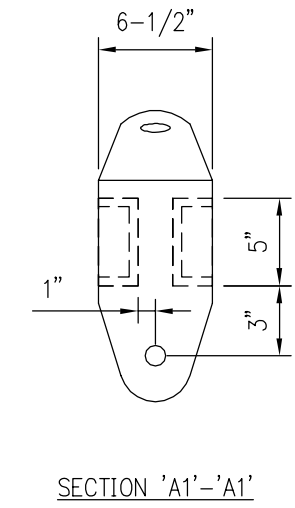
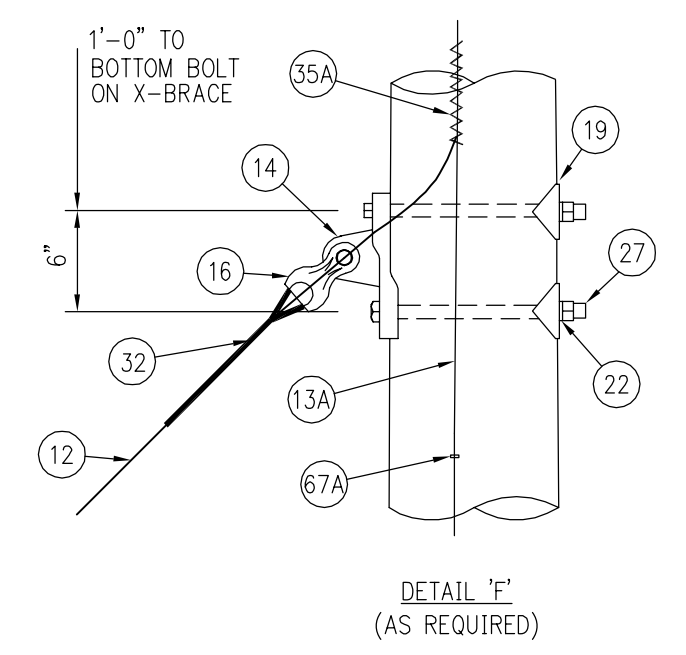
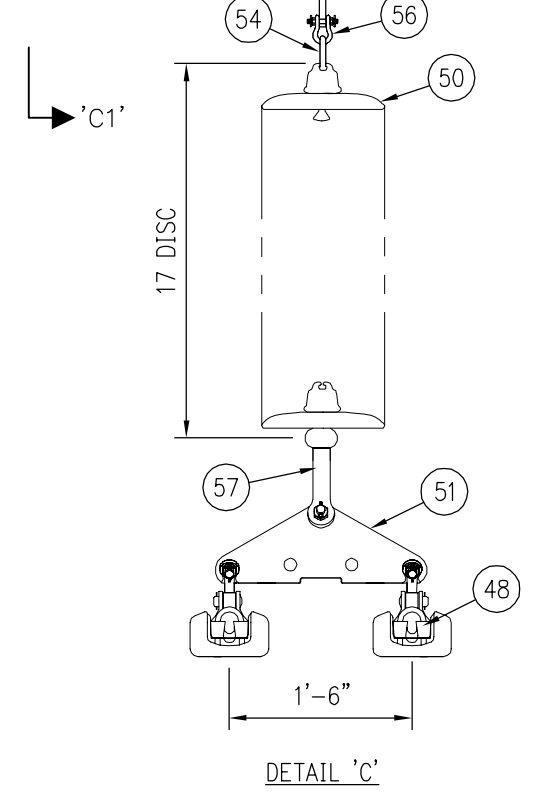
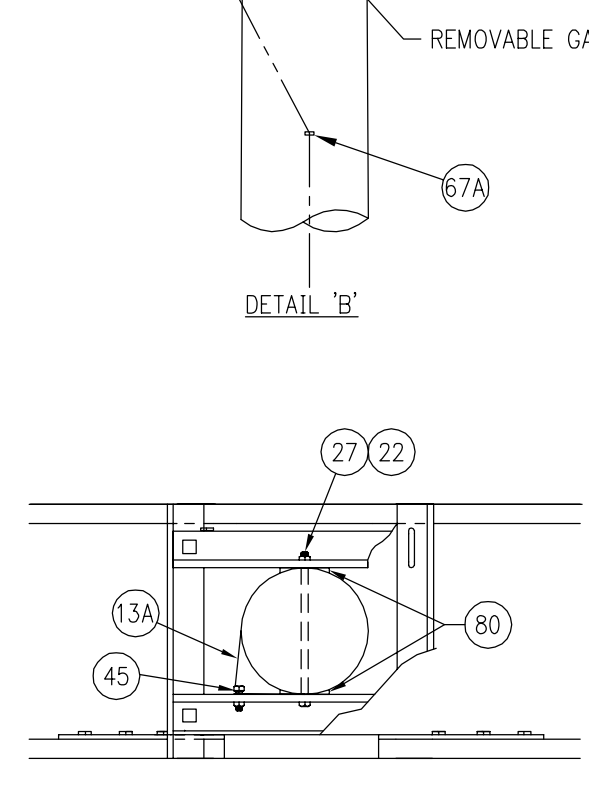
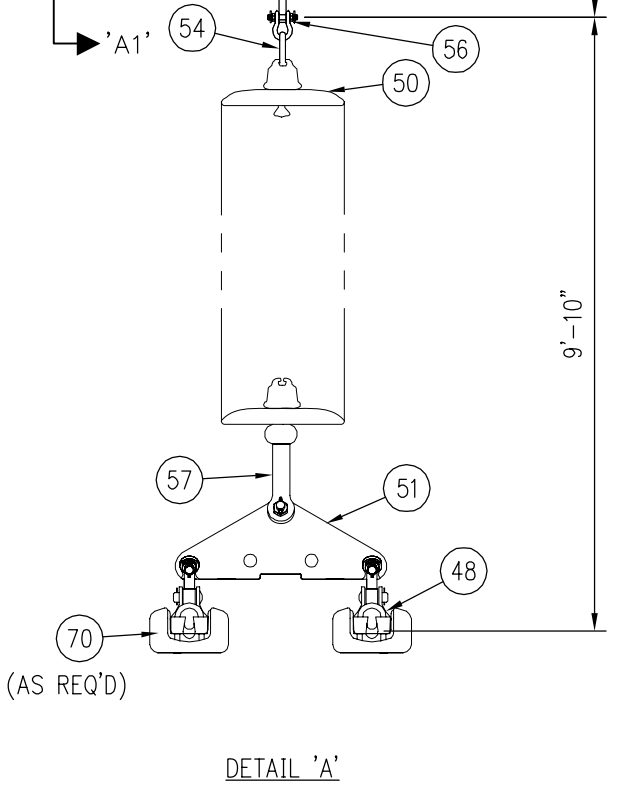
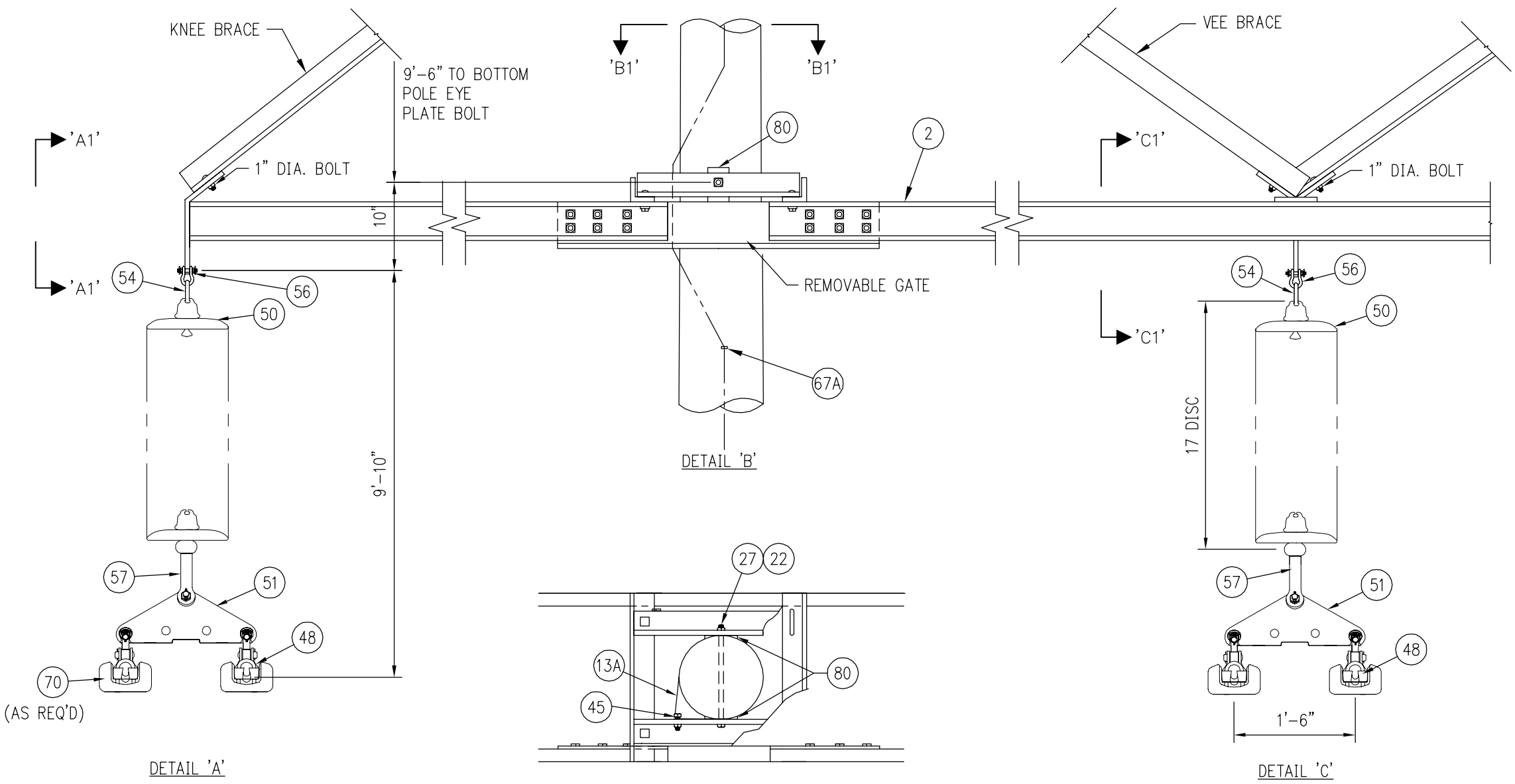
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1	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION
REV	DATE	DR	CK	DESCRIPTION
<b>VELCO</b>				<b>VERMONT ELECTRIC POWER CO., INC.</b> RUTLAND, VERMONT WEST RUTLAND - NEW HAVEN 345 KV
<b>TANGENT SUSPENSION STRUCTURE TYPE 'A'</b>				
SCALE: NONE	DRAWN BY: BMcD		APPROVED BY:	
DATE: 11/05	CHECKED BY: KAW		DATE:	
DRAWING NUMBER: 345-1.0			1	FILE:
PLOT: 1=1			REV.	

FOR ANCHOR AND GUY GROUNDING DETAILS, SEE DWG. #345-10.0 & #345-10.1  
 FOR POLE GUYING DETAILS, SEE DWG. #345-10.2  
 FOR GROUNDING DETAILS, SEE DWG. #345-11.0  
 FOR FOUNDATION DETAILS, SEE DWG. #345-FDN-1 THRU FDN-4

N: Velco 345-1.0.dwg 02-07-2006 11:30 DSM BMcD





**Burns & McDonnell**  
**CONFORMED TO CONSTRUCTION RECORDS**  
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1	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION
REV	DATE	DR	CK	DESCRIPTION
				<b>VELCO</b> VERMONT ELECTRIC POWER CO., INC. RUTLAND, VERMONT WEST RUTLAND - NEW HAVEN 345 KV
<b>TANGENT SUSPENSION POLE TOP DETAILS TYPE 'A'</b>				
SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:		
DATE: 11/05	CHECKED BY: KAW			DATE
DRAWING NUMBER: PLOT: 1=1	345-1.1			1 REV.

**BILL OF MATERIALS**

MARK	STOCK NO.	QUANTITY	DESCRIPTION	MANUFACTURE	CATALOG NUMBER
1		2	POLE, WOOD		
2	0000560	1	CROSSARM, ASSEMBLY, WEATHERING STEEL, 345kv, 52', INCLUDES CROSSARM, 2 KNEE BRACES & 2 VEE BRACES WEATHERING STEEL, AND ALL MOUNTING HARDWARE EXCEPT TURNBUCKLES, THRU BOLTS FOR ARM, HARDWARE FOR UPPER END OF BRACES.	T&B/MEYER	DWG #7453
12		27	GUY STRAND, 1/2"EHS-7 STRAND (FT)		
13A		235	BONDING WIRE #2 COPPER, SOLID (FT)		
13B		38	GROUND WIRE, 7 NO. 8 COPPERWELD (FT) DEAD SOFT ANNEALED		
14		2	PLATE, POLE EYE, 7/8" BOLT, 6" BOLT SPCG, SGL EYE, 7/8" PIN	MACLEAN	EPR-77S-7
16	0201520	2	THIMBLE CLEVIS, 20K	MACLEAN	CT-88H
19		2	WASHER, SQ, CURVED, 4"x4", FOR 7/8" BOLT	JOSLYN	P144B
20	0204650	2	WASHER, ROUND, 2", FOR 3/4" BOLT	HUGHES	RW2-70
22		12	WASHER, COIL, DOUBLE SPRING, FOR 7/8" BOLT	HUGHES	SLW2-80
23	0200110	4	WASHER, COIL, DOUBLE SPRING, FOR 3/4" BOLT	HUGHES	SLW2-70
25		2	BOLT, DBL ARM, EYE BOLT, W/2 NUTS, 3/4"xXX"	JOSLYN	J96XX
27		4	BOLT, MACHINE, 7/8"xXX", W/NUT	HUGHES	B8XX
30		2	SUPPORT, STATIC WIRE, 3/4"xXX", W/ 5/8" LINK	HUGHES	2812.6-XX-BCL
32	0203860	2	GUY GRIP, DEADEND, GALV, 1/2" BLUE 7W	HELICAL	HG212-1/2
33A		2	CONNECTOR, GROUND CLAMP, BRONZE FOR OPTICAL WIRE SUSPENSION CLAMP, SX-48/33/520	ANDERSON	GTCL-23A
34A		1	L-TAP, 3/8" GALV TO #2 SOLID CU	HELICAL	
35A		2	L-TAP, 1/2" GALV TO #2 SOLID CU	HELICAL	
38		1	BRACE-X, ASSEMBLY, 345KV, 5-1/8" x 7-1/2", 26' POLE SP, LAMINATED, INCLUDES DEADEND TEES, CURVED WASHERS, NUTS, 7/8" x XX" MTG BOLTS, GRID GAINS AND CENTER CLAMP.	HUGHES	2093K-26-0-CPT
42		2	TURNBUCKLE, CLEVIS-CLEVIS, 7/8" x 12", 35K	HUGHES	AS2545-C
43	0204530	8	CLIP, GRND WIRE BONDING, #2 CU TO 7/8 BOLT	HUGHES	2727.8
45	0202660	2	CLIP, GROUND WIRE BONDING, GALV, #2 CU TO FLAT SURF. 1/2" BOLT, NUT AND LOCK NUT	HUGHES	GWB-51-1/2
46	0100050	1	CLAMP, SHIELD WIRE, SUSP., 3/8"EHS-7 STRAND (.20-.46) W/O FITTING	MACLEAN	FS-46-N
46C		1	CLAMP, OPTICAL WIRE, SUSP., SX-48/33/520	ALCOA	SUME 500/527
46C1		1	SOCKET EYE	HUBBELL	SA16
46C2		1	Y-CLEVIS BALL	MACLEAN	YCB-65A
48	0101850	6	CLAMP, COND, FORMULA, SUSPENSION, 1.2" MAX DIA, 15"L, 23K, W/90° Y-CLEVIS EYE FITTING F/954MCM 45/7ACSR CORONA FREE	MACLEAN	ACFS-120-15-23-RYCE
50		51	INSULATOR, SUSP, 30K M&E, 5-3/4"x10", BALL & SOCKET, GRAY	LAPP	5960A-70
51		3	PLATE, YOKE, TRI, 18" SPCG, 15/16" HOLES, 40K ULT, 5/8" THICK	MACLEAN	ASM-6229-3
54	0201600	3	OVAL-EYE BALL, GALV, FORGED STEEL, 30K, 3-23/32" LONG	ANDERSON	BE-30
56	0206010	3	SHACKLE, ANCHOR, BNK, 35K, W/ 3/4" BOLT NUT & COTTER KEY	ANDERSON	AS-35-BNK
57	0207860	3	SOCKET, CLEVIS, 4-1/2" L, 13/16"W, 2"D, 5/8"P, 30K	MACLEAN	SCL-55B
65A		4	GROUND ROD, COPPER CLAD, 3/4" x 10'	BLACKBURN	7510
65B		2	COUPLING, GROUND ROD, 3/4" COPPER CLAD COMPRESSION	E&J DEMARK	GRC-34B
66A		2	EXOTHERMIC WELD, #2 SOLID CU TO 3/4" CU ROD	ERICO/CADWELD	
66B		2	EXOTHERMIC WELD, 7 NO. 8 COPPERWELD TO 3/4" CU ROD	ERICO/CADWELD	
67A		110	STAPLE, GROUND WIRE, COPPERCLAD, 1-1/2"x3/8", ROLLED POINT	CHANCE	9167
80	0203760	4	GRID GAIN, CURVED, 6-3/4"x4-1/8", FOR 7/8" BOLT CTR HOLE, F/CROSSARM	JOSLYN	PX261

**BILL OF MATERIALS**

MARK	STOCK NO.	QUANTITY	DESCRIPTION	MANUFACTURE	CATALOG NUMBER
91		2	ANCHOR, POLE, 4-SECTION, W/ 7/8" x XX" THREADED ROD W/4 NUTS, 4 LOCKNUTS & LAG SCREWS	HUGHES	A1895-3-XX
100		8	NUT, SQUARE, 7/8"	HUGHES	N80
101		8	LOCKNUT, SQUARE, 7/8"	HUGHES	MF80
<b>MATERIAL REQUIRED FOR DOUBLE OPTICAL WIRE SUSPENSION</b>					
46E		1	CLAMP ASSEMBLY, OPTICAL WIRE, DBL. SUSP. W/2 CLEVIS EYE, 1 YOKE PLATE, 1 Y-CLEVIS CLEVIS, SX-48/33/520	ALCOA	OSPSS4
<b>SIDE GUY MATERIAL ONLY</b>					
12		110	GUY STRAND, 1/2"EHS-7 STRAND (FT)		
14		2	PLATE, POLE EYE, 7/8" BOLT, 6" BOLT SPCG, SGL EYE, 7/8" PIN	MACLEAN	EPR-77S-7
16	0201520	2	THIMBLE CLEVIS, 20K	MACLEAN	CT-88H
19		4	WASHER, SQ, CURVED, 4"x4", FOR 7/8" BOLT	JOSLYN	P144B
21		2	WASHER RND 6" FOR 1" ANCHOR ROD	JOSLYN	P85A-1
22		4	WASHER, COIL, DOUBLE SPRING, FOR 7/8" BOLT	HUGHES	SLW2-80
27		4	BOLT, MACHINE, 7/8"xXX", W/NUT	HUGHES	B8XX
32	0203860	4	GUY GRIP, DEADEND, GALV, 1/2" BLUE 7W	HELICAL	HG212-1/2
35A		2	L-TAP, 1/2" GALV. TO #2 SOLID CU	HELICAL	
44		2	CLAMP, BONDING, GUY-GROUND, FOR #2 CU TO 1/2"-7 STRAND	CHANCE	6484
71	0205180	2	ANCHOR, LOG, 8"x8"x8'		
72		2	ANCHOR ROD, 1"x10' LONG, HD GALV., THMBL EYE	CHANCE	5340
73	0205950	2	GUY MARKER, FULL RND, YEL, 84"x 1.5", 3/16-1/2" W/PIGTAIL POLYETHYLENE	CHANCE	84FRPM-YEL
<b>MATERIAL USED AS REQUIRED</b>					
68	0204390	AR	POLE ROOF, NON METALLIC	OSMOSE	70-110-020-016
70	0202550	AR	WEIGHT, HOLD DOWN, 150#, W/ HARDWARE, FOR FORMULA CLAMP 954MCM ACSR 45/7	MACLEAN	ASM-389-150

**CONFORMED TO CONSTRUCTION RECORDS**

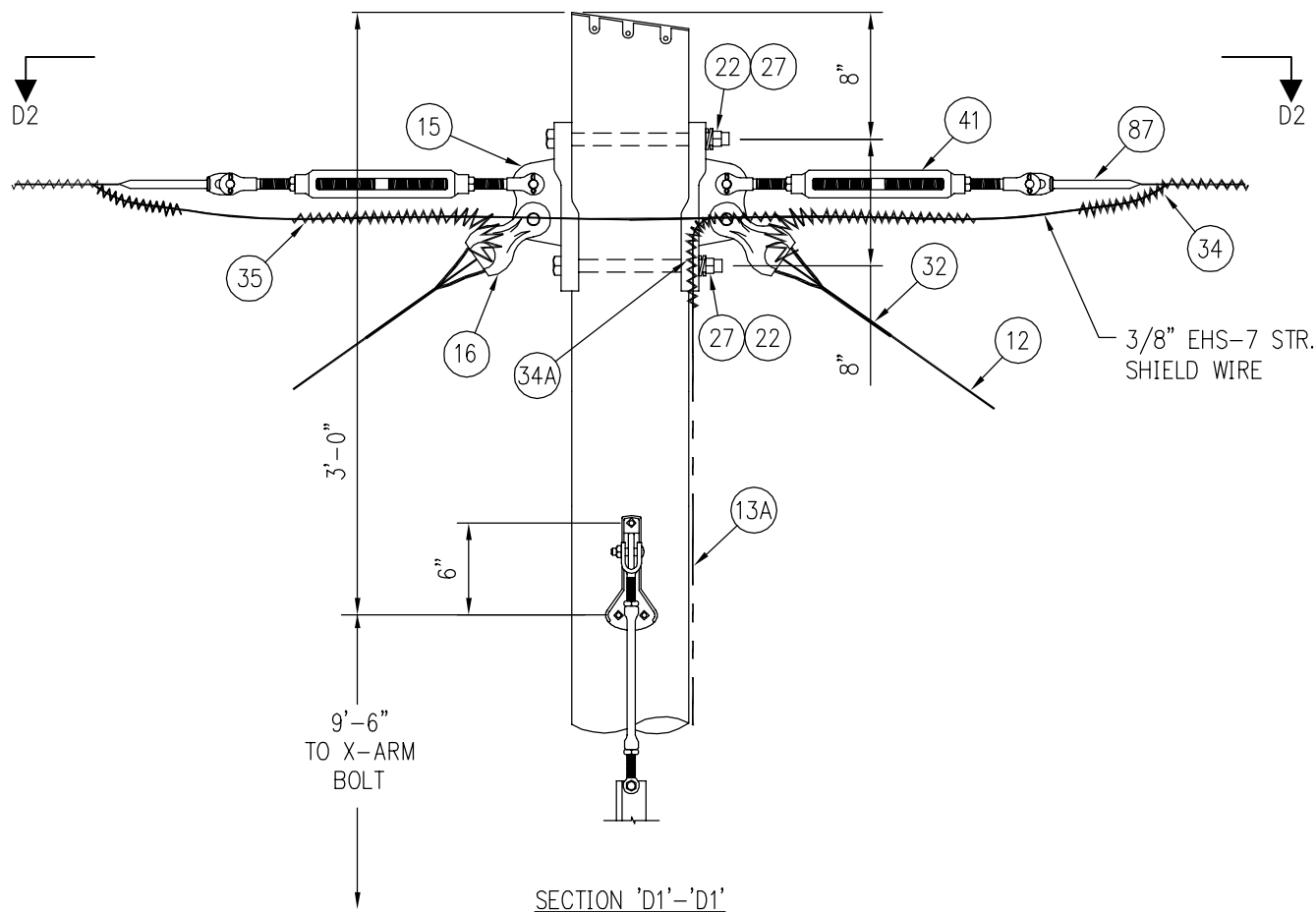
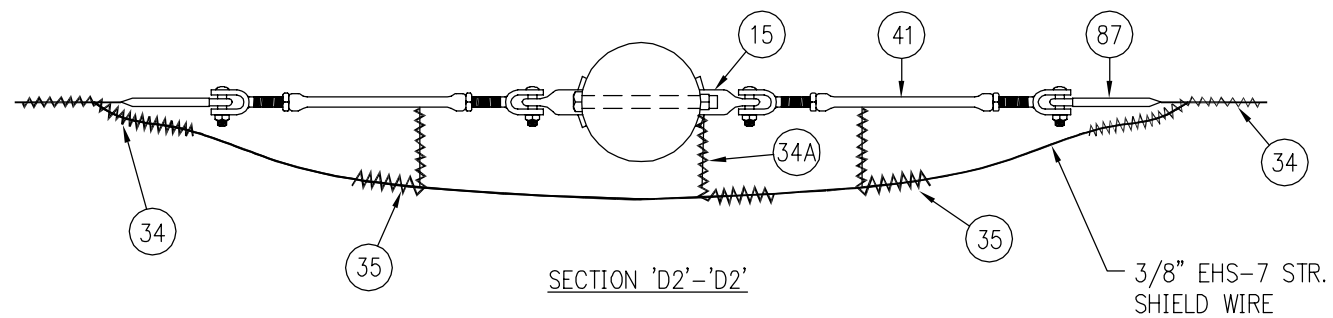
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1	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS	
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION	
REV	DATE	DR	CK	DESCRIPTION	
				<b>VERMONT ELECTRIC POWER CO., INC.</b> RUTLAND, VERMONT WEST RUTLAND - NEW HAVEN 345 KV	
<b>TANGENT SUSPENSION BILL OF MATERIALS TYPE 'A'</b>					
SCALE: NONE		DRAWN BY: BMcD		APPROVED BY:	
DATE: 11/05		CHECKED BY: KAW		DATE	
DRAWING NUMBER: 345-1.2				1	
PLOT: 1=1				REV.	

N: Velco\36445-WF-WH-EP\Cadd\STANDARD POLES\345KV\345-1.2.dwg 02-07-2006 11:30 DSM BMD  
 FILE:



BILL OF MATERIALS

MARK	STOCK NO.	QUANTITY	DESCRIPTION	MANUFACTURER	CATALOG NUMBER
MATERIALS REQUIRED TO DOUBLE DEADEND 1 SHIELD WIRE ON TYPE "A" STRUCTURE					
15	0201470	2	PLATE, POLE EYE, DBL EYE, GALV, 15/16" HOLES, 8" BOLT SPCG, 7/8" BOLTS, & PIN	MACLEAN	EPR8-77-D7
22		2	WASHER, COIL, DOUBLE SPRING, FOR 7/8" BOLT	HUGHES	SLW2-80
27		2	BOLT, MACHINE, 7/8"x XX", W/NUT	HUGHES	B8XX
34		2	L-TAP, 3/8" GALV. TO 3/8" GALV.	HELICAL	
34A		1	L-TAP, 3/8" GALV. TO #2 SOLID CU	HELICAL	
41	0202540	2	TURNBUCKLE, CLEVIS-CLEVIS, 3/4"x 9", 28K	HUGHES	AS2545-A
87	0101410	2	DEADEND, ALUM, COMP, W/EYE, SHIELD WIRE, 3/8" EHS-7 STR, STL	ALCOA	E4514.12

MATERIALS REQUIRED FOR IN-LINE GUYING

12		200	GUY STRAND, 1/2" EHS-7 STRAND (FT)		
13A		200	BONDING WIRE, #2 COPPER, SOLID (FT)		
16	0201520	2	THIMBLE CLEVIS, 20K	MACLEAN	CT-88H
21		2	WASHER RND 6" FOR 1" ANCHOR ROD	JOSYLN	P85A-1
32	0203860	4	GUY GRIP, DEADEND, GALV, 1/2" BLUE 7W	HELICAL	HG212-1/2
35	0202780	2	L-TAP, 1/2" GALV. TO 3/8" GALV.	HELICAL	
44		2	CLAMP, BONDING, GUY-GROUND, FOR #2 CU TO 1/2"-7 STRAND	CHANCE	6484
66A		2	EXOTHERMIC WELD, #2 SOLID CU WIRE TO 3/4" CU ROD	ERICO/CADWELD	
71	0205180	2	ANCHOR, LOG, 8"x8"x8"		
72		2	ANCHOR ROD, 1"x10'-0" LONG, HOT DIP GALV, THIMBLE EYE	CHANCE	5340
73	0205950	2	GUY MARKER, FULL RND, YEL, 84"x 1.5", 3/16"-1/2" W/PIGTAIL POLYETHYLENE	CHANCE	84FRPM-YEL

NOTES:

- 1) THESE ITEMS WILL BE CALLED FOR BY THE LINE DESIGNER, AS NEEDED
- 2) IF DEAD ENDS ARE USED FOR UPLIFT, GUYS MAY BE ELIMINATED.

**Burns & McDonnell**  
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REV	DATE	DR	CK	DESCRIPTION
1	1/01/08	JAH	JRW	CONFORMED TO CONSTRUCTION RECORDS
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

**VERMONT ELECTRIC POWER CO., INC.**  
 RUTLAND, VERMONT  
 WEST RUTLAND - NEW HAVEN 345 KV

**VELCO**

**SHIELD WIRE DEAD END ATTACHMENT TYPE 'A' STRUCTURE**

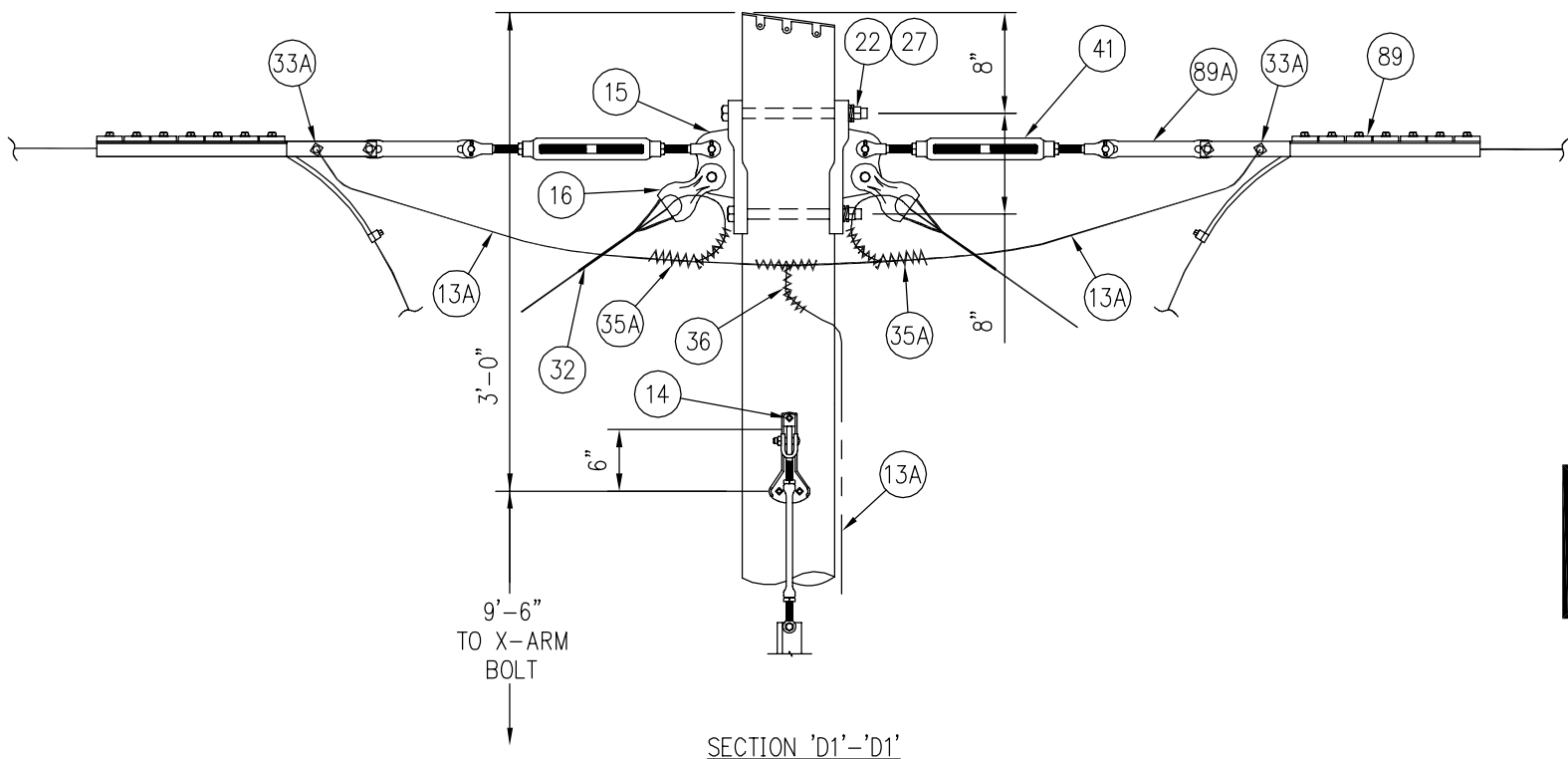
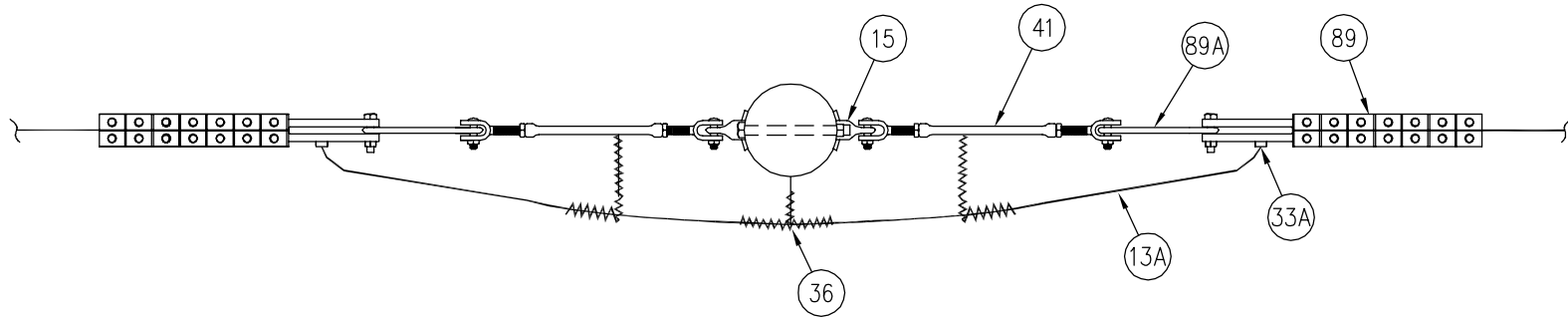
SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	
DATE: 11/05	CHECKED BY: KAW		DATE

DRAWING NUMBER: 345-1.3  
 PLOT: 1=1

1  
 REV.

FILE:

N:\Velco\36445-WR-NH-EP\Cadd\STANDARD POLES\345KV\345-1.3.dwg 02-07-2006 11:30 DSM BMcD



BILL OF MATERIALS

MARK	STOCK NO.	QUANTITY	DESCRIPTION	MANUFACTURER	CATALOG NUMBER
MATERIALS REQUIRED TO DOUBLE DEADEND 1 OPTICAL WIRE ON TYPE "A" STRUCTURE					
13A		10	BONDING WIRE, #2 COPPER, SOLID (FT)		
15	0201470	2	PLATE, POLE EYE, DBL EYE, GALV, 15/16" HOLES, 8" BOLT SPCG, 7/8" BOLTS, & PIN	MACLEAN	EPR8-77-D7
22		2	WASHER, COIL, DOUBLE SPRING, FOR 7/8" BOLT	HUGHES	SLW2-80
27		2	BOLT, MACHINE, 7/8"x XX", W/NUT	HUGHES	B8XX
33A		2	CONNECTOR, GROUND CLAMP, BRONZE	ANDERSON	GTCL-23A
36		1	L-TAP, #2 SOLID CU TO #2 SOLID CU	HELICAL	
41		2	TURNBUCKLE, CLEVIS-CLEVIS, 3/4"x 9", 28K	HUGHES	AS2545-A
89		2	BOLTED DEADEND, OPTICAL WIRE, SX-48/33/520	ALCOA	ODE 47/34520G
89A		2	LINK, EXTENSION, OPTICAL WIRE, 5" C-C	ALCOA	ODELP05
89B		15	GUIDE CLAMP, WOOD POLE FOR OPTICAL WIRE, W/LAG SCREW, SX-48/33/520	ALCOA	OGW469/561
MATERIALS REQUIRED FOR IN-LINE GUYING					
12		200	GUY STRAND, 1/2" EHS-7 STRAND (FT)		
13A		200	BONDING WIRE, #2 COPPER, SOLID (FT)		
16	0201520	2	THIMBLE CLEVIS, 20K	MACLEAN	CT-88H
21		2	WASHER RND 6" FOR 1" ANCHOR ROD	JOSYLN	P85A-1
32	0203860	4	GUY GRIP, DEADEND, GALV, 1/2" BLUE 7W	HELICAL	HG212-1/2
35A		2	L-TAP, 1/2" GALV. TO #2 SOLID CU	HELICAL	
44		2	CLAMP, BONDING, GUY-GROUND, FOR #2 CU TO 1/2"-7 STRAND	CHANCE	6484
66A		2	EXOTHERMIC WELD, #2 SOLID CU WIRE TO 3/4" CU ROD	ERICO/CADWELD	
71	0205180	2	ANCHOR, LOG, 8"x8"x8"		
72		2	ANCHOR ROD, 1"x10'-0" LONG, HOT DIP GALV, THIMBLE EYE	CHANCE	5340
73	0205950	2	GUY MARKER, FULL RND, YEL, 84"x 1.5", 3/16"-1/2" W/PIGTAIL POLYETHYLENE	CHANCE	84FRPM-YEL

NOTES:

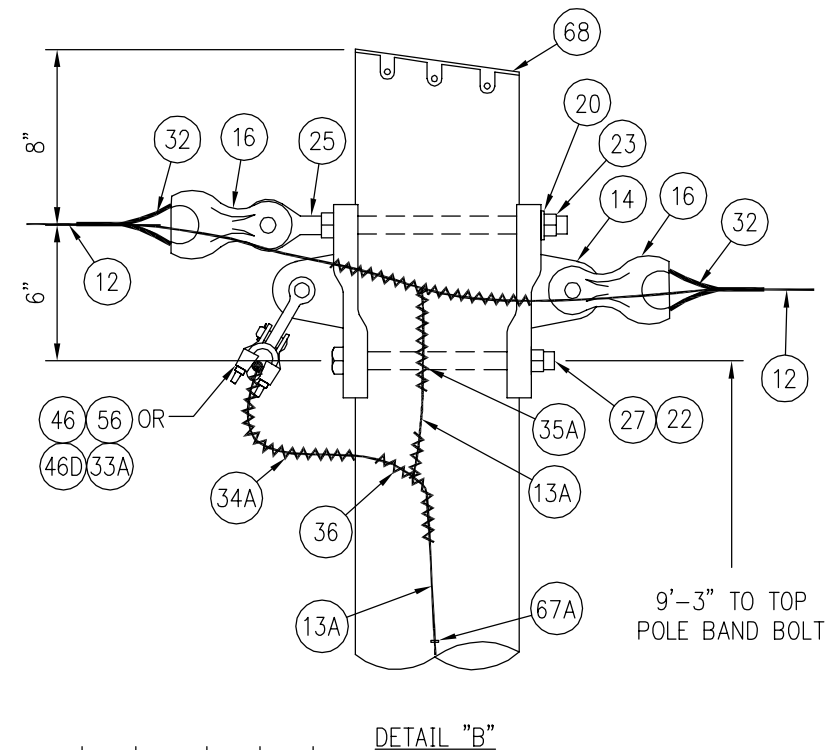
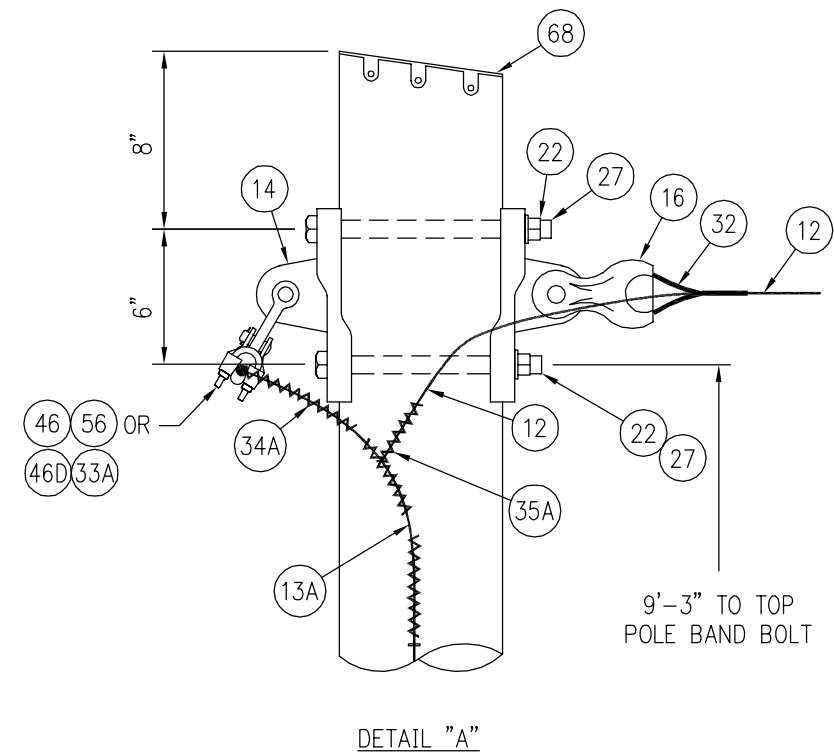
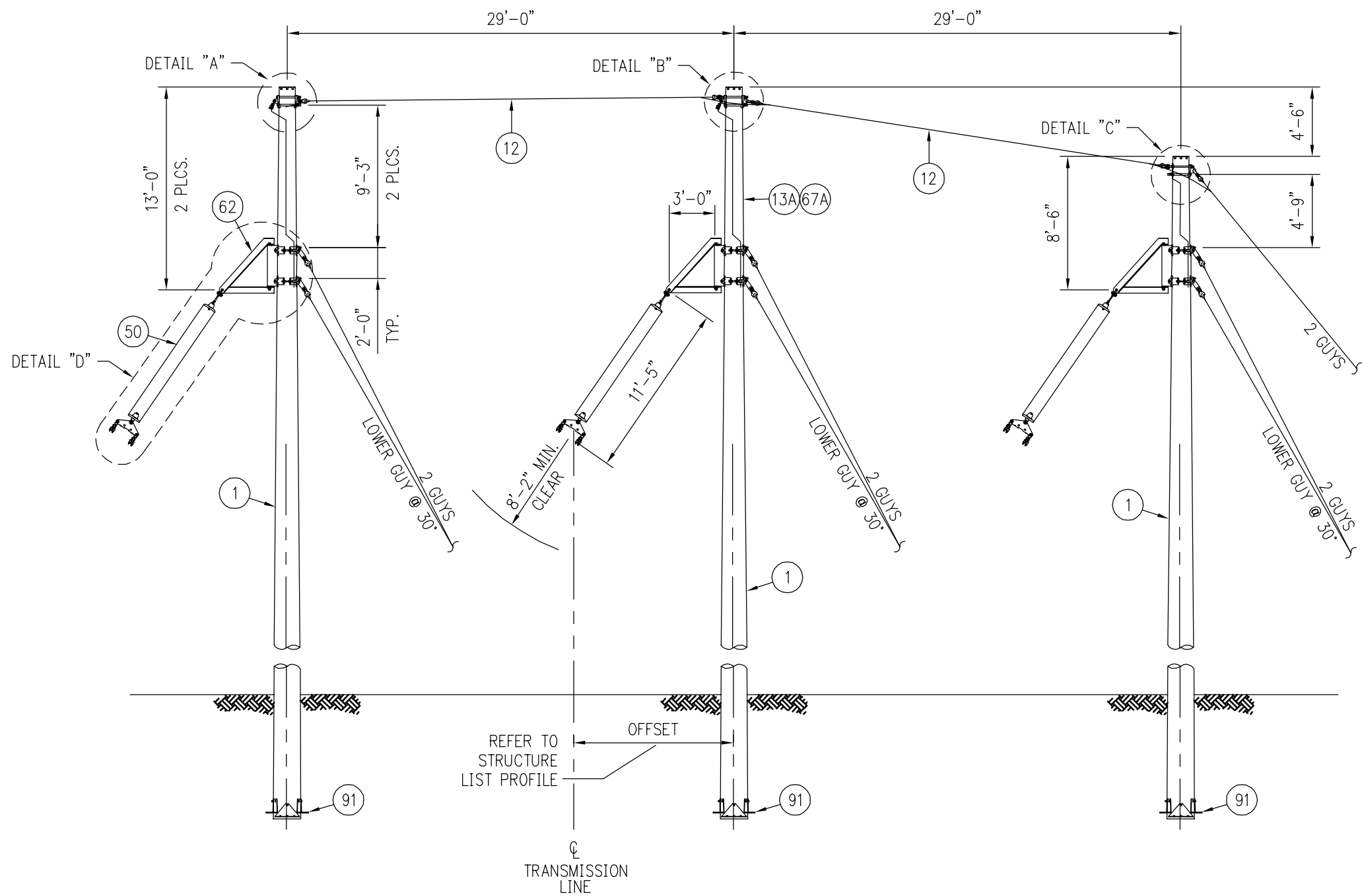
- 1) THESE ITEMS WILL BE CALLED FOR BY THE LINE DESIGNER, AS NEEDED
- 2) IF DEAD ENDS ARE USED FOR UPLIFT, GUYS MAY BE ELIMINATED.

**Burns & McDonnell**  
**CONFORMED TO CONSTRUCTION RECORDS**  
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1	1/01/08	JAH	JRW	COMFORMED TO CONSTRUCTION RECORDS
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION
REV	DATE	DR	CK	DESCRIPTION
<b>VELCO</b>				VERMONT ELECTRIC POWER CO., INC. RUTLAND, VERMONT WEST RUTLAND - NEW HAVEN 345 KV
<b>OPTICAL WIRE DEAD END ATTACHMENT TYPE 'A' STRUCTURE</b>				
SCALE: NONE	DRAWN BY: BMcD		APPROVED BY:	
DATE: 11/05	CHECKED BY: KAW		DATE	
DRAWING NUMBER: 345-1.4			1	FILE:
PLOT: 1=1			REV.	

N: \\velco\36445-WR-NH-EP\Cadd\STANDARD POLES\345KV\345-1.4.dwg 02-07-2006 11:29 DSM BMcD



FOR ANCHOR AND GUY GROUNDING DETAILS, SEE DWG. #345-10.0 & #345-10.1  
 FOR POLE GUYING DETAILS, SEE DWG. #345-10.2  
 FOR GROUNDING DETAILS, SEE DWG. #345-11.0  
 FOR FOUNDATION DETAILS, SEE DWG. #345-FDN-1 THRU FDN-4

**Burns & McDonnell**  
 SINCE 1936

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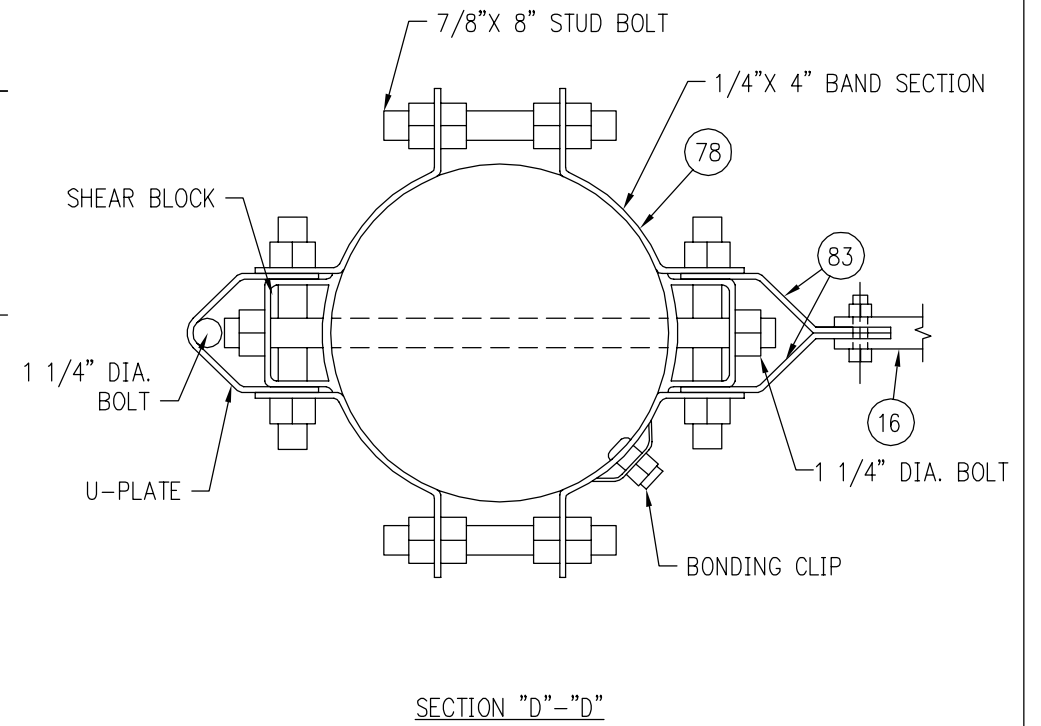
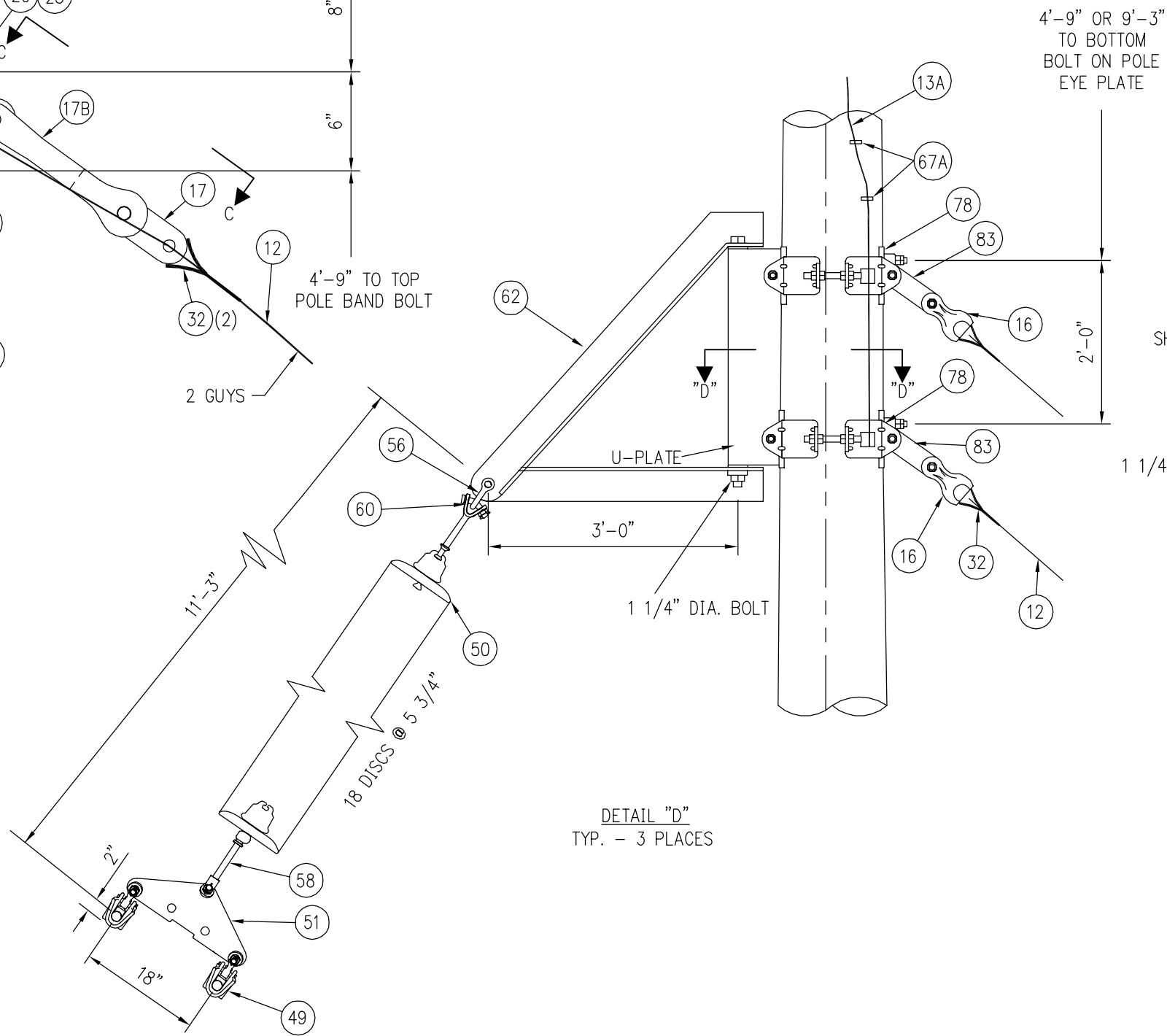
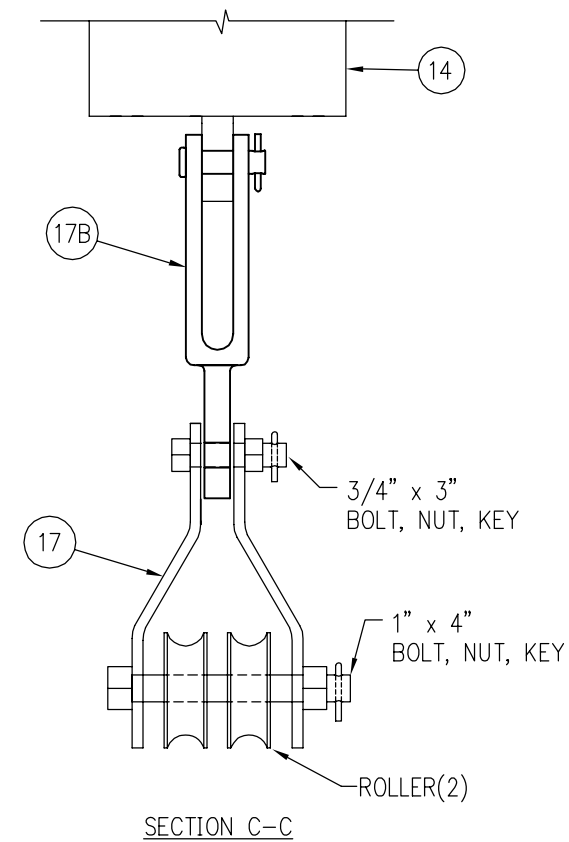
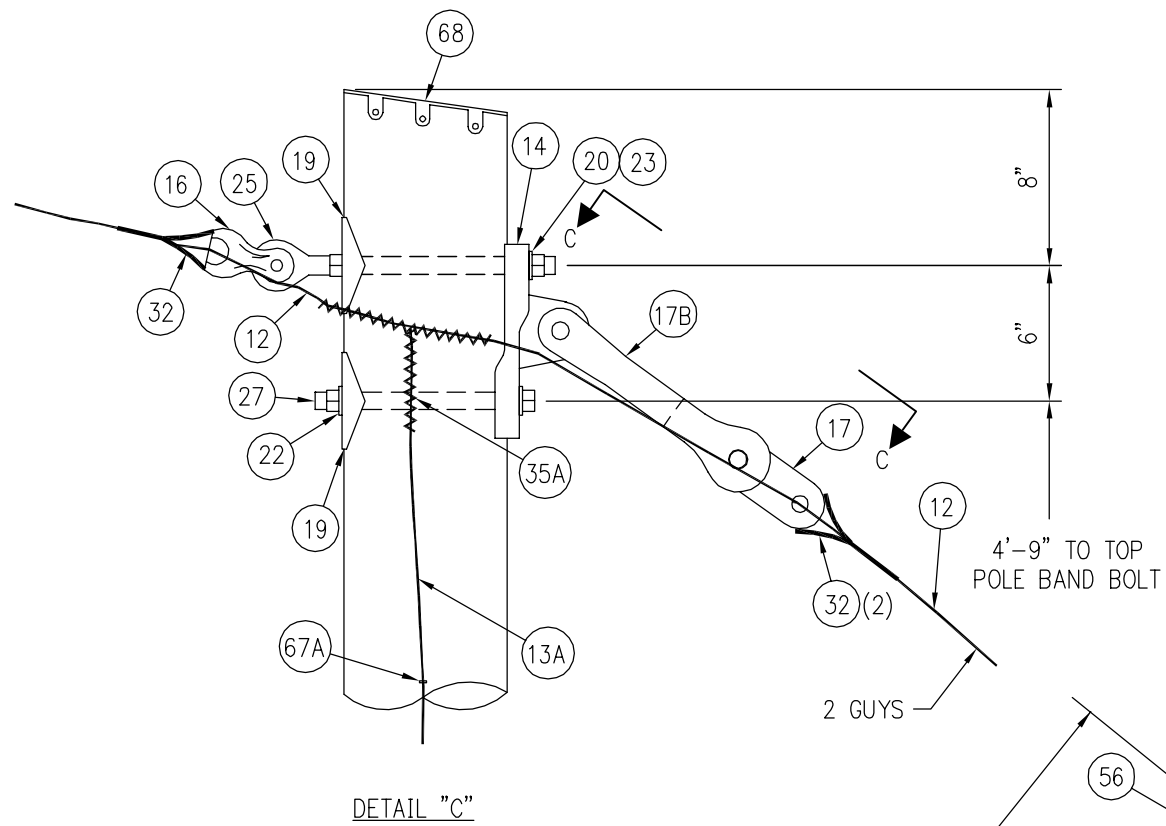
REV	DATE	DR	CK	DESCRIPTION
1	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

**VERMONT ELECTRIC POWER CO., INC.**  
 RUTLAND, VERMONT  
 WEST RUTLAND - NEW HAVEN 345 KV

**SUSPENSION ANGLE STRUCTURE TYPE 'SA2' (12° TO 22°)**

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:
DATE: 11/05	CHECKED BY: KAW	DATE:
DRAWING NUMBER: 345-3.0		1
PLOT: 1=1		REV.

FILE: N:\velco\36445-WR-NH-EP\Cadd\STANDARD POLES\345KV\345-3.0.dwg 02-07-2006 13:26 DSM BMcD



**Burns & McDonnell**  
SINCE 1786

**CONFORMED TO CONSTRUCTION RECORDS**  
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2	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
1	6/14/06	CSM	JRW	ADDED EXT. LINK RE-ISSUED FOR CONSTRUCTION
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION
REV	DATE	DR	CK	DESCRIPTION

<b>VELCO</b>		VERMONT ELECTRIC POWER CO., INC. RUTLAND, VERMONT	
		WEST RUTLAND - NEW HAVEN 345 KV	
<b>SUSPENSION ANGLE POLE TOP DETAILS TYPE 'SA2' ( 12° TO 22°)</b>			
SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	
DATE: 11/05	CHECKED BY: KAW		DATE
DRAWING NUMBER: PLOT: 1=1		345-3.1	
		2	FILE:
		REV.	

N: \velco\36445-WR-NH-EP\Cadd\STANDARD POLES\345KV\345-3.1.dwg 02-07-2006 13:26 DSM BMcD

BILL OF MATERIALS

MARK	STOCK NO.	QUANTITY	DESCRIPTION	MANUFACTURER	CATALOG NUMBER
1		3	POLE, WOOD		
12		740	GUY STRAND, 1/2"EHS-7 STRAND (FT)		
13A		320	BONDING WIRE #2 COPPER, SOLID (FT)		
14		5	PLATE, POLE EYE, 7/8" BOLT, 6" BOLT SPCG, SGL EYE, 7/8" PIN	MACLEAN	EPR-77S-7
16	0201520	10	THIMBLE CLEVIS, 20K	MACLEAN	CT-88H
17	0203470	1	PLATE, GUY, DBL, ASSEMBLY, INCL: 2 LINKS (#3157); 2 ROLLERS (#28083); 1 BOLT 3/4"x3" BNK; 1 BOLT 1"x4" BNK.	HUGHES	
17B		1	CLEVIS, EYE, EXTENSION LINK	ANDERSON	CEEL-093-06.5
19		2	WASHER, SQ, CURVED, 4"x4", FOR 7/8" BOLT	JOSLYN	P144B
20	0204650	2	WASHER, ROUND, 2", FOR 3/4" BOLT	HUGHES	RW2-70
21		8	WASHER RND 6" FOR 1" ANCHOR ROD	JOSLYN	P85A-1
22		4	WASHER, COIL, DOUBLE SPRING, FOR 7/8" BOLT	HUGHES	SLW2-80
23	0200110	2	WASHER, COIL, DOUBLE SPRING, FOR 3/4" BOLT	HUGHES	SLW2-70
25		2	BOLT, DBL ARM, EYE BOLT, W/2 NUTS, 3/4"xXX"	JOSLYN	J96XX
27		4	BOLT, MACHINE, 7/8"xXX", W/ NUT	HUGHES	B8XX
32	0203860	20	GUY GRIP, DEADEND, GALV, 1/2" BLUE 7W	HELICAL	HG212-1/2
33A		1	CONNECTOR, GROUND CLAMP, BRONZE, FOR OPTICAL WIRE SUSP. CLAMP SX-48/33/520	ANDERSON	GTCL-23A
34A		1	L-TAP, 3/8" GALV. TO #2 SOLID CU	HELICAL	
35A		3	L-TAP, 1/2" GALV. TO #2 SOLID CU	HELICAL	
36		1	L-TAP, #2 SOLID CU TO #2 SOLID CU	HELICAL	
44		8	CLAMP, BONDING, GUY-GROUND, FOR #2 CU TO 1/2"-7 STRAND	CHANCE	6484
46	0100050	1	CLAMP, SHIELD WIRE, SUSP., 3/8"EHS-7 STRAND (.20-.46) W/O FITTING	MACLEAN	FS-46-N
46D		1	CLAMP, OPTICAL WIRE, SGL. SUSPENSION W/ Y-CLEVIS EYE, SX-48/33/520	ALCOA	OSPSP4
49	0101650	6	CLAMP, COND, FORMULA, SUSPENSION, 1.2" MAX DIA, 19"L, 30K, W/90° Y-CLEVIS EYE FITTING F/954MCM 45/7ACSR CORONA FREE	MACLEAN	ACFS-120-19-30-RYCE
50		54	INSULATOR, SUSP, 30K M&E, 5-3/4"x10", BALL & SOCKET, GRAY	LAPP	5960A-70
51		3	PLATE, YOKE, TRI, 18" SPCG, 15/16" HOLES, 40K ULT, 5/8" THICK	MACLEAN	ASM-6229-3
56	0206010	4	SHACKLE, ANCHOR, BNK, 35K, W/ 3/4" BOLT NUT & COTTER KEY	ANDERSON	AS-35-BNK
58		3	SOCKET CLEVIS, HOT LINE, 35K, 10" L	MACLEAN	SCHL-55A
60		3	BALL Y-CLEVIS, HOT LINE, 35K, 10-1/8" L	MACLEAN	YCBHL-65A
62	0203930	3	BRACKET, SWINGING ANGLE, 2'x3', 35K W/1-1/4" BOLT & LOCKNUT	HUGHES	1796-C
65A		2	GROUND ROD, COPPER CLAD, 3/4" x 10'	BLACKBURN	7510
66A		2	EXOTHERMIC WELD, #2 SOLID CU TO 3/4" CU ROD	ERICO/CADWELD	
67A		40	STAPLE, GROUND WIRE, COPPERCLAD, 1-1/2"x3/8", ROLLED POINT	CHANCE	9167
71	0205180	8	ANCHOR, LOG, 8"x8"x8'		
72		8	ANCHOR ROD, 1"x10'-0" LONG, HOT DIP GALV, THIMBLE EYE	CHANCE	5340
73	0205950	8	GUY MARKER, FULL RND, YEL, 84"x 1.5", 3/16-1/2" W/PIGTAIL POLYETHYLENE	CHANCE	84FRPM-YEL
78		6	POLE, BAND, HEAVY DUTY, ASSEMBLY, INCLUDES: 1 BONDING CLIP (#2718.55)	HUGHES	3107.X-1796
83		6	CONNECTING LINKS, GUYING 3/8"x3"x12" PAIR	HUGHES	3157
91		3	ANCHOR, POLE, 4-SECTION, W/7/8" x XX" THREADED RODS W/4 NUTS, 4 LOCKNUTS & LAG SCREWS	HUGHES	A1895-3-XX

BILL OF MATERIALS

MARK	STOCK NO.	QUANTITY	DESCRIPTION	MANUFACTURER	CATALOG NUMBER
MATERIAL USED AS REQUIRED					
68	0204390	AR	POLE ROOF, NON METALLIC	OSMOSE	70-110-020-016

**CONFORMED TO CONSTRUCTION RECORDS**

The revision dated 01.01.08 supercedes all revisions with an earlier revision date

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2	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
1	6/14/06	CSM	JRW	ADDED MARK No. 17B, REVISED BOLT SIZE IN MARK #17 AND RE-ISSUED FOR CONSTRUCTION
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION
REV	DATE	DR	CK	DESCRIPTION

**VELCO** VERMONT ELECTRIC POWER CO., INC.  
RUTLAND, VERMONT  
WEST RUTLAND - NEW HAVEN 345 KV

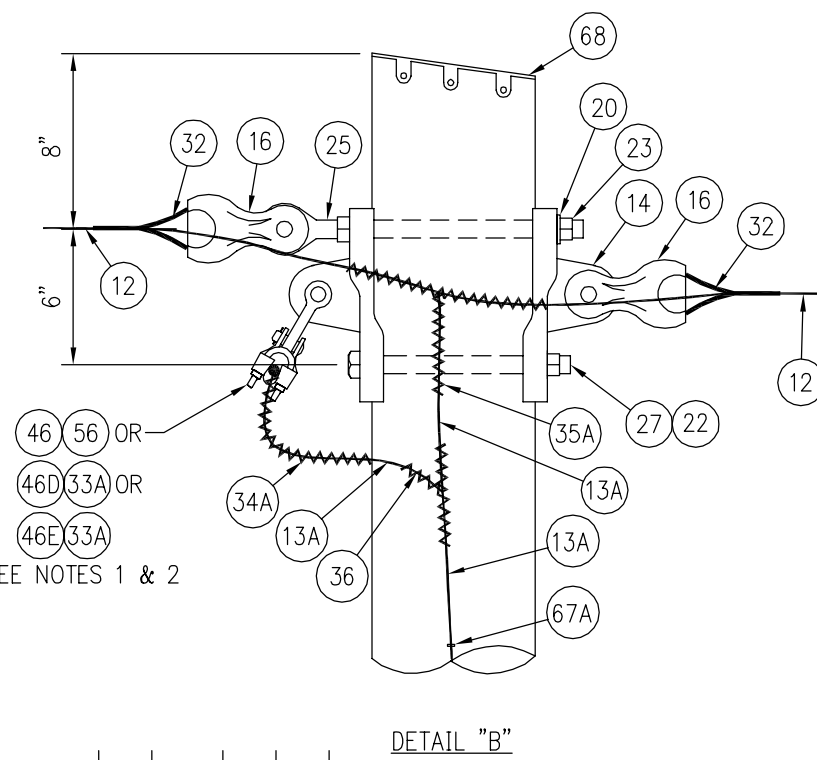
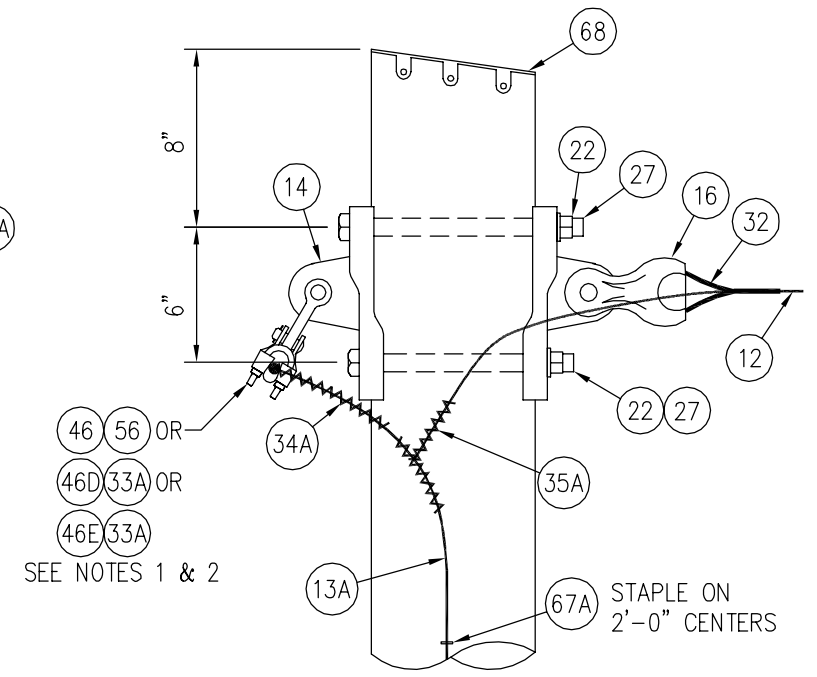
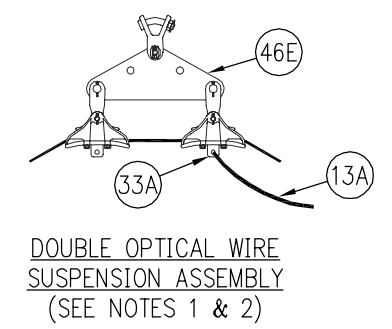
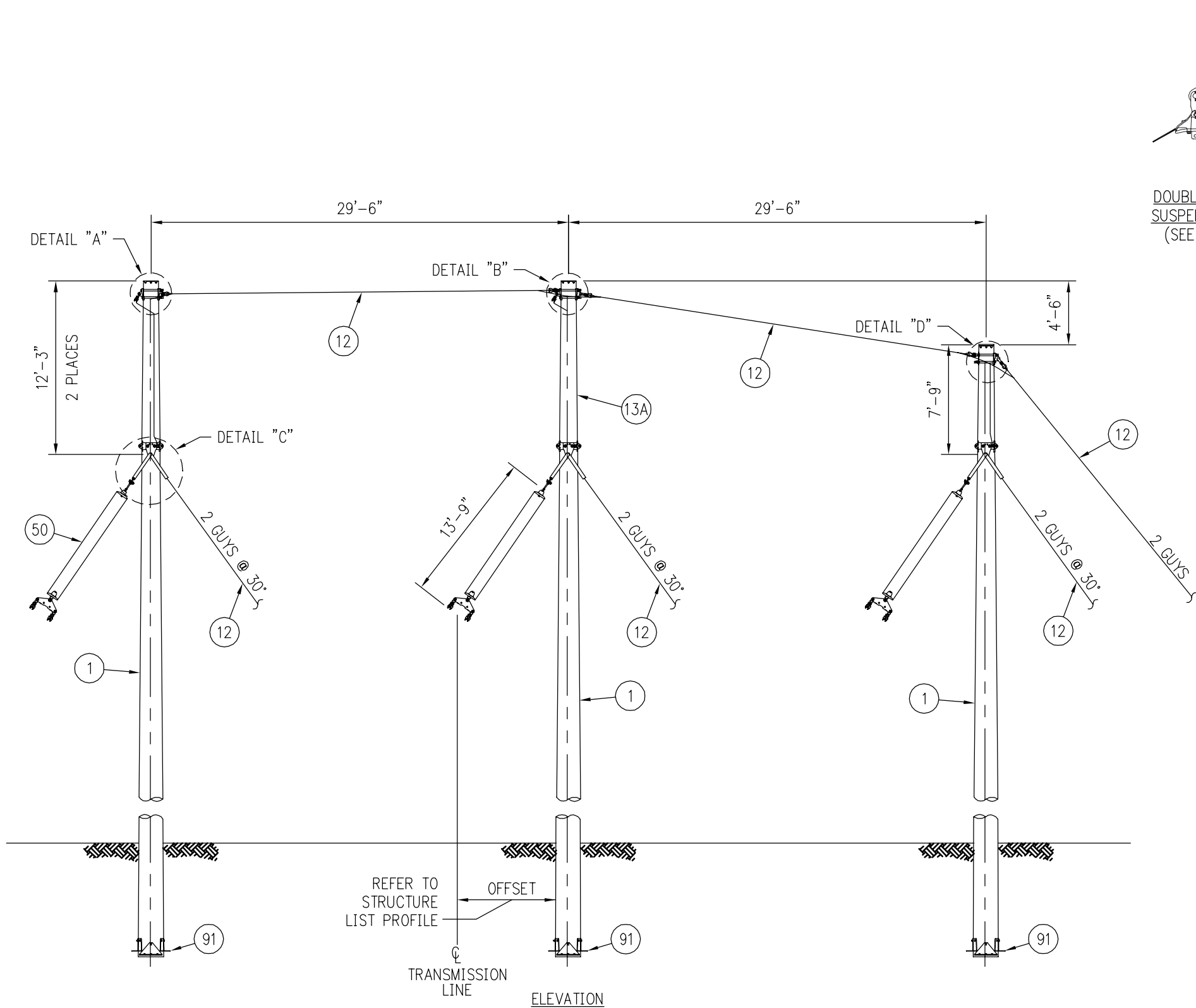
**SUSPENSION ANGLE BILL OF MATERIALS TYPE 'SA2' (12° TO 22°)**

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	6/06
DATE: 11/05	CHECKED BY: KAW		DATE

DRAWING NUMBER: 345-3.2  
PLOT: 1=1

2  
REV.

N: \velco\36445-WB-NH-EP\Cadd\STANDARD POLES\345KV\345-3.2.dwg 02-07-2006 13:26 DSM BmcD FILE:



FOR ANCHOR AND GUY GROUNDING DETAILS, SEE DWG. #345-10.0 & #345-10.1  
 FOR POLE GUYING DETAILS, SEE DWG. #345-10.2  
 FOR GROUNDING DETAILS, SEE DWG. #345-11.0  
 FOR FOUNDATION DETAILS, SEE DWG. #345-FDN-1 THRU FDN-4

- NOTE:
- FOR LINE ANGLES LESS THAN 30 DEGREES, USE SINGLE OPTICAL WIRE SUSPENSION ASSEMBLY, ITEM #46D.
  - FOR LINE ANGLES GREATER THAN 30 DEGREES OR WHEN VERTICAL ANGLE EXCEEDS 30 DEGREES, USE DOUBLE OPTICAL WIRE SUSPENSION ASSEMBLY ITEM #46E.

**Burns & McDonnell**  
 SINCE 1898

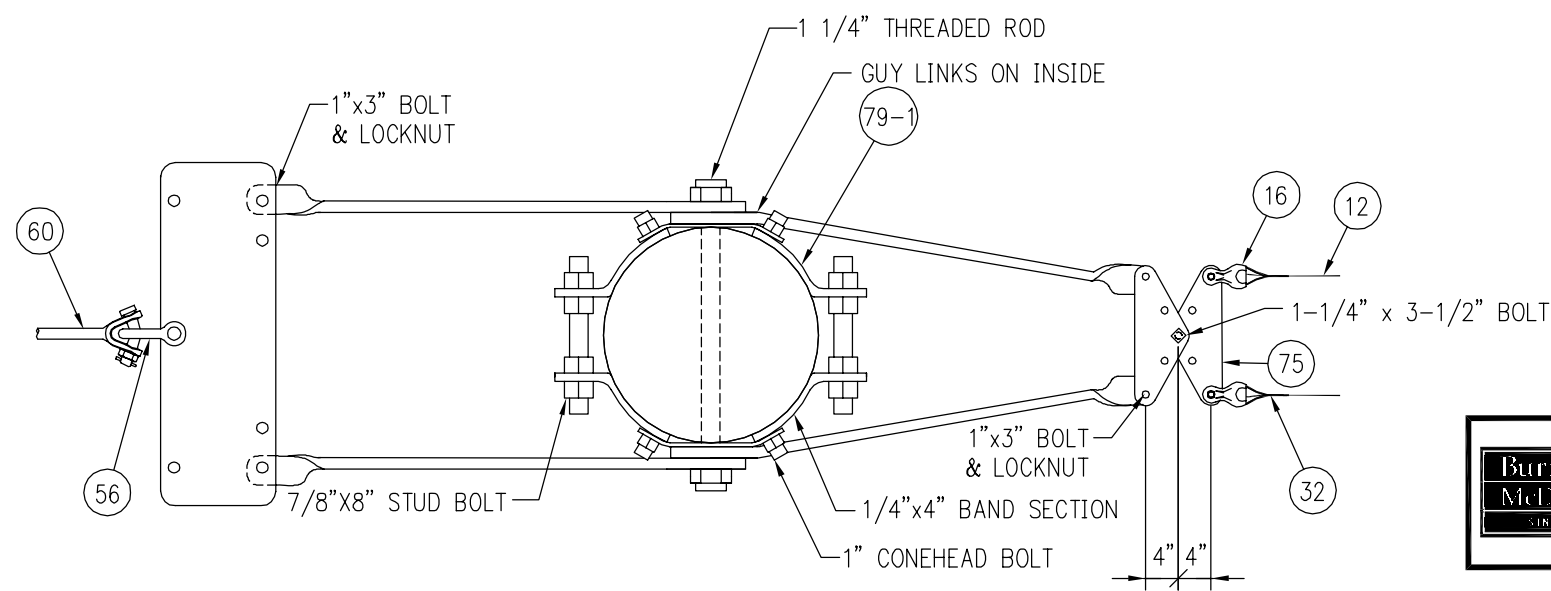
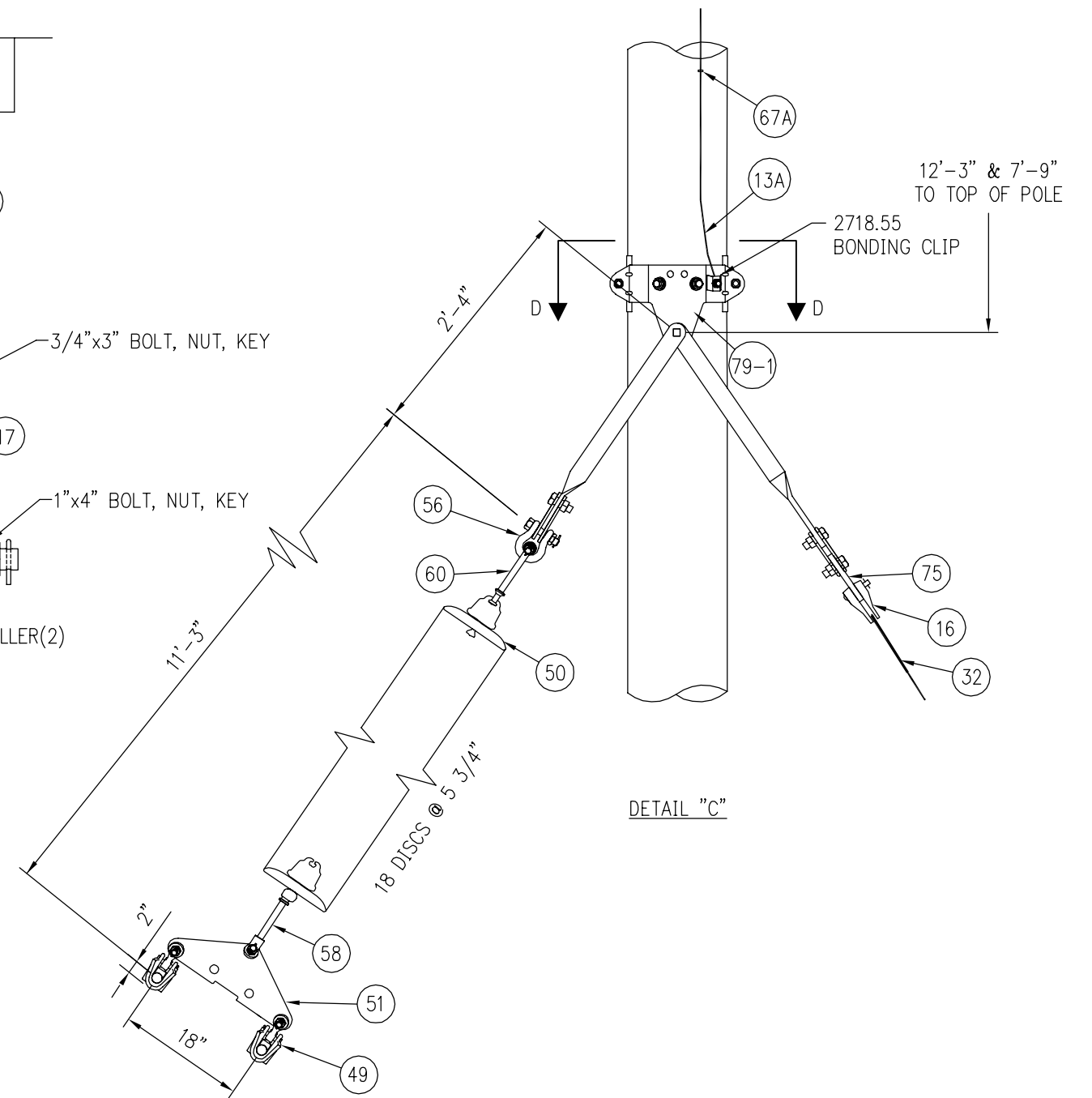
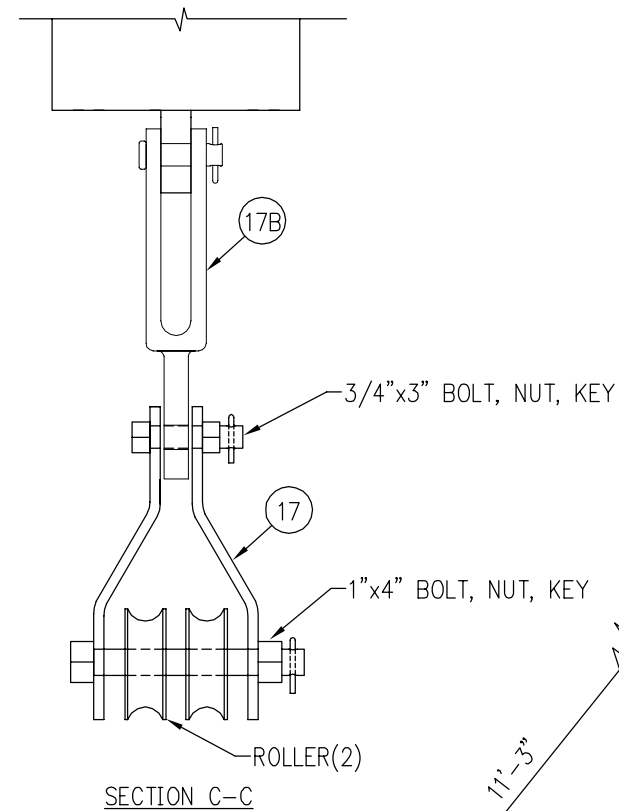
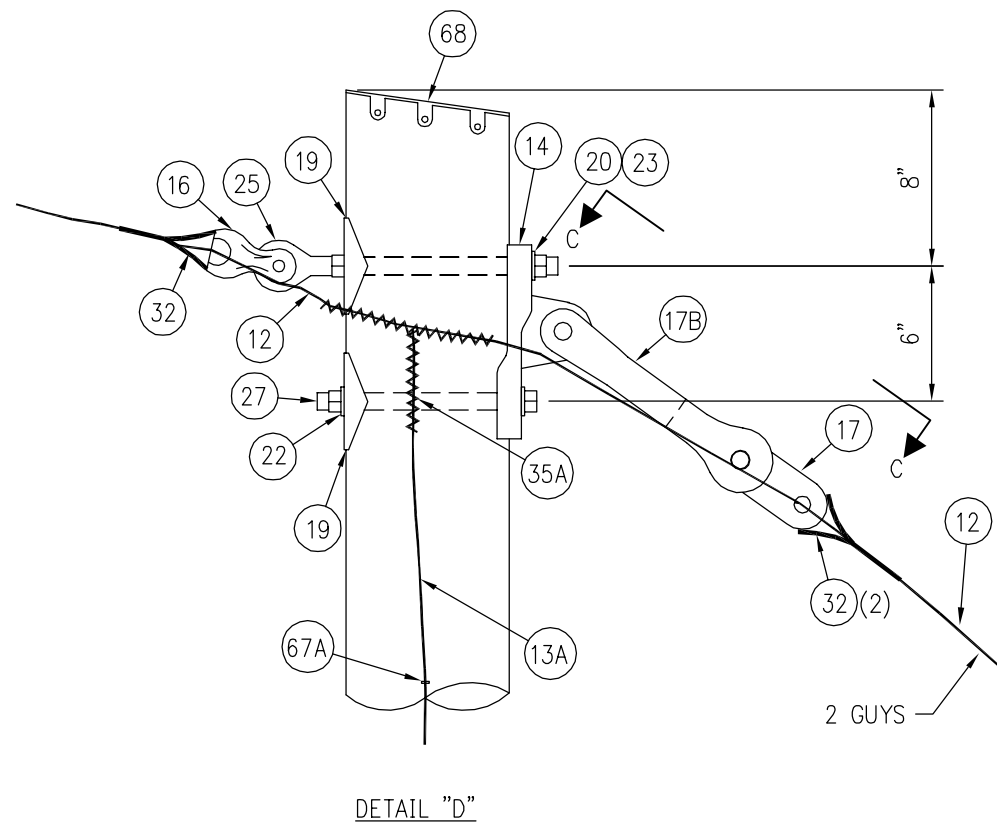
**CONFORMED TO CONSTRUCTION RECORDS**  
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1	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION
REV	DATE	DR	CK	DESCRIPTION
<p><b>VELCO</b> VERMONT ELECTRIC POWER CO., INC.          RUTLAND, VERMONT          WEST RUTLAND - NEW HAVEN 345 KV</p> <p><b>SUSPENSION ANGLE STRUCTURE TYPE 'SA3' (22' TO 35')</b></p>				
SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:		
DATE: 11/05	CHECKED BY: KAW	DATE		
DRAWING NUMBER: 345-4.0	PLOT: 1=1	1	REV.	FILE:

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REV	DATE	DR	CK	DESCRIPTION
2	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
1	6/27/06	CSM	JRW	ADDED EXT. LINK, REVISED POLE BAND ASSEMBLY AND RE-ISSUED FOR CONSTRUCTION
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

**VELCO** VERMONT ELECTRIC POWER CO., INC.  
 RUTLAND, VERMONT  
 WEST RUTLAND - NEW HAVEN 345 KV

**SUSPENSION ANGLE POLE TOP DETAILS**  
 TYPE 'SA3' (22° TO 35°)

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	6/06
DATE: 11/05	CHECKED BY: KAW		DATE


DRAWING NUMBER: 345-4.1  
 PLOT: 1=1  
 REV. 2

**BILL OF MATERIALS**

MARK	STOCK NO.	QUANTITY	DESCRIPTION	MANUFACTURER	CATALOG NUMBER
1		3	POLE, WOOD		
12		740	GUY STRAND, 1/2"EHS-7 STRAND (FT)		
13A		320	BONDING WIRE, #2 COPPER, SOLID (FT)		
14		5	PLATE, POLE EYE, 7/8" BOLT, 6" BOLT SPCG, SGL EYE, 7/8" PIN	MACLEAN	EPR-77S-7
16	0201520	10	THIMBLE CLEVIS, 20K	MACLEAN	CT-88H
17	0203470	1	PLATE, GUY, DBL, ASSEMBLY, INCL: 2 LINKS (#3157); 2 ROLLERS (#28083); 1 BOLT 3/4"x3" BNK; 1 BOLT 1"x4" BNK.	HUGHES	
17B		1	CLEVIS, EYE, EXTENSION LINK	ANDERSON	CEEL-093-06.5
19		2	WASHER, SQ, CURVED, 4"x4", FOR 7/8" BOLT	JOSLYN	P144B
20	0204650	2	WASHER, ROUND, 2", FOR 3/4" BOLT	HUGHES	RW2-70
21		8	WASHER RND 6" FOR 1" ANCHOR ROD	JOSLYN	P85A-1
22		4	WASHER, COIL, DOUBLE SPRING, FOR 7/8" BOLT	HUGHES	SLW2-80
23	0200110	2	WASHER, COIL, DOUBLE SPRING, FOR 3/4" BOLT	HUGHES	SLW2-70
25		2	BOLT, DBL ARM, EYE BOLT, W/2 NUTS, 3/4"xXX"	JOSLYN	J96XX
27		4	BOLT, MACHINE, 7/8"xXX", W/NUT	HUGHES	B8XX
32	0203860	20	GUY GRIP, DEADEND, GALV, 1/2" BLUE 7W	HELICAL	HG212-1/2
33A		1	CONNECTOR, GROUND CLAMP, BRONZE FOR OPTICAL WIRE SUSPENSION CLAMP, SX-48/33/520	ANDERSON	GTCL-23A
34A		1	L-TAP, 3/8" GALV. TO #2 SOLID CU	HELICAL	
35A		3	L-TAP, 1/2" GALV. TO #2 SOLID CU	HELICAL	
36		1	L-TAP, #2 SOLID CU TO #2 SOLID CU	HELICAL	
44		8	CLAMP, BONDING, GUY-GROUND, FOR #2 CU TO 1/2"-7 STRAND	CHANCE	6484
46	0100050	1	CLAMP, SHIELD WIRE, SUSP., 3/8"EHS-7 STRAND (.20-.46) W/O FITTING	MACLEAN	FS-46-N
46D		1	CLAMP, OPTICAL WIRE, SGL. SUSPENSION W/ Y-CLEVIS EYE, SX-48/33/520	ALCOA	OSPSP4
49	0101650	6	CLAMP, COND, FORMULA, SUSPENSION, 1.2" MAX DIA, 19"L, 30K, W/90° Y-CLEVIS EYE FITTING F/ 954MCM 45/7ACSR CORONA FREE	MACLEAN	ACFS-120-19-30-RYCE
50		54	INSULATOR, SUSP, 30K M&E, 5-3/4"x10", BALL & SOCKET, GRAY	LAPP	5960A-70
51		3	PLATE, YOKE, TRI, 18" SPCG, 15/16" HOLES, 40K ULT, 5/8" THICK	MACLEAN	ASM-6229-3
56		5	SHACKLE, ANCHOR, BNK, 35K, W/3/4" BOLT NUT & COTTER	ANDERSON	AS-35-BNK
58		3	SOCKET CLEVIS, HOT LINE, 35K, 10" L	MACLEAN	SCHL-55A
60		3	BALL Y-CLEVIS, HOT LINE, 30K, 10-1/8" L	MACLEAN	YCBHL-65A
65A	0204200	2	GROUND ROD, COPPER CLAD, 3/4" x 10'	BLACKBURN	7510
66A		2	EXOTHERMIC WELD, #2 SOLID CU TO 3/4" CU ROD	ERICO/CADWELD	
67A		40	STAPLE, GROUND WIRE, COPPERCLAD, 1-1/2"x3/8", ROLLED POINT	CHANCE	9167
71	0205180	8	ANCHOR, LOG, 8"x8"x8'		
72		8	ANCHOR ROD, 1"x10'-0" LONG, HOT DIP GALV, THIMBLE EYE	CHANCE	5340
73	0205950	8	GUY MARKER, FULL RND, YEL, 84"x 1.5", 3/16-1/2" W/PIGTAIL POLYETHYLENE	CHANCE	84FRPM-YEL
79-1		3	POLE BAND, EXTRA HEAVY DUTY (SPECIAL NO. 3340 POLE BAND), ASSEMBLY INCLUDES: 1 BONDING CLIP (#2727.8) W/LOCK NUT, 2 TWISTED LINKS (#B1784.1A), 2 TWISTED LINKS (#3341.1A), 1 DOUBLE YOKE PLATE (#3341.1B), 1 YOKE PLATE (#3341.1C), 1 DOUBLE YOKE PLATE (B1784.1B) (POLE DIA. 12"-17")	HUGHES	B1784-A.6
91		3	ANCHOR, POLE, 4-SECTION, W/ 7/8"xXX" THREADED RODS W/4 NUTS, 4 LOCKNUTS & LAG SCREWS	HUGHES	A1895-3-XX


**BILL OF MATERIALS**

MARK	STOCK NO.	QUANTITY	DESCRIPTION	MANUFACTURER	CATALOG NUMBER
<b>MATERIAL REQUIRED FOR DOUBLE OPTICAL WIRE SUSPENSION</b>					
46E		1	CLAMP ASSEMBLY, OPTICAL WIRE, DBL. SUSP. W/2 CLEVIS EYE, 1 YOKE PLATE, 1 Y-CLEVIS CLEVIS, SX-48/33/520	ALCOA	OSPSS4
<b>MATERIAL USED AS REQUIRED</b>					
68	0204390	AR	POLE ROOF, NON METALLIC	OSMOSE	70-110-020-016


**CONFORMED TO CONSTRUCTION RECORDS**  
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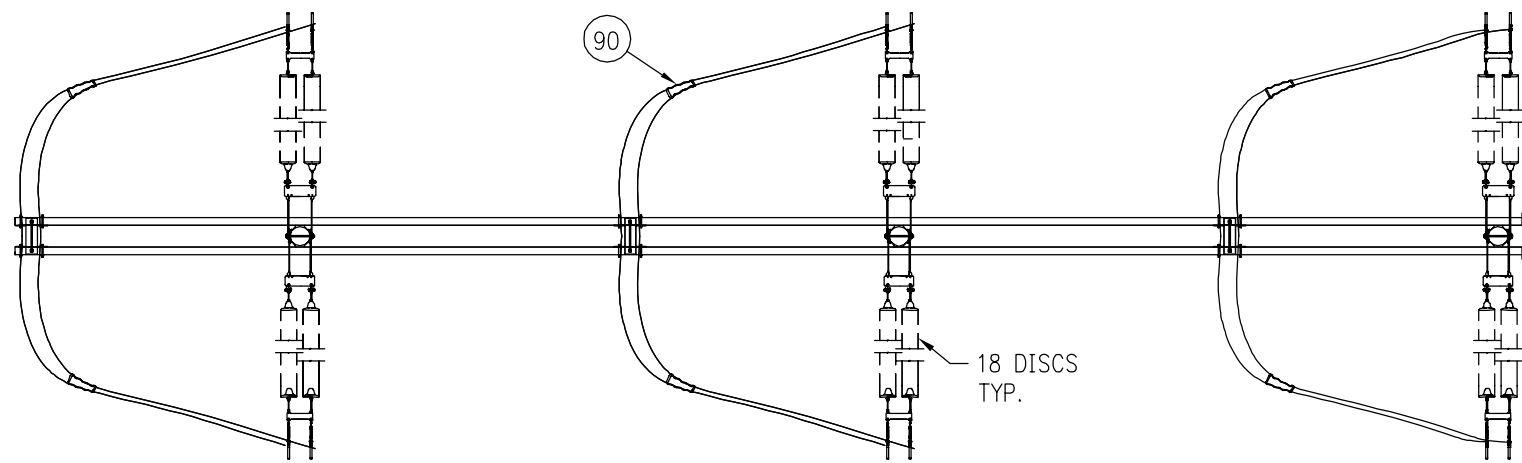
2	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
1	1/27/06	CSM	JRW	ADDED MARK #17B, REVISED BOLT SIZE IN MARK # 17, REMOVED MARK #'S 74 AND 85, RE-ISSUED FOR CONSTRUCTION
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION
REV	DATE	DR	CK	DESCRIPTION


**VERMONT ELECTRIC POWER CO., INC.**  
 RUTLAND, VERMONT  
 WEST RUTLAND - NEW HAVEN 345 KV

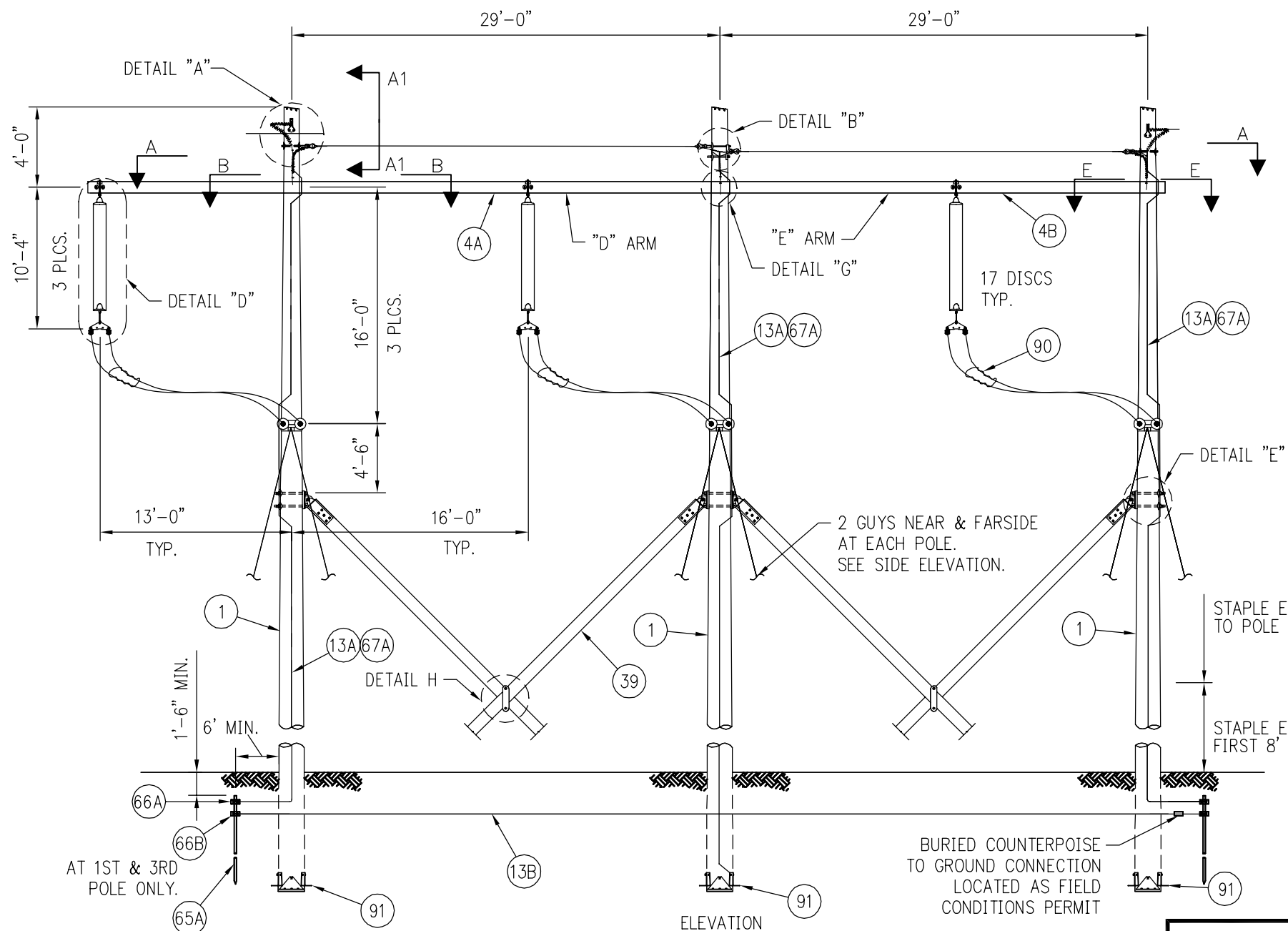
**SUSPENSION ANGLE BILL OF MATERIALS TYPE 'SA3' (22° TO 35°)**

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	6/06
DATE: 11/05	CHECKED BY: KAW		DATE
DRAWING NUMBER: 345-4.2			2
PLOT: 1=1			REV.

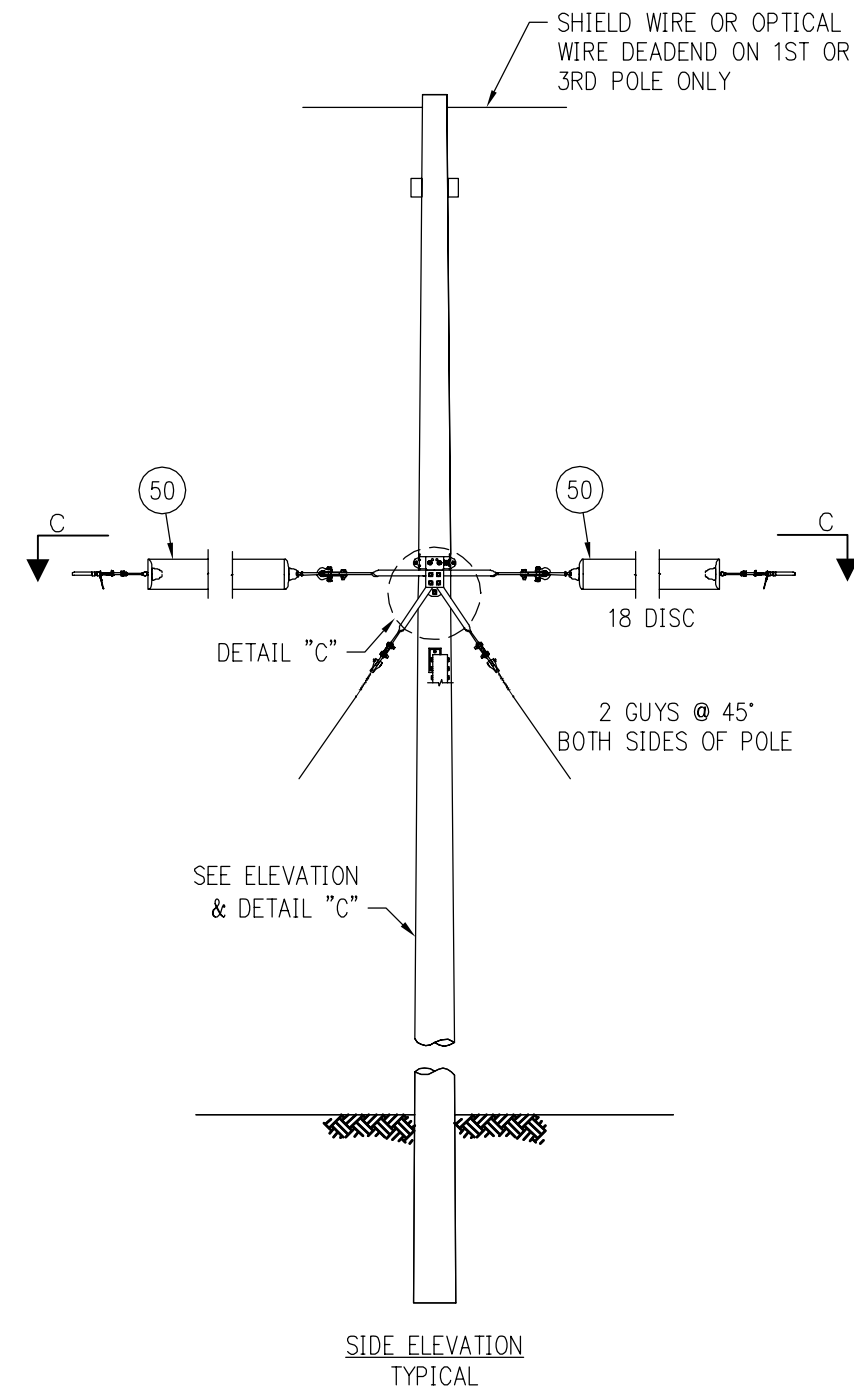
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SECTION A-A



ELEVATION



SIDE ELEVATION TYPICAL

AT 1ST & 3RD POLE ONLY.

BURIED COUNTERPOISE TO GROUND CONNECTION LOCATED AS FIELD CONDITIONS PERMIT

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REV	DATE	DR	CK	DESCRIPTION
2	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
1	6/14/06	CSM	JRW	REVISED POLE BAND MATERIALS AND RE-ISSUED FOR CONSTRUCTION
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

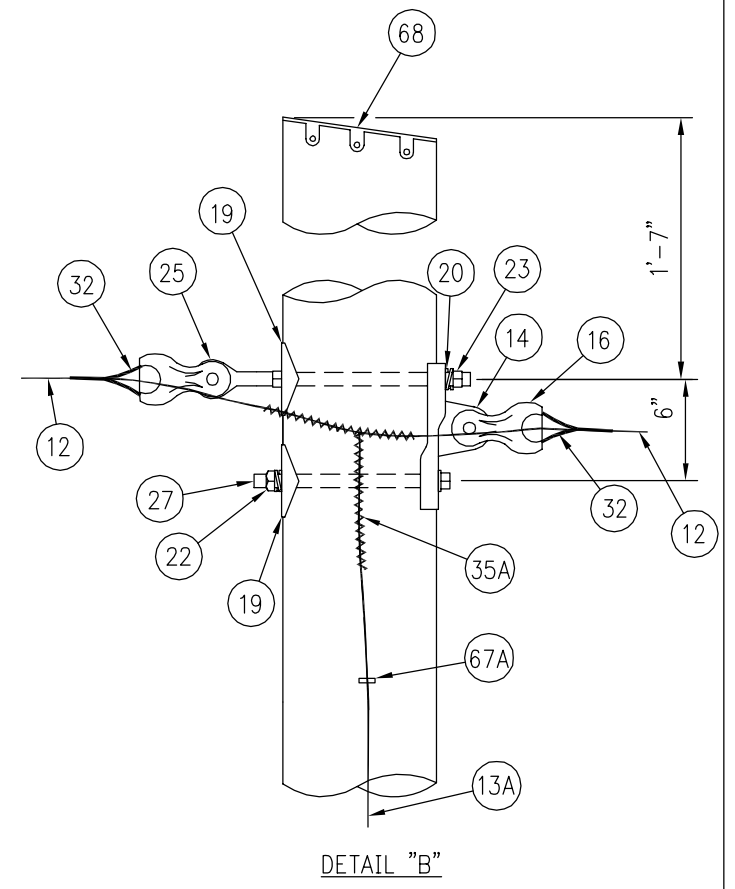
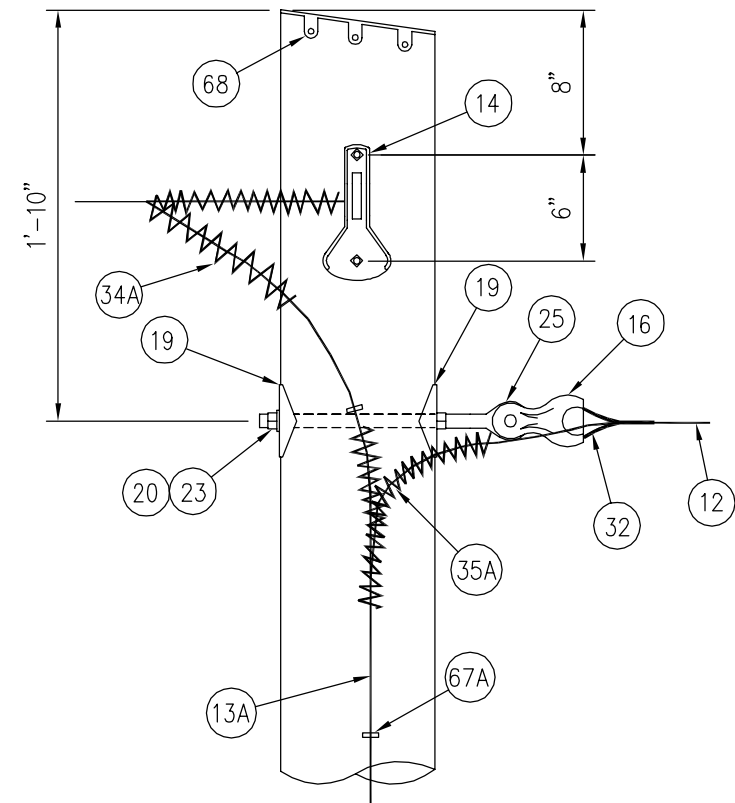
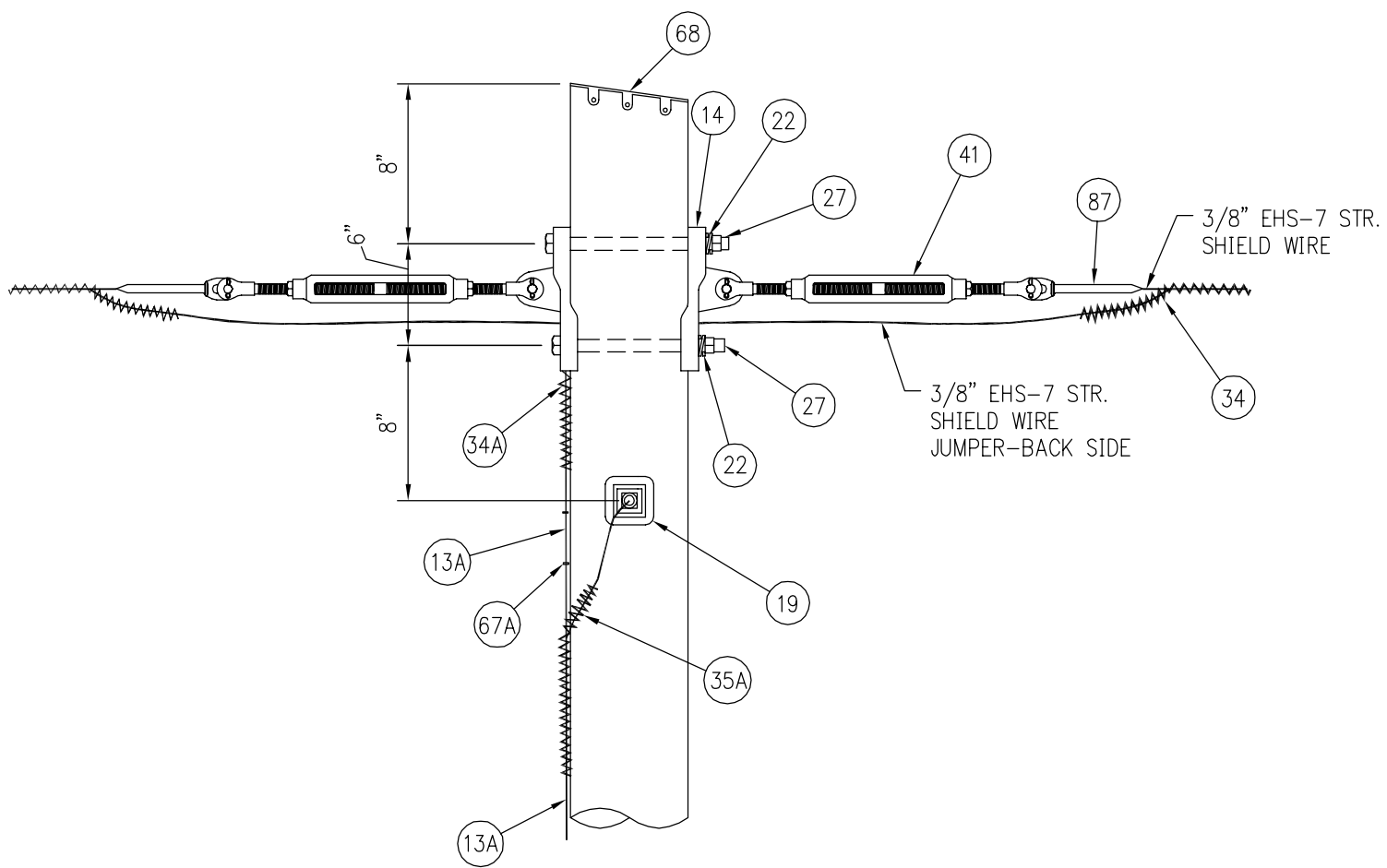
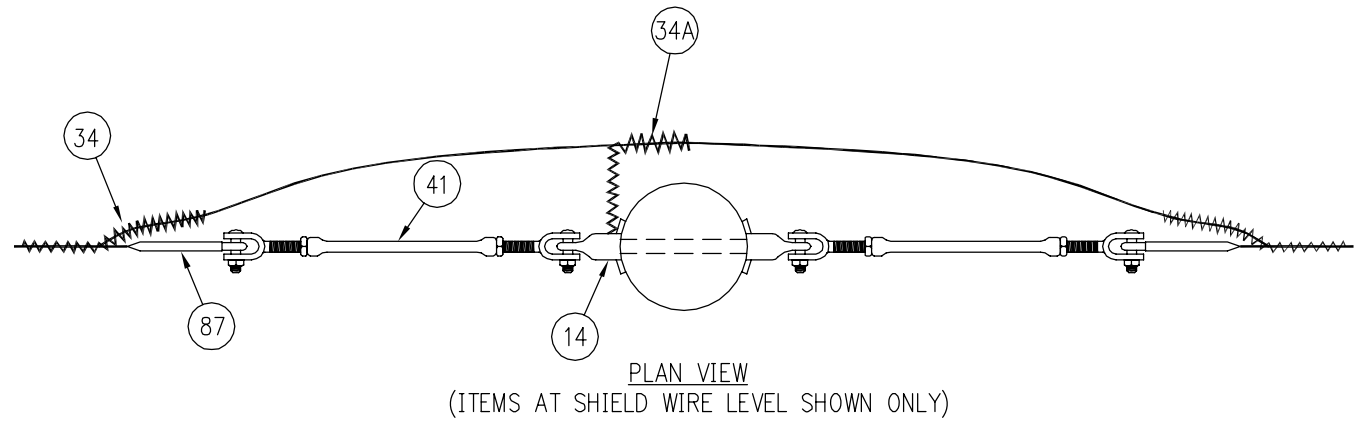
**VELCO** VERMONT ELECTRIC POWER CO., INC.  
RUTLAND, VERMONT  
WEST RUTLAND - NEW HAVEN 345 KV

**STRAIGHT LINE DEAD END STRUCTURE TYPE 'DE1'**

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	6/06
DATE: 11/05	CHECKED BY: KAW		DATE
DRAWING NUMBER:	345-5.0		2
PLOT: 1=1			REV.

FOR ANCHOR AND GUY GROUNDING DETAILS, SEE DWG. #345-10.0 & #345-10.1  
FOR POLE GUYING DETAILS, SEE DWG. #345-10.2  
FOR GROUNDING DETAILS, SEE DWG. #345-11.0  
FOR FOUNDATION DETAILS, SEE DWG. #345-FDN-1 THRU FDN-4

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**Burns & McDonnell**  
ENGINEERS

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REV	DATE	DR	CK	DESCRIPTION
1	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

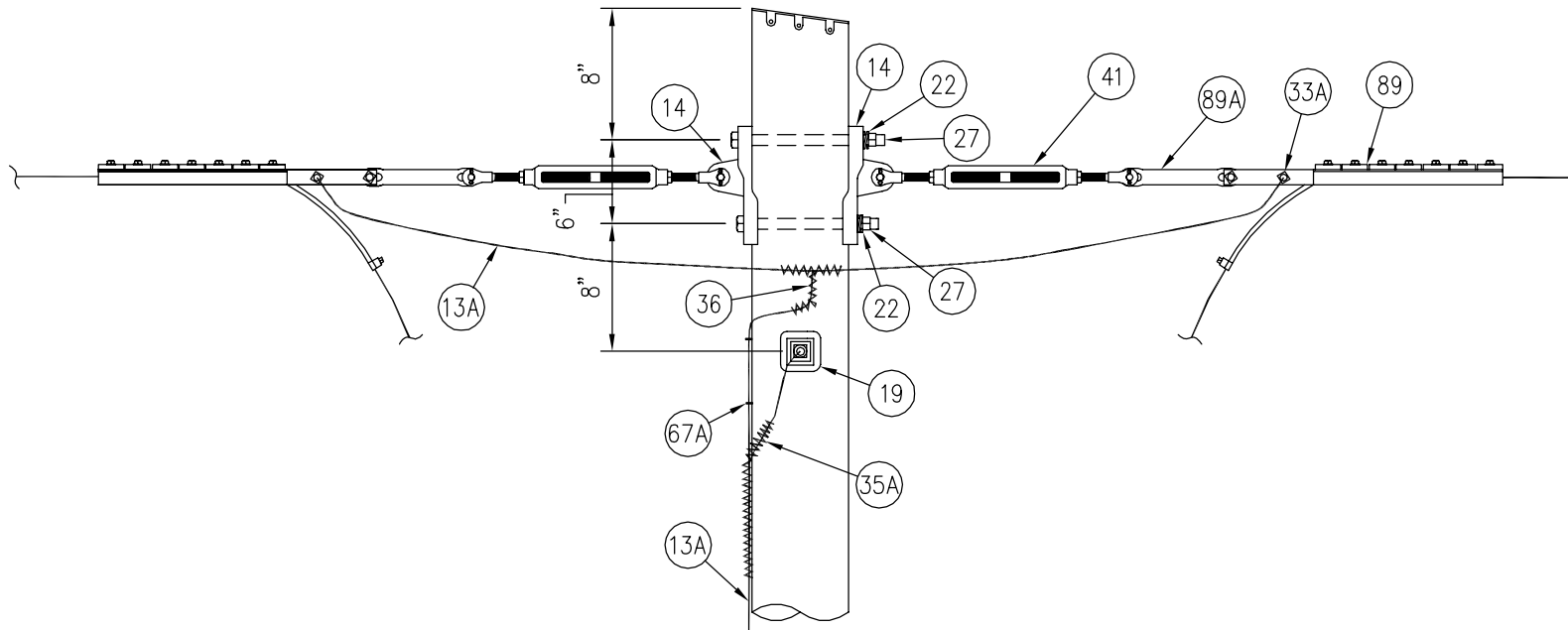
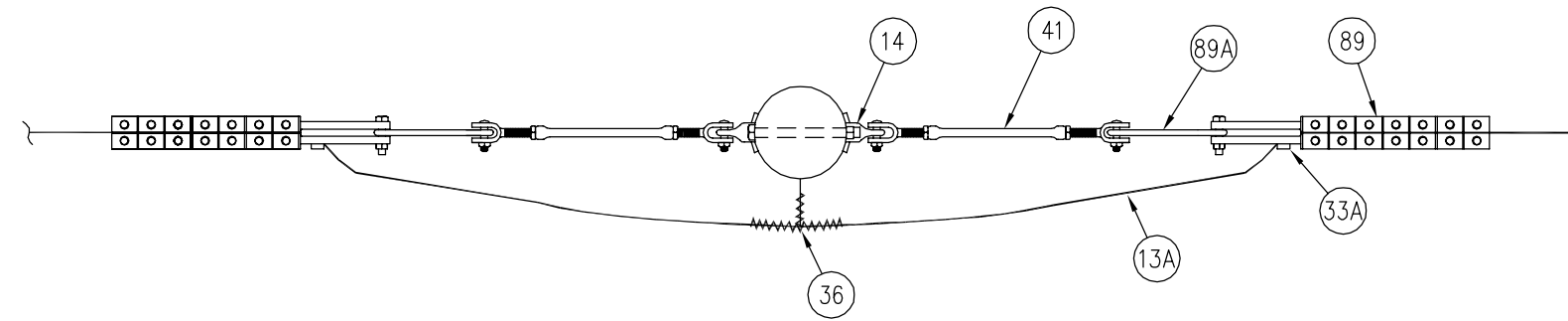
**VELCO** VERMONT ELECTRIC POWER CO., INC.  
RUTLAND, VERMONT  
WEST RUTLAND - NEW HAVEN 345 KV

**STRAIGHT LINE DEAD END SHIELD WIRE DEADEND TYPE 'DE1'**

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	
DATE: 11/05	CHECKED BY: KAW		DATE

DRAWING NUMBER: 345-5.1  
PLOT: 1=1

1	REV.
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SECTION 'A1'-'A1'

**Burns & McDonnell**  
SINCE 1992

**CONFORMED TO CONSTRUCTION RECORDS**

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REV	DATE	DR	CK	DESCRIPTION
1	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

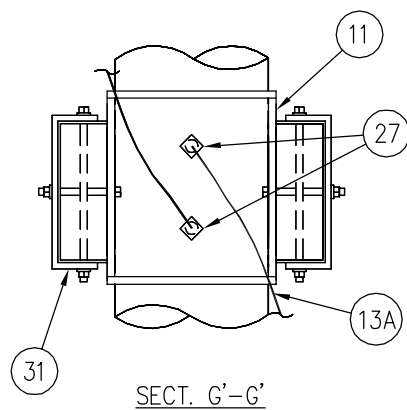
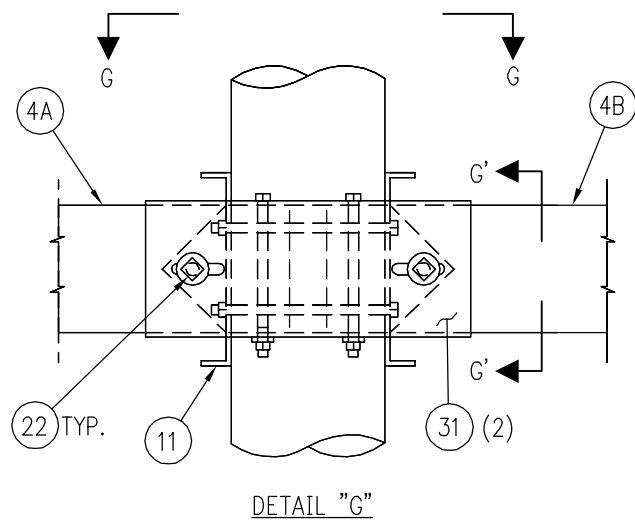
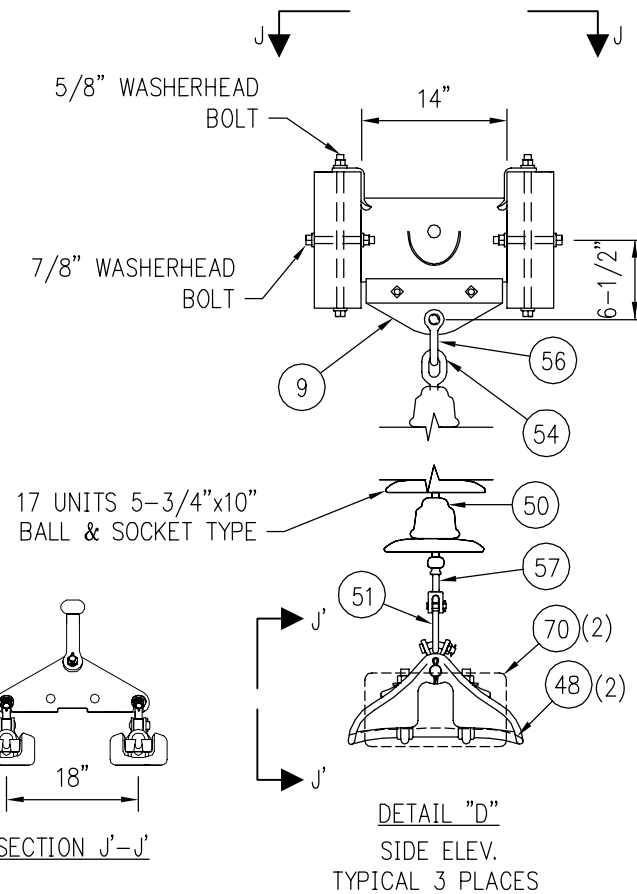
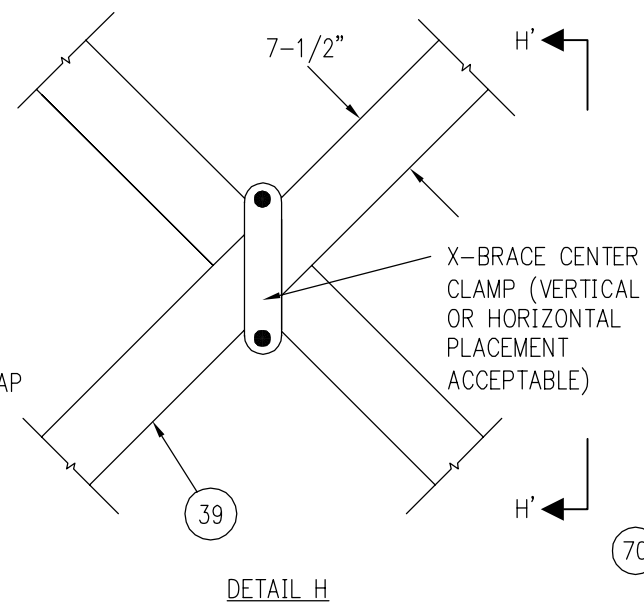
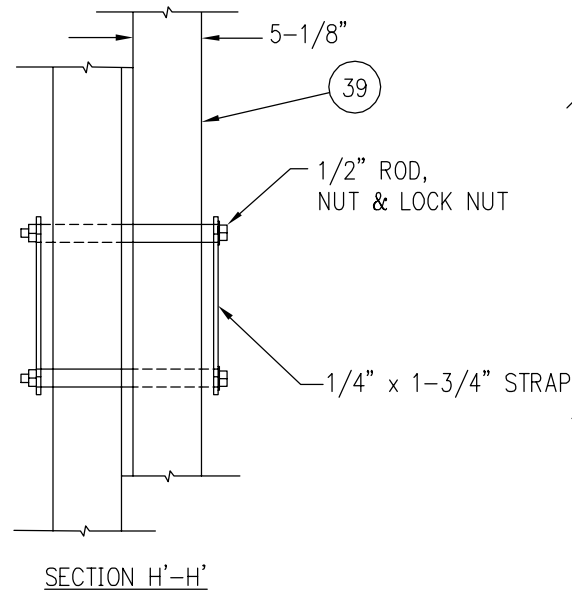
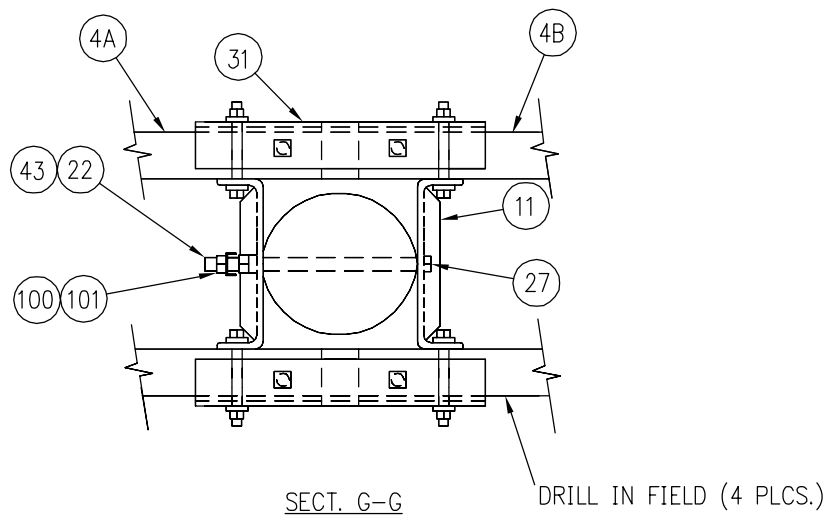
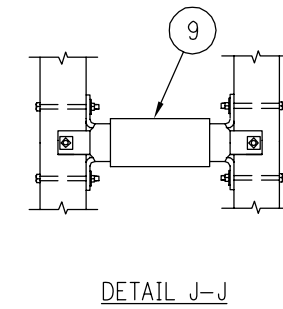
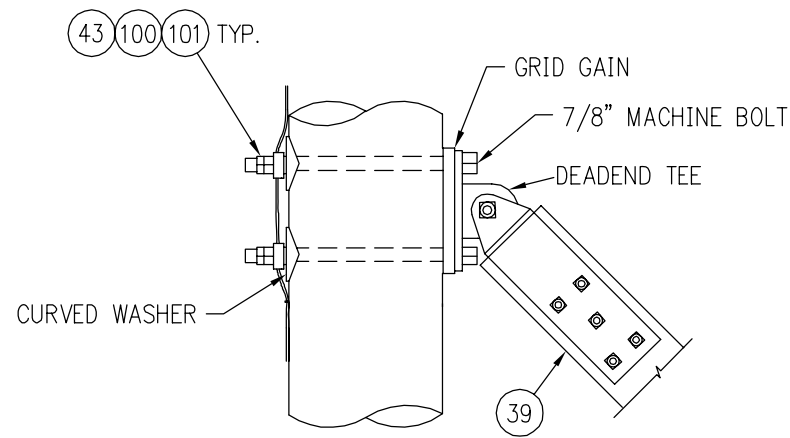
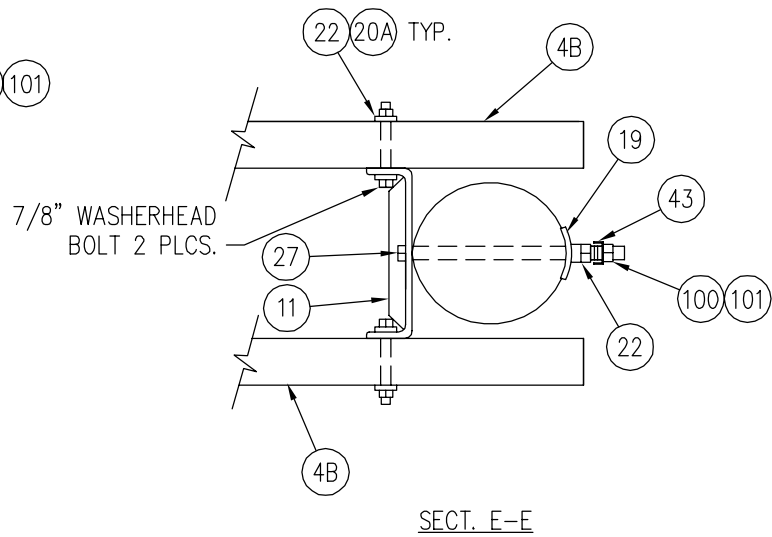
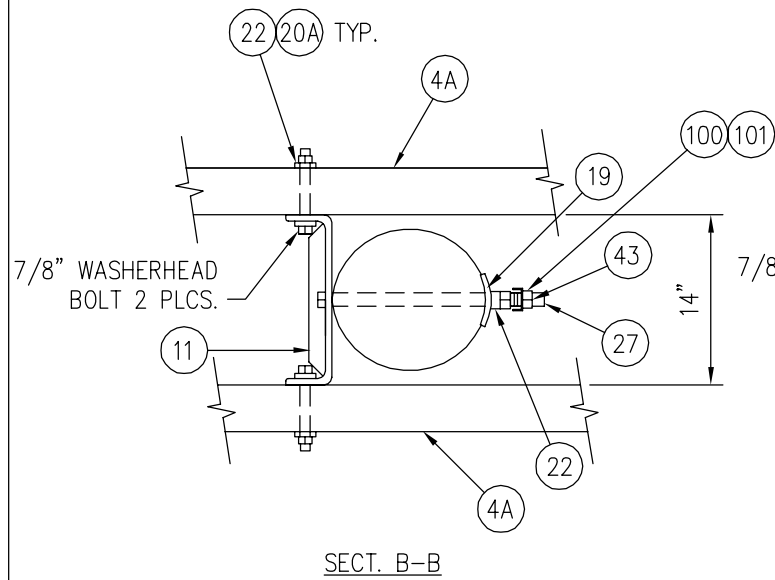
**VELCO** VERMONT ELECTRIC POWER CO., INC.  
RUTLAND, VERMONT  
WEST RUTLAND - NEW HAVEN 345 KV

**STRAIGHT LINE DEAD END OPTICAL WIRE DEADEND TYPE 'DE1'**

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	
DATE: 11/05	CHECKED BY: KAW		DATE

DRAWING NUMBER: 345-5.2  
PLOT: 1=1

1	REV.
---	------



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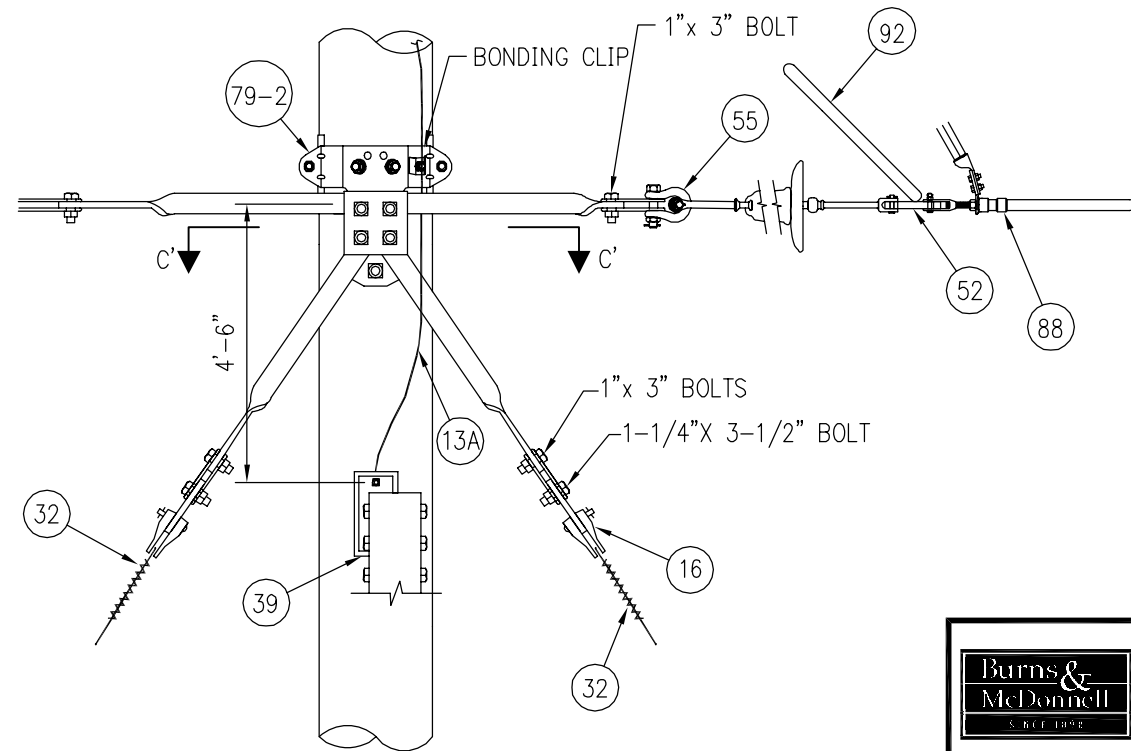
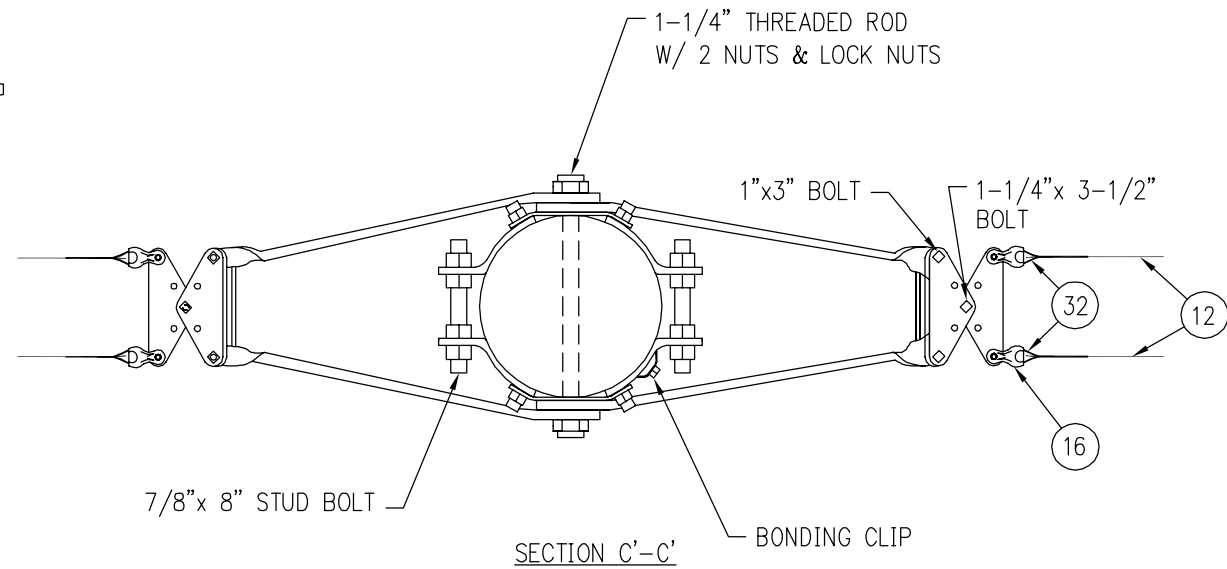
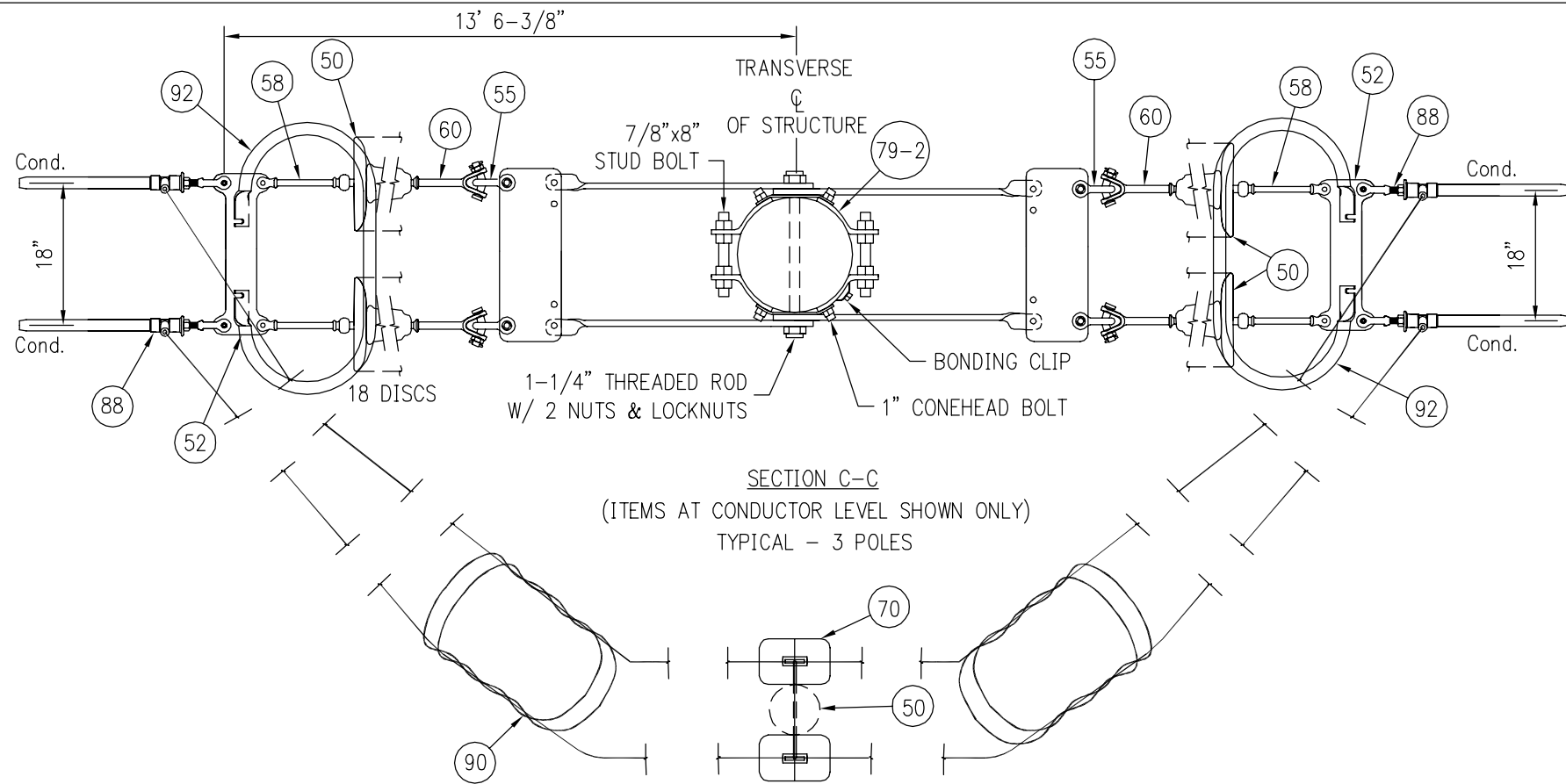
REV	DATE	DR	CK	DESCRIPTION
1	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

**VERMONT ELECTRIC POWER CO., INC.**  
 RUTLAND, VERMONT  
 WEST RUTLAND - NEW HAVEN 345 KV

**STRAIGHT LINE DEAD END POLE TOP DETAILS - TIMBER CONNECTIONS TYPE 'DE1'**

SCALE: NONE	DRAWN BY: BMCD	APPROVED BY:	
DATE: 11/05	CHECKED BY: KAW		DATE
DRAWING NUMBER: 345-5.3		1	REV.
PLOT: 1=1			

FILE: N:\Velpco\36445 MR-NH EP\Cadd\STANDARD POLES\345KV\345-5.3.dwg 02-07-2006 13:12 DSM BMD



DETAIL "C"  
SIDE ELEVATION  
TYP. 3 PLACES

**Burns & McDonnell**  
SINCE 1898

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REV	DATE	DR	CK	DESCRIPTION
2	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
1	6/14/06	CSM	JRW	REVISED POLE BAND MATERIALS AND RE-ISSUED FOR CONSTRUCTION
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

**VELCO** VERMONT ELECTRIC POWER CO., INC.  
RUTLAND, VERMONT  
WEST RUTLAND - NEW HAVEN 345 KV

STRAIGHT LINE DEAD END  
POLE TOP DETAILS-COND. & GUY ATTACH.  
TYPE 'DE1'

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	6/06
DATE: 11/05	CHECKED BY: KAW		DATE

DRAWING NUMBER: 345-5.4  
PLOT: 1=1


N:\Velco\36445 WR-EP\Cadd\STANDARD POLES\345KV\345-5.4.dwg 02-07-2006 13:12 DSM BMcD  
 FILE:

**BILL OF MATERIALS**

MARK	STOCK NO.	QUANTITY	DESCRIPTION	MANUFACTURER	CATALOG NUMBER
1		3	POLE, WOOD		
4		1	CROSSARMS, WOOD, 345KV, LAM, ASSEMBLY 0000530 2 5-1/8"x9"x42'-4"(TYPE D) 0000490 2 5-1/8"x9"x29'-4"(TYPE E)	HUGHES	
9	0203410	3	SPACER FITTING 5-1/8"x9" DBL CROSSARM 14" SEPERATION, ADJUSTABLE	HUGHES	3414.10WV-140
11		4	PLATE, POLE, ARM F/5-1/8"x9" DBL X-ARM, 14" SEPERATION, W/2 7/8" WASHERHEAD BOLTS	HUGHES	A2173-A
12		1220	GUY STRAND, 1/2"EHS-7 STRAND (FT)		
13A		540	BONDING WIRE, #2 COPPER, SOLID (FT)		
13B		70	GROUND WIRE, 7 NO. 8 COPPERWELD, DEAD SOFT ANNEALED (FT)		
14		5	PLATE,POLE EYE,7/8"BOLT,6"BOLT SPCG,SGL EYE, 7/8" PIN	MACLEAN	EPR-77S-7
16	0201520	16	THIMBLE CLEVIS, 20K	MACLEAN	CT-88H
19		8	WASHER, SQ, CURVED, 4"x4",FOR 7/8" BOLT	JOSLYN	P144B
20	0204650	3	WASHER, ROUND, 2" FOR 3/4" BOLT	HUGHES	RW2-70
20A		4	WASHER, ROUND, 3" FOR 7/8" BOLT	HUGHES	RW3-80
21		12	WASHER, RND, 6" FOR 1" ANCHOR ROD	JOSLYN	P85A-1
22		31	WASHER, COIL, DOUBLE SPRING, FOR 7/8" BOLT	HUGHES	SLW2-80
23	0200110	3	WASHER, COIL, DOUBLE SPRING, FOR 3/4" BOLT	HUGHES	SLW2-70
25		3	BOLT, DBL ARM, EYE BOLT, W/2 NUTS, 3/4"xxx"	JOSLYN	J96XX
27		11	BOLT, MACHINE, 7/8"xxx", W/NUT	HUGHES	B8XX
31	0000040	2	PLATE, CROSSARM SPLICE, 345KV, 2'-0" W/2 BOLTS	HUGHES	A1956.1
32	0203860	28	GUY GRIP, DEADEND, GALV, 1/2" BLUE 7W	HELICAL	HG212-1/2
33A		2	CONNECTOR, GROUND CLAMP, BRONZE FOR OPTICAL WIRE SUSPENSION CLAMP, SX-48/33/520	ANDERSON	GTCL-23A
34		2	L-TAP, 3/8" GALV. TO 3/8" GALV.	HELICAL	
34A		1	L-TAP, 3/8" GALV. TO #2 SOLID CU	HELICAL	
35A		3	L-TAP, 1/2" GALV. TO #2 SOLID CU	HELICAL	
36		1	L-TAP, #2 SOLID CU TO #2 SOLID CU	HELICAL	
39		2	BRACE-X ASSEMBLY 345KV 5-1/8"x 7-1/2", 29' POLE SP LAMINATED, INCLUDES TEES AND MTG BOLTS W/ 7/8"xxx" BOLTS	HUGHES	2093K-29-0-CPT
41		4	TURNBUCKLE, CLEVIS-CLEVIS, 3/4"x 9", 28K	HUGHES	AS2545-A
43	0204530	18	CLIP, GRND WIRE BONDING, #2 CU TO 7/8" BOLT	HUGHES	2727.8
44		12	CLAMP, BONDING, GUY-GROUND, FOR #2 CU TO 1/2"-7 STRAND	CHANCE	6484
48	0101850	6	CLAMP, COND, FORMULA, SUSPENSION, 1.2" MAX DIA, 15"L, 23K, W/90' Y-CLEVIS EYE FITTING F/ 954MCM 45/7 ACSR, CORONA FREE	MACLEAN	ACFS-120-15-23-RYCE
50		267	INSULATOR, SUSP, 30K M&E, 5-3/4"x10", BALL & SOCKET, GRAY	LAPP	5960A-70
51		3	PLATE, YOKE, TRI, 18" SPCG, 15/16" HOLES, 40K ULT, 5/8" THICK	MACLEAN	ASM-6229-3
52	0204130	6	PLATE, YOKE, DOGBONE, 18" SPCG, 15/16" HOLES, 40K ULT, 5/8" THICK, GALV. W/CORONA RING MOUNTING HOLES	MACLEAN	M6606-4A
54	0201600	3	OVAL-EYE BALL, GALV, FORGED STEEL, 30K, 3-23/32" LONG	ANDERSON	BE-30
55		12	SHACKLE, ANCHOR, BNK, 80K, 1-1/2" W, W/1" BOLT NUT & COTTER	MACLEAN	ASH-78-BC
56	0206010	3	SHACKLE, ANCHOR, BNK, 35K, W/ 3/4" BOLT NUT & COTTER	ANDERSON	AS-35-BNK
57	0207860	3	SOCKET, CLEVIS, 4-1/2"L, 13/16"W, 2"D, 5/8"P, 30K	MACLEAN	SCL-55B
58		12	SOCKET CLEVIS, HOT LINE, 35K, 10"L	MACLEAN	SCHL-55A
60		12	BALL Y-CLEVIS, HOT LINE, 35K, 10-1/8"L	MACLEAN	YCBHL-65A
65A		2	GROUND ROD, COPPER CLAD, 3/4" X 10'	BLACKBURN	7510
66A		6	EXOTHERMIC WELD, #2 SOLID CU TO 3/4" CU ROD	ERICO/CADWELD	

**BILL OF MATERIALS**


MARK	STOCK NO.	QUANTITY	DESCRIPTION	MANUFACTURER	CATALOG NUMBER
66B		2	EXOTHERMIC WELD, 7 NO. 8 COPPERWELD TO 3/4" CU ROD	ERICO/CADWELD	
67A		60	STAPLE, GROUND WIRE, COPPERCLAD, 1-1/2"x 3/8", ROLLED POINT	CHANCE	9167
70	0202550	6	WEIGHT, HOLD DOWN,150#, W/ HARDWARE, FOR FORMULA CLAMP 954MCM ACSR 45/7	MACLEAN	ASM-389-150
71	0205180	12	ANCHOR, LOG, 8"x8"x8'		
72		12	ANCHOR ROD, 1"x10'-0" LONG, HOT DIP GALV, THIMBLE EYE	CHANCE	5340
73	0205950	12	GUY MARKER, FULL RND, YEL, 84"x 1.5", 3/16-1/2" W/PIGTAIL POLYETHYLENE	CHANCE	84FRPM-YEL
79-2		3	POLE BAND, EXTRA HEAVY DUTY: ASSEMBLY INCLUDES: 4 TWISTED LINKS (#B1784.1A), 4 TWISTED LINKS (#3341.1A), 2 SETS DOUBLE YOKE PLATES (#B1784.1B), 2 SETS DOUBLE YOKE PLATES, (#3341.1B), 2 YOKE PLATES (#3341.1C)	HUGHES	B1784-R4.6
87	0101410	2	DEADEND, ALUM, COMP, W/EYE, 3/8"EHS-7 STRAND	ALCOA	E4514.12
88		12	COMPRESSION DEADEND W/ADJUSTABLE CLEVIS FITTING 954MCM 45/7 ACSR	ALCOA	C43648
89		2	BOLTED DEADEND, OPTICAL WIRE, SX-48/33/520	ALCOA	ODE 47/34520G
89A		2	LINK, EXTENSION, OPTICAL WIRE, 5" C-C	ALCOA	ODELP05
90	0101950	6	SPACER, CONDUCTOR, 18" BUNDLE, 1.141 to 1.196"	PLP	SU-MS-3850
91		3	ANCHOR, POLE, 4-SECTION, W 7/8" xxx" THREADED RODS W/4 NUTS, 4 LOCKNUTS & LAG SCREWS	HUGHES	A1895-3-XX
92	0202770	6	CORONA RING	MACLEAN	ASM-516-5
100		18	NUT, SQUARE, 7/8"	HUGHES	N80
101		18	LOCKNUT, SQUARE, 7/8"	HUGHES	MF80
MATERIAL USED AS REQUIRED					
68	0204390	AR	POLE ROOF, NON METALLIC	OSMOSE	70-110-020-016



**CONFORMED TO  
CONSTRUCTION RECORDS**

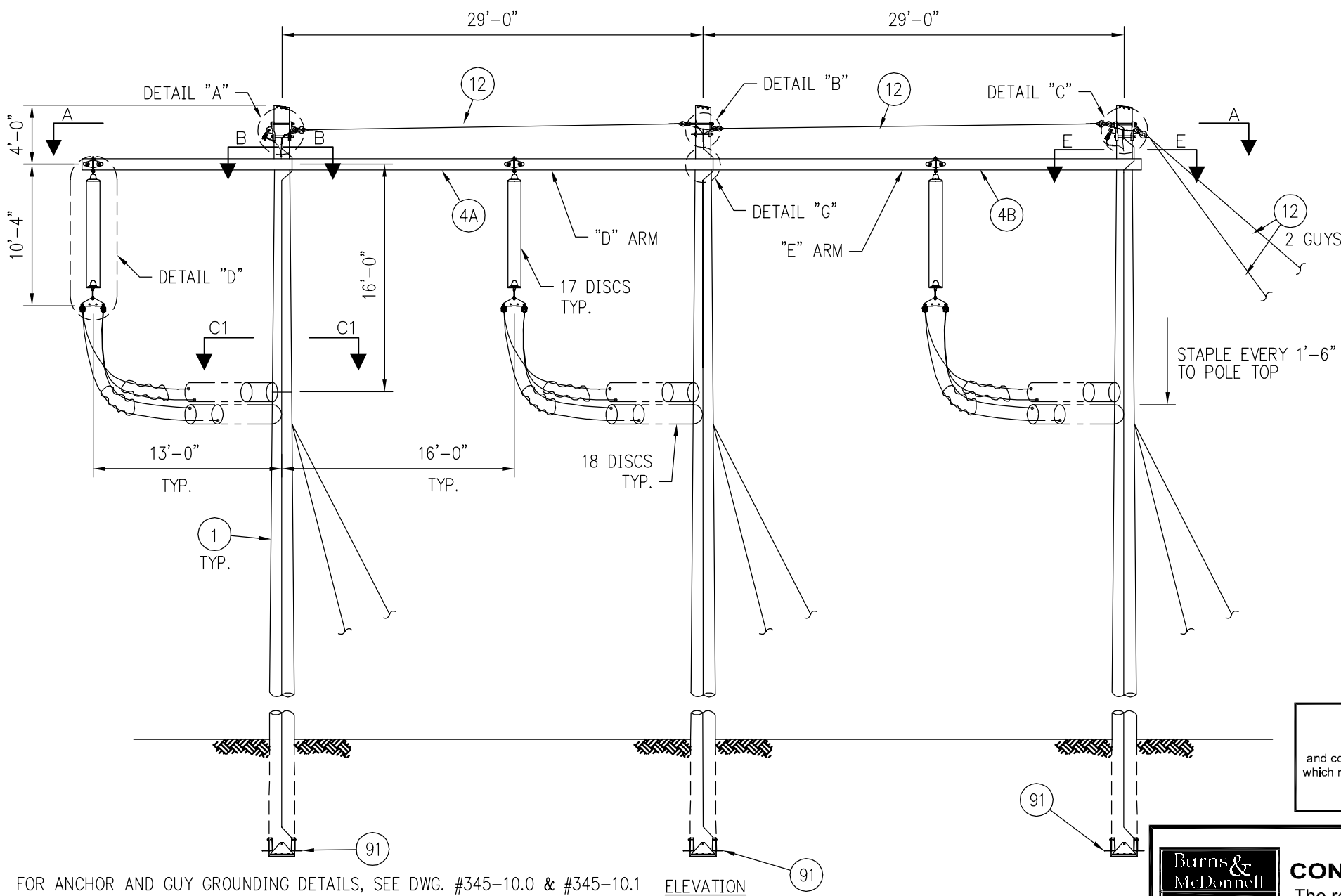
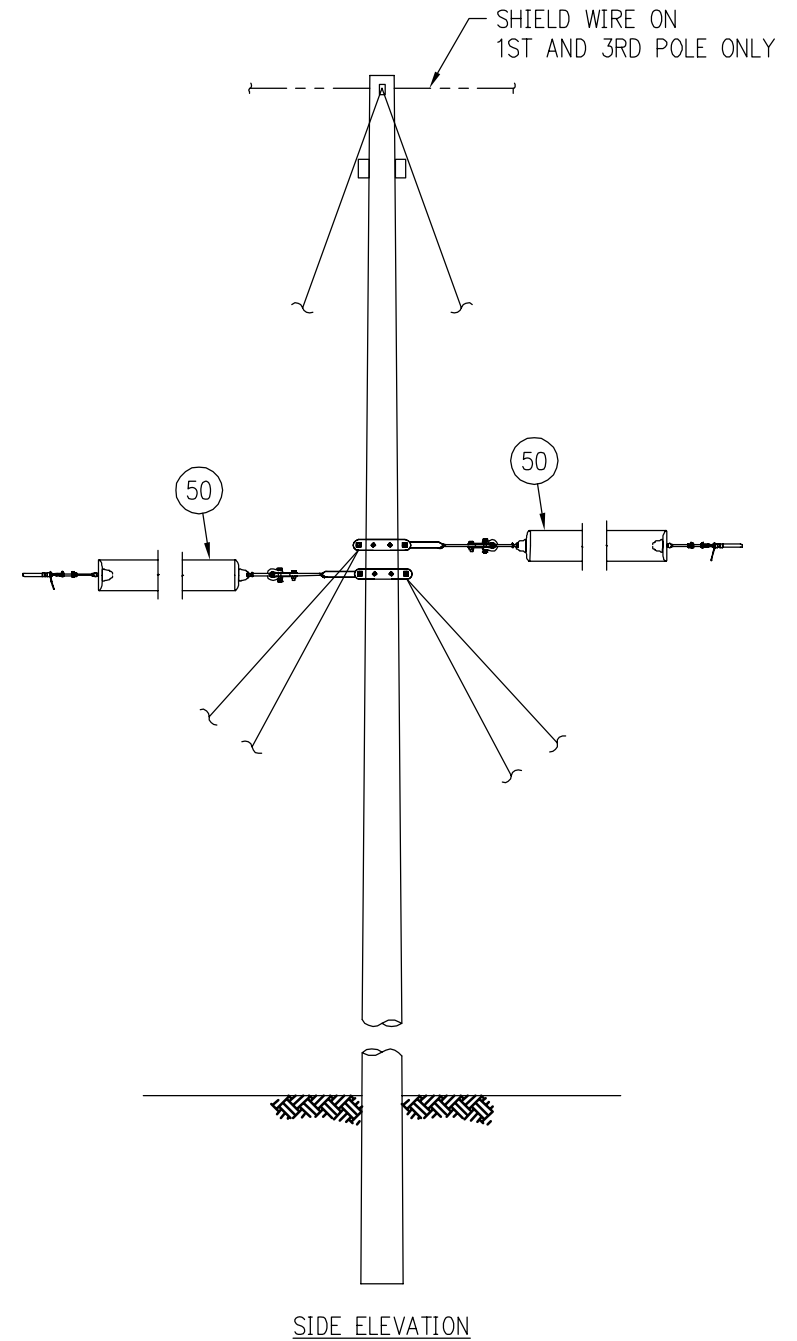
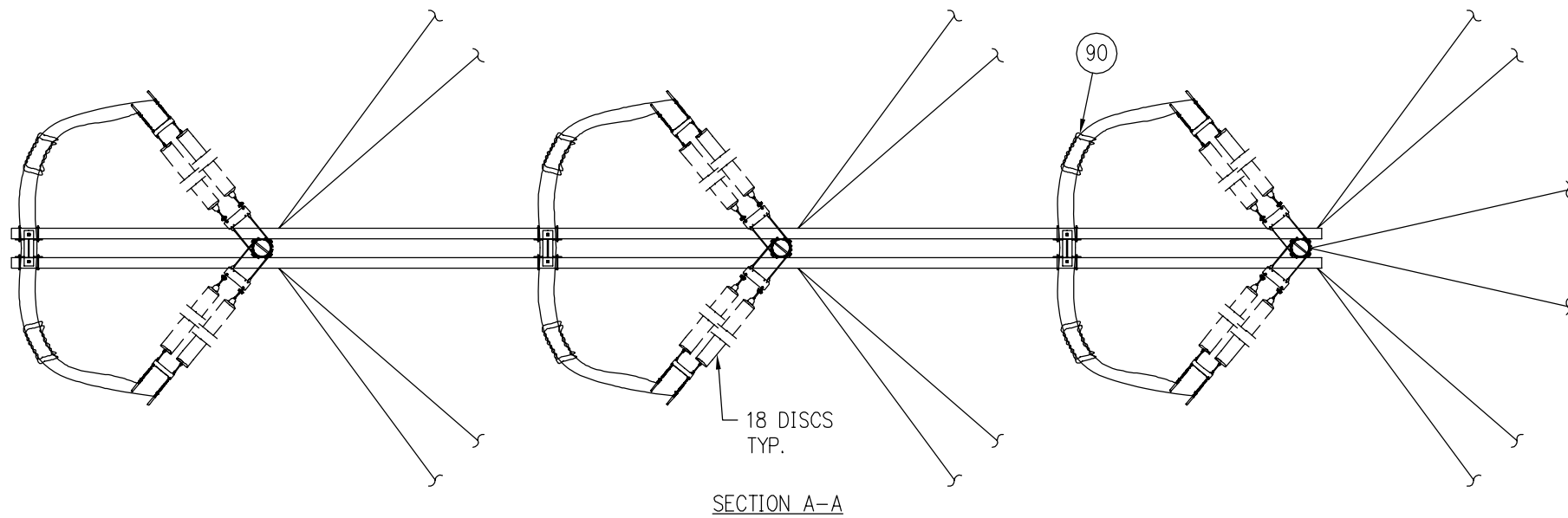
The revision dated 01.01.08 supercedes  
all revisions with an earlier revision date

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2	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
1	6/14/06	CSM	JRW	REVISED POLE BAND MATERIALS AND RE-ISSUED FOR CONSTRUCTION
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION
REV	DATE	DR	CK	DESCRIPTION
				<b>VERMONT ELECTRIC POWER CO., INC.</b> RUTLAND, VERMONT WEST RUTLAND - NEW HAVEN 345 KV
<b>STRAIGHT LINE DEAD END BILL OF MATERIALS TYPE 'DE1'</b>				
SCALE: NONE		DRAWN BY: BMcD		APPROVED BY:
DATE: 11/05		CHECKED BY: KAW		6/06 DATE
DRAWING NUMBER: PLOT: 1=1			345-5.5	
				2 REV.

N:\velco\36445-WR-NH-EP\Coad\STANDARD\_POLES\345KV\345-5.5.dwg 02-07-2006 13:12 DSM BMcD





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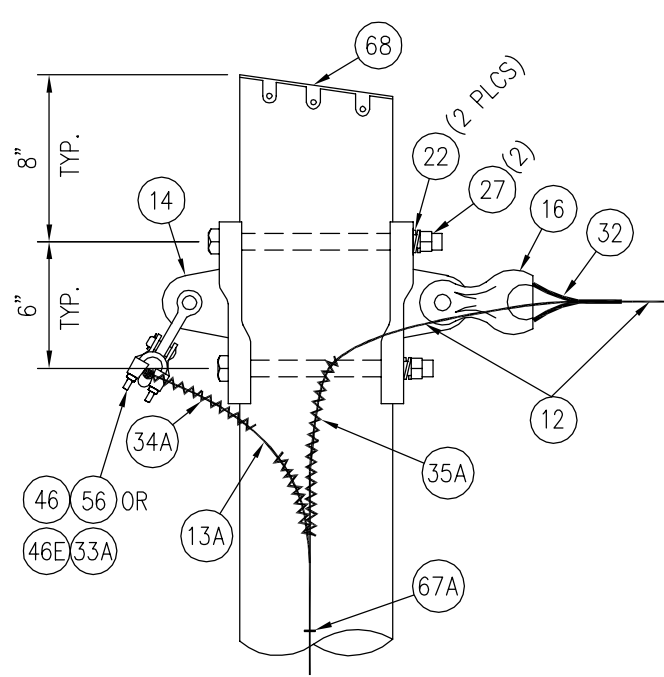
REV	DATE	DR	CK	DESCRIPTION
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0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

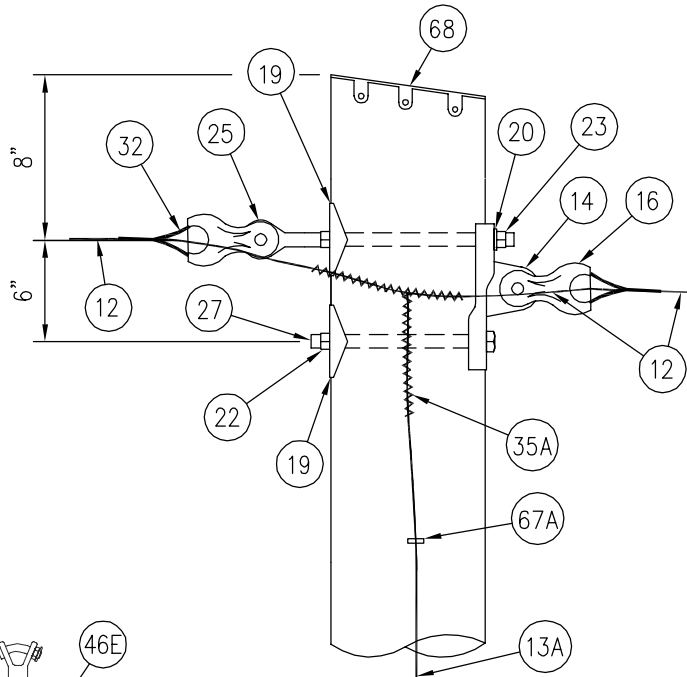
<b>VELCO</b>	<b>VERMONT ELECTRIC POWER CO., INC.</b> RUTLAND, VERMONT		
	WEST RUTLAND - NEW HAVEN 345 KV		
	<b>ANGLE DEAD END STRUCTURE</b> TYPE 'DE2' (7' TO 55')		
SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	
DATE: 11/05	CHECKED BY: KAW	DATE:	
DRAWING NUMBER: PLOT: 1=1	345-6.0		1 REV.

FOR ANCHOR AND GUY GROUNDING DETAILS, SEE DWG. #345-10.0 & #345-10.1  
 FOR POLE GUYING DETAILS, SEE DWG. #345-10.2  
 FOR GROUNDING DETAILS, SEE DWG. #345-11.0  
 FOR FOUNDATION DETAILS, SEE DWG. #345-FDN-1 THRU FDN-4

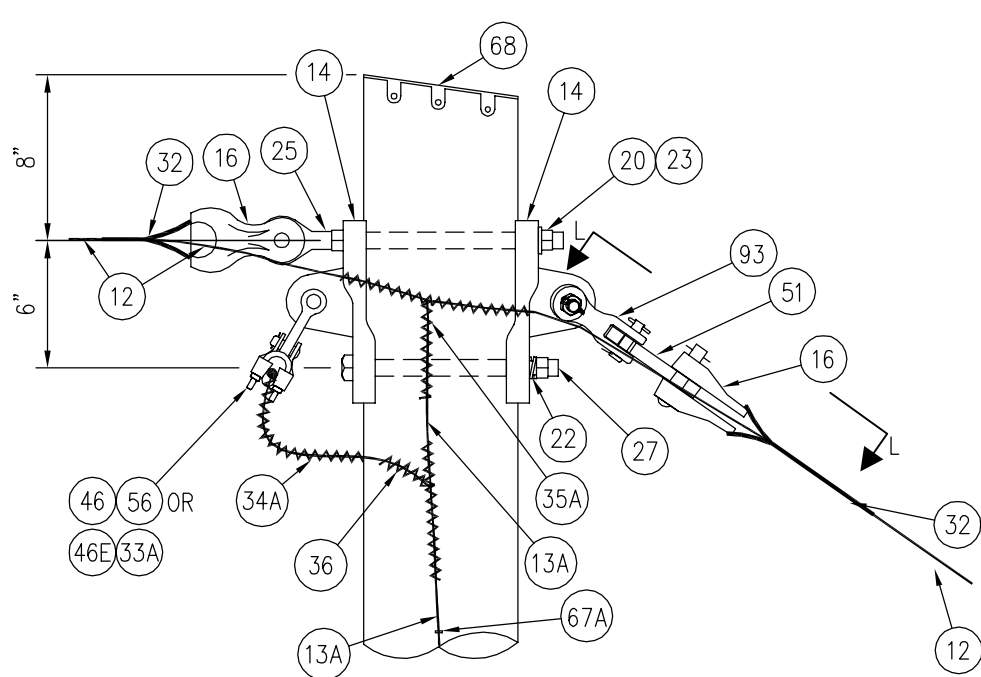
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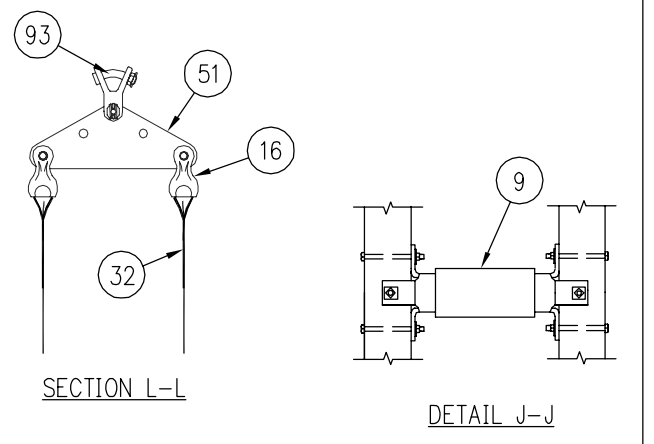
DETAIL "A"



DETAIL "B"

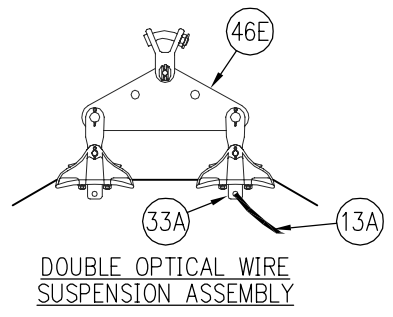


DETAIL "C"

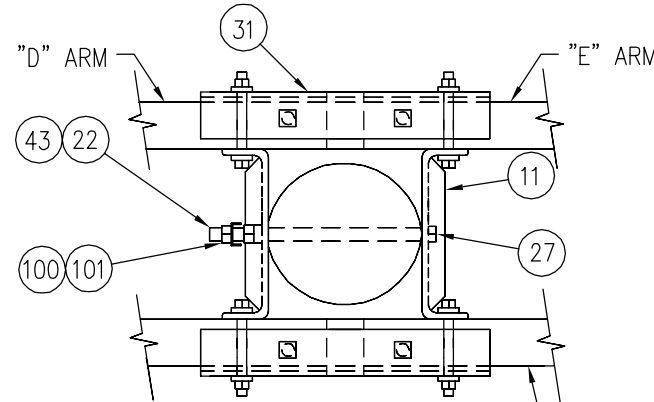


SECTION L-L

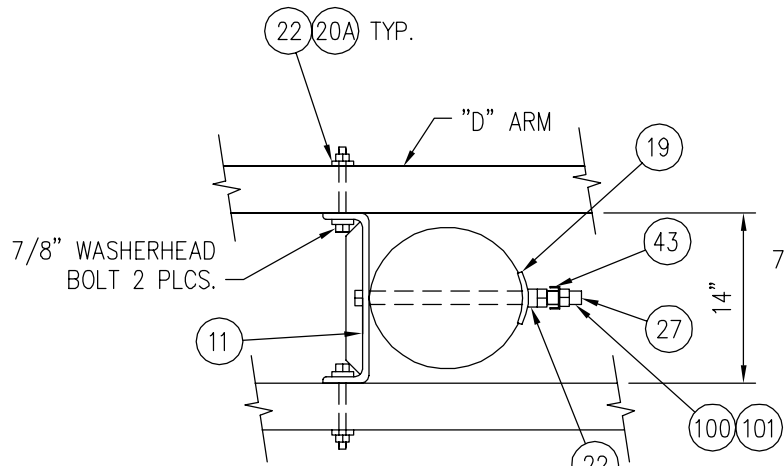
DETAIL J-J



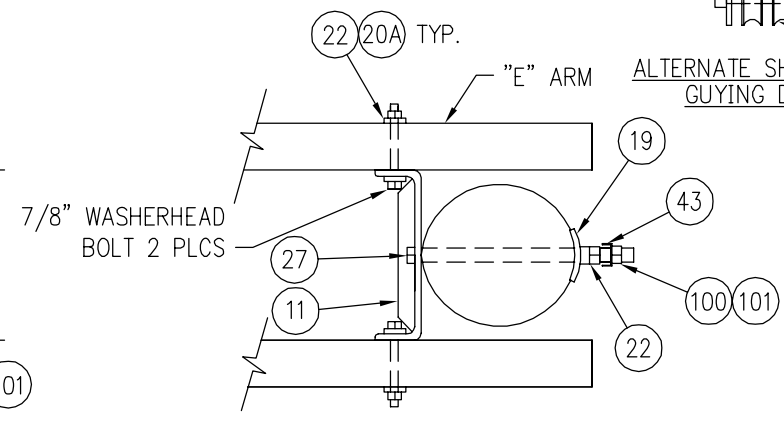
DOUBLE OPTICAL WIRE SUSPENSION ASSEMBLY



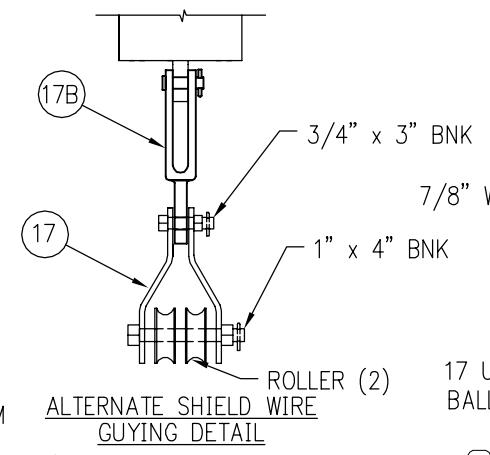
SECTION G-G



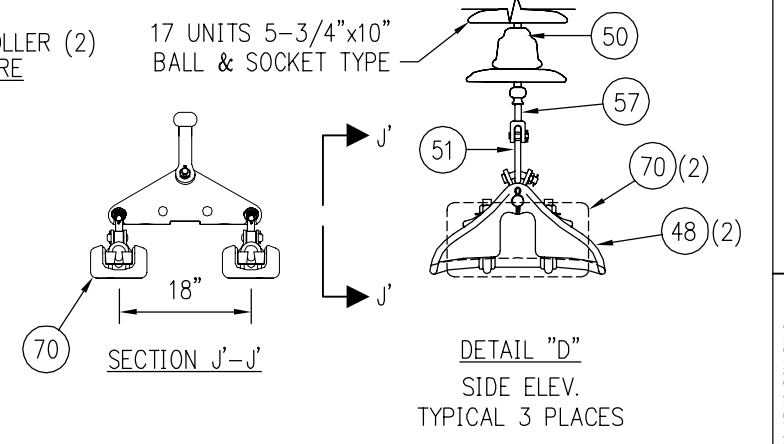
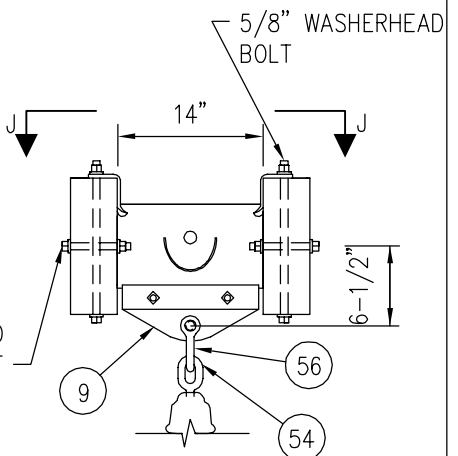
SECT. B-B



SECT. E-E

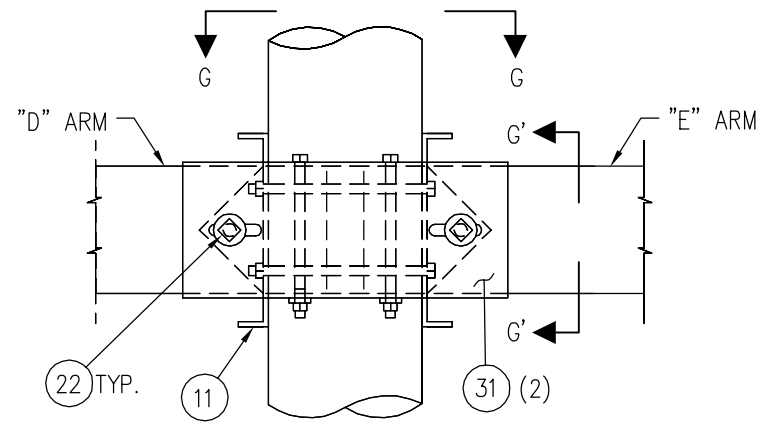


ALTERNATE SHIELD WIRE GUYING DETAIL

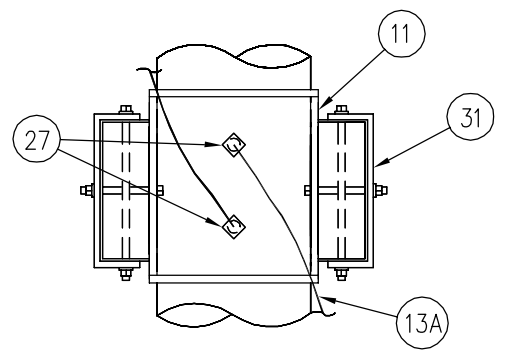


SECTION J'-J'

DETAIL "D" SIDE ELEV. TYPICAL 3 PLACES



DETAIL "G"



SECT. G'-G'

**Burns & McDonnell**  
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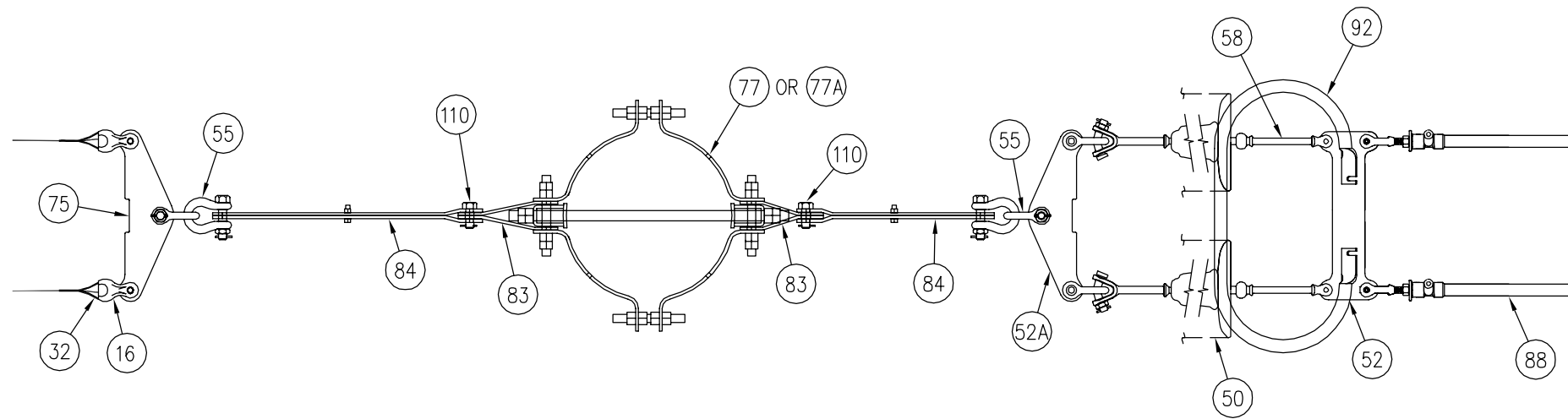
REV	DATE	DR	CK	DESCRIPTION
2	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
1	6/27/06	CSM	JRW	ADDED CLEVIS EYE EXTENSION LINK AND RE-ISSUED FOR CONSTRUCTION
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

**VERMONT ELECTRIC POWER CO., INC.**  
 RUTLAND, VERMONT  
 WEST RUTLAND - NEW HAVEN 345 KV

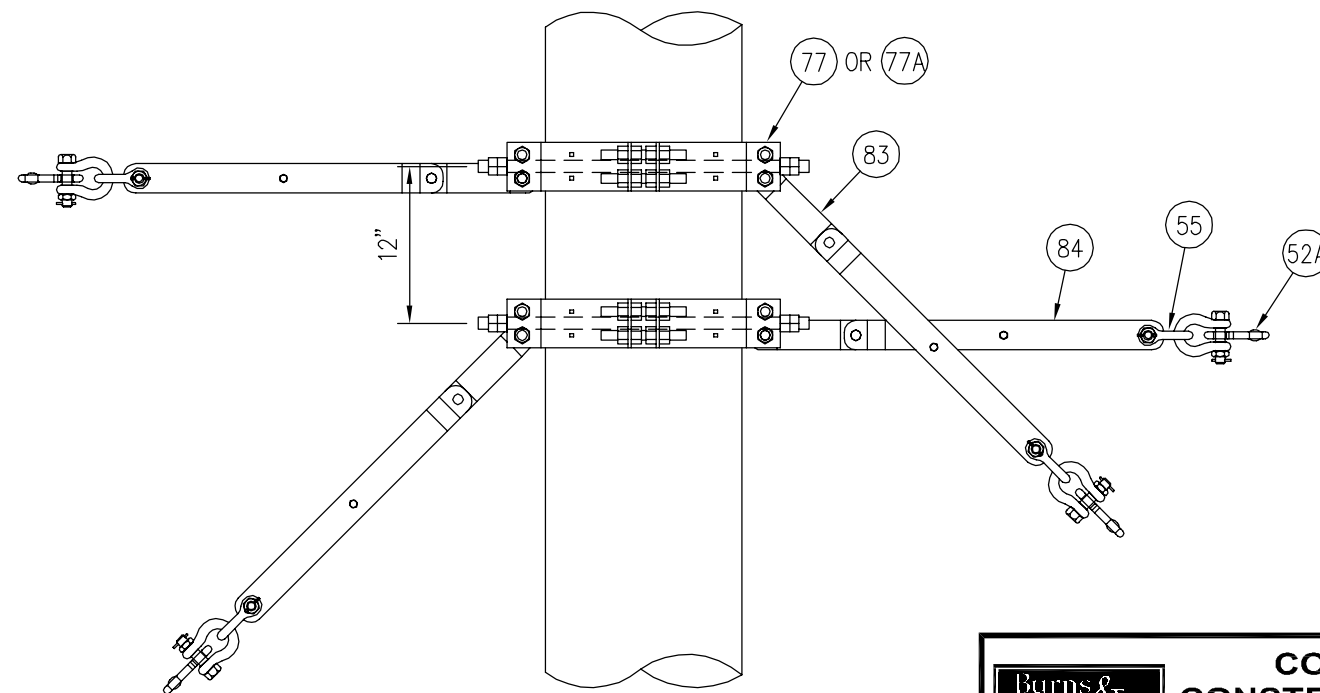
**ANGLE DEAD END POLE TOP DETAILS**  
 TYPE 'DE2' (7' TO 55')

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	6/06
DATE: 11/05	CHECKED BY: KAW		DATE
DRAWING NUMBER: 345-6.1		2	
PLOT: 1=1		REV.	

FILE: N:\Velco\36445-WR-EP\Cadd\STANDARD\_POLES\345KV\345-6.1.dwg 02-07-2006 13:12 DSM BMcD



SECTION C1-C1



**Burns & McDonnell**  
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REV	DATE	DR	CK	DESCRIPTION
2	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
1	6/14/06	CSM	JRW	REVISED SECTION C1-C1 AND RE-ISSUED FOR CONSTRUCTION
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

**VELCO** VERMONT ELECTRIC POWER CO., INC.  
 RUTLAND, VERMONT  
 WEST RUTLAND - NEW HAVEN 345 KV

**ANGLE DEAD END  
 POLE TOP DETAILS-COND. & GUY ATTACH.  
 TYPE 'DE2' (7' TO 55')**

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	6/06
DATE: 11/05	CHECKED BY: KAW		DATE


DRAWING NUMBER:	345-6.2	2
PLOT: Q		REV.

BILL OF MATERIALS

MARK	STOCK NO.	QUANTITY	DESCRIPTION	MANUFACTURER	CATALOG NUMBER
1		3	POLE, WOOD		
4		1	CROSSARM, WOOD, 345KV, LAM, ASSEMBLY 0000530 2 5-1/8"x9"x42'-4"(TYPE D) 0000490 2 5-1/8"x9"x29'-4"(TYPE E)	HUGHES	
9	0203410	3	SPACER FITTING 5-1/8"x9" DBL CROSSARM, 14" SEPERATION, ADJUSTABLE	HUGHES	3414.10WV-140
11		4	PLATE, POLE, ARM F/5-1/8"x9" DBL X-ARM, 14" SEPERATION, W/2 7/8" WASHERHEAD BOLTS	HUGHES	A2173-A
12		1500	GUY STRAND, 1/2"EHS-7 STRAND (FT)		
13A		470	BONDING WIRE, #2 COPPER, SOLID (FT)		
14		5	PLATE,POLE EYE, 7/8"BOLT,6"BOLT SP,SGL EYE,7/8" PIN	MACLEAN	EPR-77S-7
16	0201520	18	THIMBLE CLEVIS, 20K	MACLEAN	CT-88H
19		6	WASHER, SQ, CURVED, 4"x4",FOR 7/8" BOLT	JOSLYN	P144B
20	0204650	2	WASHER, ROUND, 2", FOR 3/4" BOLT	HUGHES	RW2-70
20A		4	WASHER, ROUND, 3", FOR 7/8" BOLT	HUGHES	RW3-80
21		14	WASHER RND 6" FOR 1" ANCHOR ROD	JOSLYN	P85A-1
22		18	WASHER, COIL, DOUBLE SPRING, FOR/7/8" BOLT	HUGHES	SLW2-80
23	0200110	2	WASHER, COIL, DOUBLE SPRING, FOR/3/4" BOLT	HUGHES	SLW2-70
25		2	BOLT, DBL ARM, EYE BOLT, W/2 NUTS, 3/4"xxx"	JOSLYN	J96XX
27		10	BOLT, MACHINE, 7/8"xxx", W/NUT	HUGHES	B8XX
31	0000040	2	PLATE, CROSSARM SPLICE, 345KV, 2'-0", W/2 BOLTS	HUGHES	A1956.1
32	0203860	32	GUY GRIP, DEADEND, GALV, 1/2" BLUE 7W	HELICAL	HG212-1/2
33A		1	CONNECTOR, GROUND CLAMP, BRONZE FOR OPTICAL WIRE SUSPENSION CLAMP, SX-48/33/520	ANDERSON	GTCL-23A
34A		2	L-TAP, 3/8" GALV. TO #2 SOLID CU	HELICAL	
35A		3	L-TAP, 1/2" GALV. TO #2 SOLID CU	HELICAL	
36		1	L-TAP, #2 SOLID CU TO #2 SOLID CU	HELICAL	
43	0204530	6	CLIP, GRND WIRE BONDING, #2 CU TO 7/8" BOLT	HUGHES	2727.8
44		14	CLAMP, BONDING, GUY-GROUND, FOR #2 CU TO 1/2"-7 STRAND	CHANCE	6484
46	0100050	1	CLAMP, SHIELD WIRE, SUSP. 3/8"EHS-7 STRAND (.20-.46) W/O FITTING	MACLEAN	FS-46-N
46E		1	CLAMP ASSEMBLY, OPTICAL WIRE, DBL. SUSP. W/2 CLEVIS EYE, 1 YOKE PLATE, 1 Y-CLEVIS CLEVIS, SX-48/33/520	ALCOA	OSPSS4 ACFS-120-15-23-RYCE
48	0101850	6	CLAMP, COND, FORMULA, SUSPENSION, 1.2"MAX DIA, 15"L, 23K, W/90° Y-CLEVIS EYE FITTING F/ 954MCM 45/7 ACSR, CORONA FREE	MACLEAN	
50		267	INSULATOR, SUSP, 30K M&E, 5-3/4"x10", BALL & SOCKET, GRAY	LAPP	5960A-70
51		4	PLATE, YOKE, TRI, 18" SPCG, 15/16" HOLES, 40K ULT, 5/8" THICK	MACLEAN	ASM-6229-3
52	0204130	6	PLATE, YOKE, DOGBONE, 18" SPCG, 15/16" HOLES, 40K ULT, 5/8" THICK, GALV. W/CORONA RING MOUNTING HOLES	MACLEAN	M6606-4A
52A		6	YOKE PLATE TRI 18" SP 1-1/16" HOLES, 50K ULT, 3/4" THICK	HUBBELL	YPD-50-18549-1
54	0201600	3	OVAL-EYE BALL, GALV, FORGED STEEL, 30K, 3-23/32" LONG	ANDERSON	BE-30
55		24	SHACKLE, ANCHOR, BNK, 80K 1-1/2" W, W/1" BOLT, NUT COTTER	MACLEAN	ASH-78-BC
56	0206010	4	SHACKLE, ANCHOR, BNK, 35K, W/ 3/4" BOLT NUT & COTTER KEY	ANDERSON	AS-35-BNK
57	0207860	3	SOCKET, CLEVIS, 4-1/2" L, 13/16"W, 2"D, 5/8" P, 30K	MACLEAN	SCL-55B
58		12	SOCKET CLEVIS, HOT LINE, 35K, 10" L	MACLEAN	SCHL-55A
60		12	BALL Y-CLEVIS, HOT LINE, 35K, 10-1/8" L	MACLEAN	YCBHL-65A
65A		2	GROUND ROD, COPPER CLAD, 3/4" X 10'	BLACKBURN	7510
66A		2	EXOTHERMIC WELD, #2 SOLID CU TO 3/4" CU ROD	ERICO/CADWELD	
67A		60	STAPLE, GROUND WIRE, COPPERCLAD, 1-1/2"x3/8", ROLLED POINT	CHANCE	9167
70	0202550	6	WEIGHT, HOLD DOWN,150#, W/ HARDWARE, FOR FORMULA CLAMP 954MCM ACSR 45/7	MACLEAN	ASM-389-150
71	0205180	14	ANCHOR, LOG, 8"x8"x8'		

BILL OF MATERIALS

MARK	STOCK NO.	QUANTITY	DESCRIPTION	MANUFACTURER	CATALOG NUMBER
72		14	ANCHOR ROD, 1"x10'-0" LONG, HOT DIP GALV, THIMBLE EYE	CHANCE	5340
73	0205950	14	GUY MARKER, FULL RND, YEL, 84"x 1.5", 3/16-1/2" W/PIGTAIL POLYETHYLENE	CHANCE	84FRPM-YEL
75		6	PLATE, YOKE, TRI, GUYING, 3/4" THICK, 50K	HUGHES	3341.1C
77		AR	POLE BAND, HEAVY DUTY FOR 15"-19" DIA. POLES	HUGHES	3112.8
77A		AR	POLE BAND, HEAVY DUTY FOR 17"-21" DIA. POLES	HUGHES	3112.9
83		12	CONNECTING LINK 45K PAIR	HUGHES	3157
84		12	LINK CLEVIS, GUYING AND CONDUCTOR	HUGHES	1906-24
88		12	COMPRESSION DEADEND W/ADJUSTABLE CLEVIS FITTING 954MCM 45/7 ACSR	ALCOA	C43648
90	0101950	6	SPACER, CONDUCTOR, 18" BUNDLE, 1.141 to 1.196"	PLP	SU-MS-3850
91		3	ANCHOR, POLE, 4-SECTION, W/ 7/8"xxx" THREADED RODS, W/4 NUTS, 4 LOCKNUTS & LAG SCREWS	HUGHES	A1895-3-XX
92	0202770	6	CORONA RING	MACLEAN	ASM-516-5
93		1	CLEVIS, Y-CLEVIS, 90° TWIST, 30K	ANDERSON	YCC-30-90
100		6	NUT, SQUARE, 7/8"	HUGHES	N80
101		6	LOCKNUT, SQUARE, 7/8"	HUGHES	MF80
110		12	1"x4" HIGH STRENGTH BOLT W/COTTOR PIN	HUGHES	AB104-1-4/4D
MATERIAL REQUIRED FOR ALTERNATE SHIELD WIRE GUYING					
17	0203470	1	PLATE, GUY, DBL, ASSEMBLY, INCLUDES: 2 LINKS (#3157); 2 ROLLERS (#28083); 1 BOLT 3/4"x3" BNK; 1 BOLT 1"x4" BNK.	HUGHES	
17B		1	CLEVIS, EYE, EXTENSION LINK	ANDERSON	CEEL-093-06.5
MATERIAL USED AS REQUIRED					
68	0204390	AR	POLE ROOF, NON METALLIC	OSMOSE	70-110-020-016




**CONFORMED TO CONSTRUCTION RECORDS**

The revision dated 01.01.08 supercedes all revisions with an earlier revision date

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2	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
1	6/27/06	CSM	JRW	ADDED MARK 17B, REVISED DEADEND ASSBLY MATS AND RE-ISSUED FOR CONSTRUCTION
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION
REV	DATE	DR	CK	DESCRIPTION



**VERMONT ELECTRIC POWER CO., INC.**  
RUTLAND, VERMONT

WEST RUTLAND - NEW HAVEN 345 KV

**ANGLE DEAD END BILL OF MATERIALS TYPE 'DE2' (7' TO 55')**

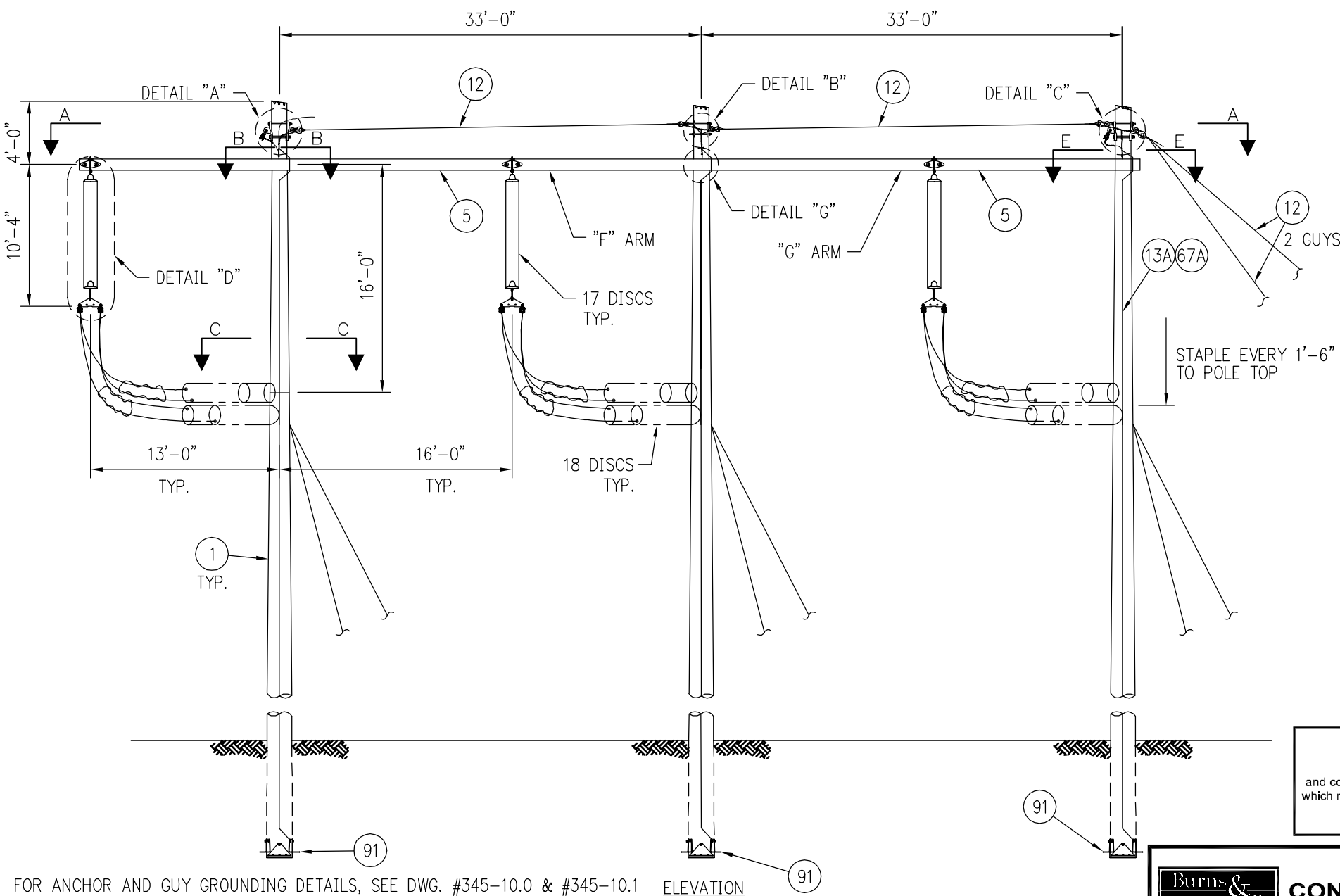
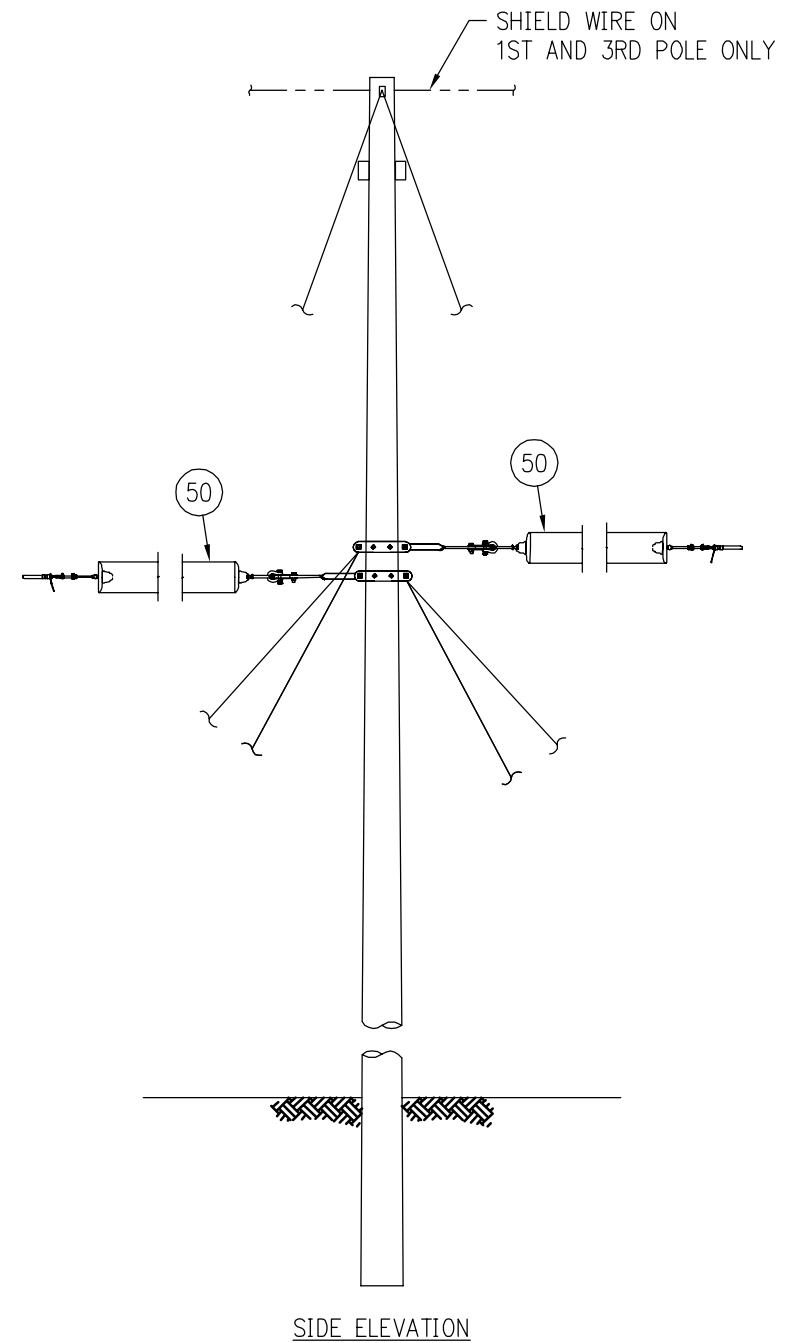
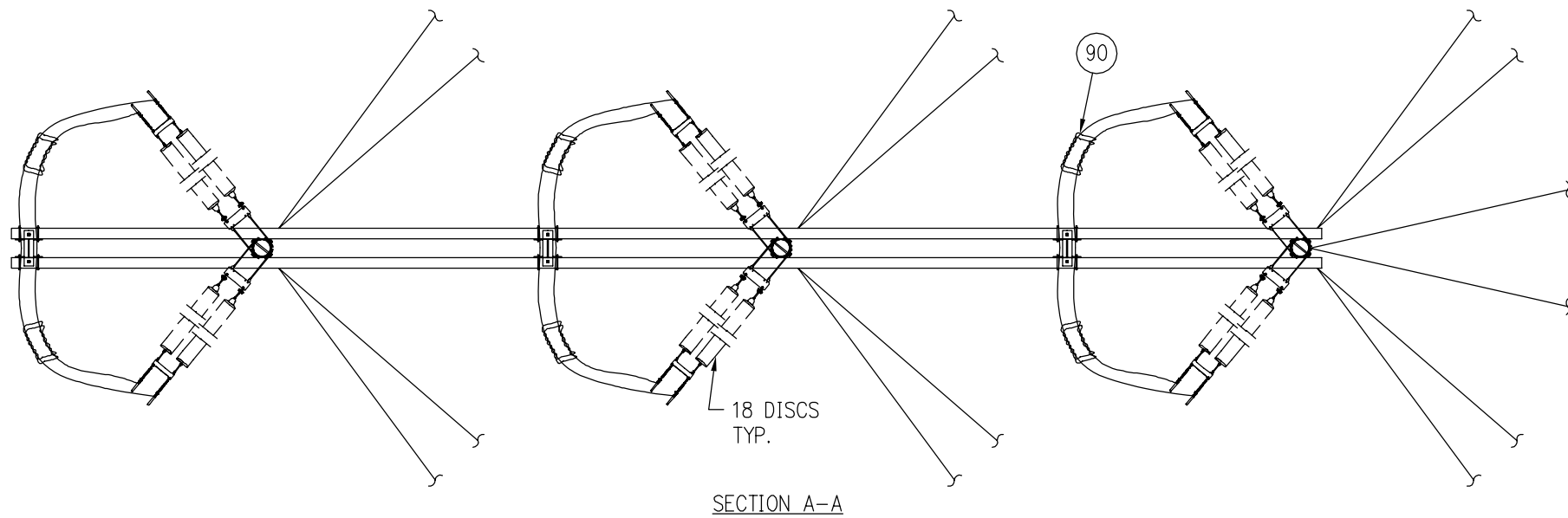
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DATE: 11/05	CHECKED BY: KAW		DATE

DRAWING NUMBER: 345-6.3

PLOT: 1=1 2

REV.

N:\velco\36445-WR-NH-EP\Coad\STANDARD\_POLES\345KV\345-6.3.dwg 02-07-2006 13:12 DSM BMcD



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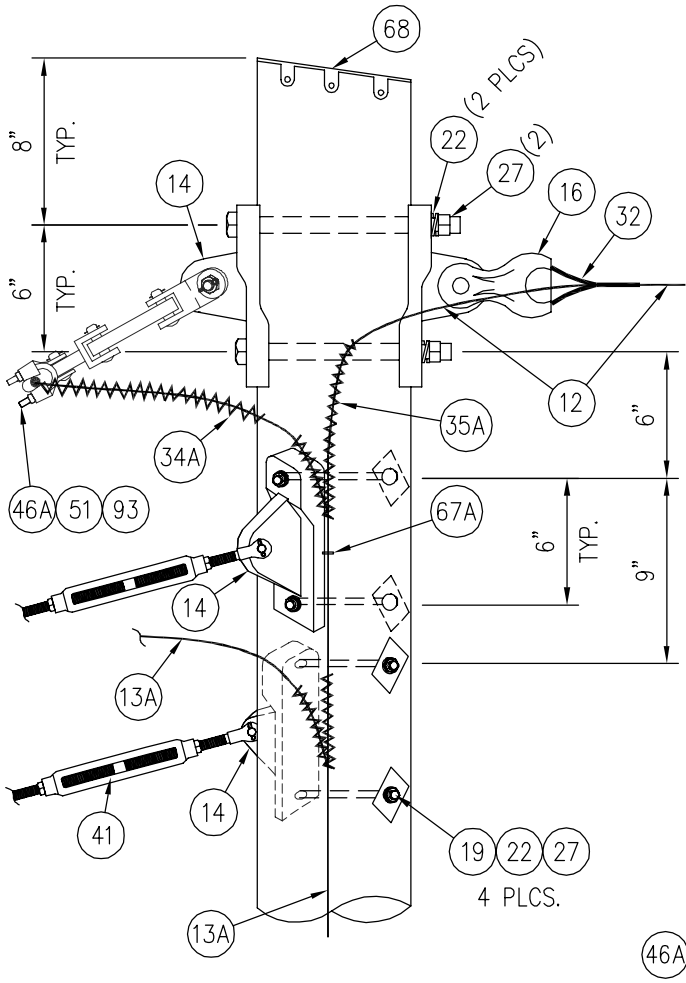
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1	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

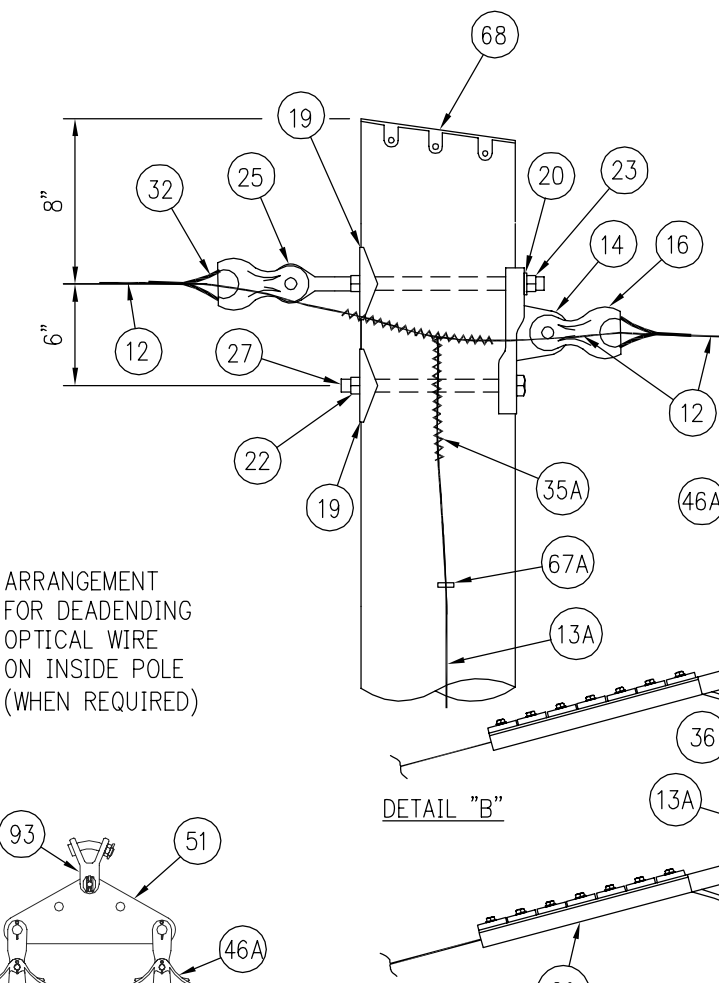
<b>VELCO</b>	<b>VERMONT ELECTRIC POWER CO., INC.</b> RUTLAND, VERMONT	
	WEST RUTLAND - NEW HAVEN 345 KV	
<b>ANGLE DEAD END STRUCTURE</b> TYPE 'DE3' (55' TO 75')		
SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:
DATE: 11/05	CHECKED BY: KAW	DATE:
DRAWING NUMBER: PLOT: 1=1	345-7.0	
		1 REV.

FOR ANCHOR AND GUY GROUNDING DETAILS, SEE DWG. #345-10.0 & #345-10.1  
 FOR POLE GUYING DETAILS, SEE DWG. #345-10.2  
 FOR GROUNDING DETAILS, SEE DWG. #345-11.0  
 FOR FOUNDATION DETAILS, SEE DWG. #345-FDN-1 THRU FDN-4

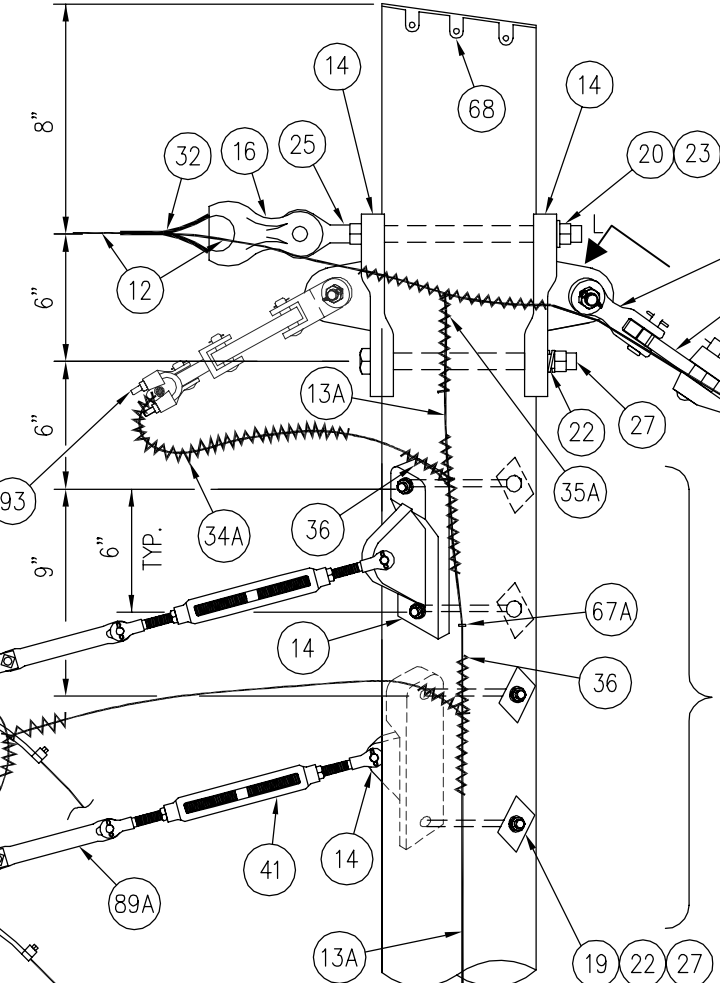
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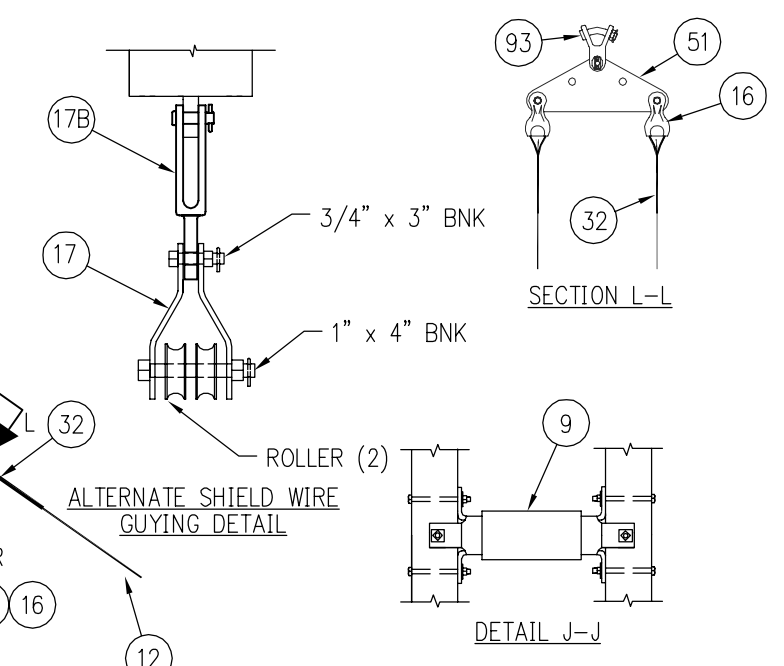
DETAIL "A"



DETAIL "B"



DETAIL "C"

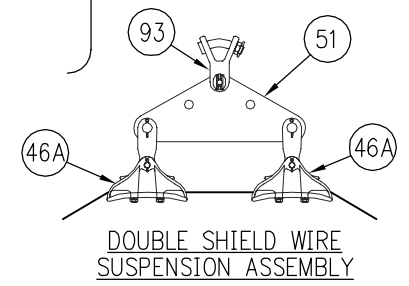


SECTION L-L

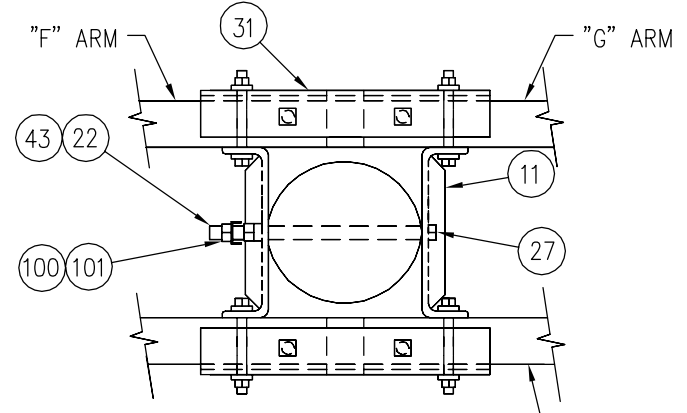
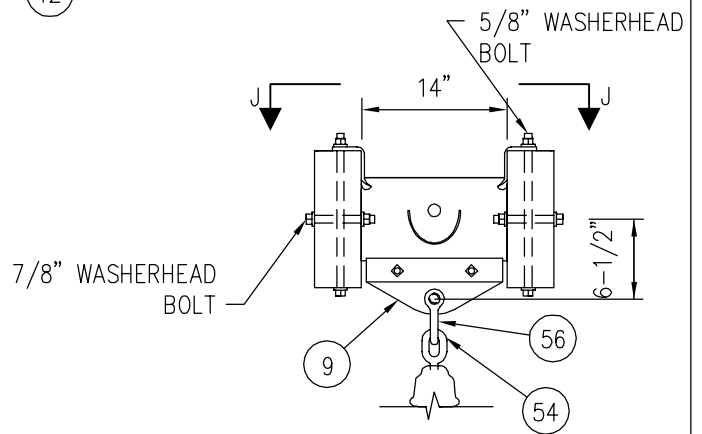
DETAIL J-J

ARRANGEMENT FOR DEADENDING OPTICAL WIRE ON INSIDE POLE (WHEN REQUIRED)

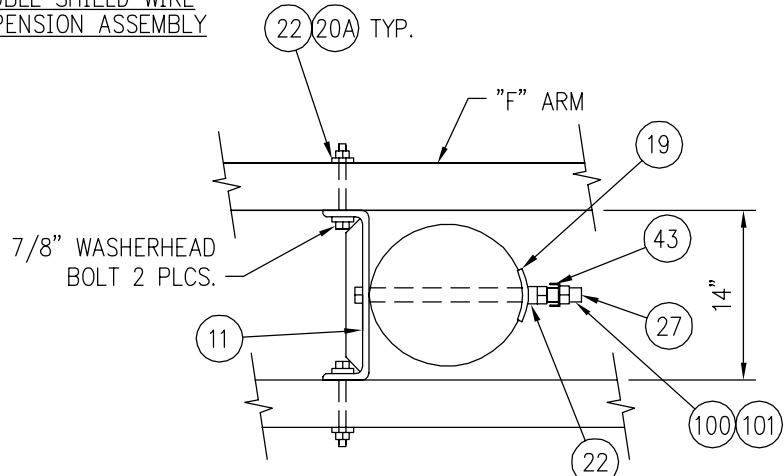
ARRANGEMENT FOR DEADENDING OPTICAL WIRE ON OUTSIDE POLE (WHEN REQUIRED)



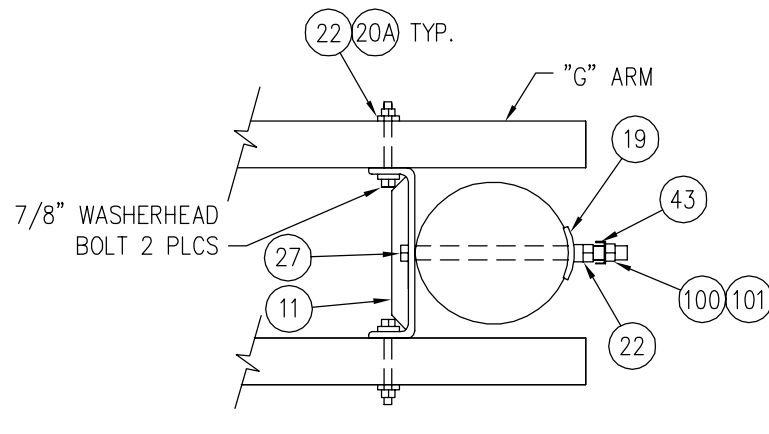
DOUBLE SHIELD WIRE SUSPENSION ASSEMBLY



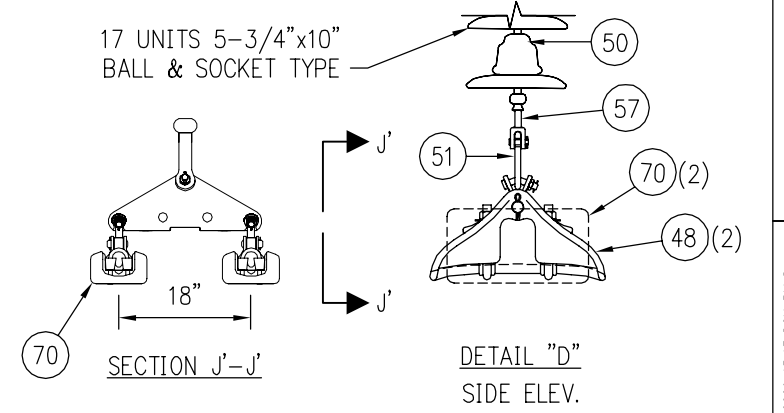
SECTION G-G



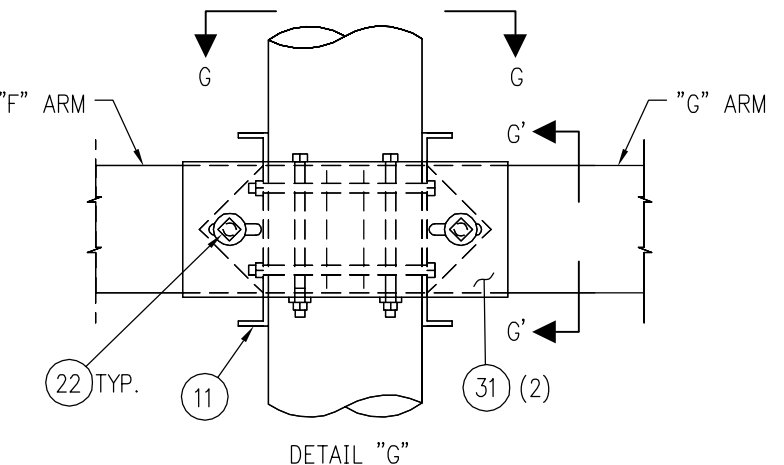
SECT. B-B



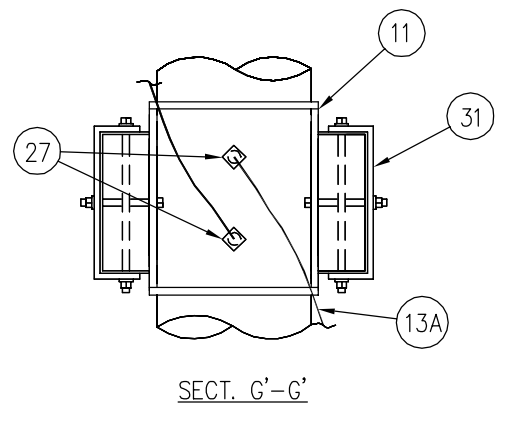
SECT. E-E



DETAIL "D" SIDE ELEV. TYPICAL 3 PLACES



DETAIL "G"



SECT. G'-G'

**Burns & McDonnell**  
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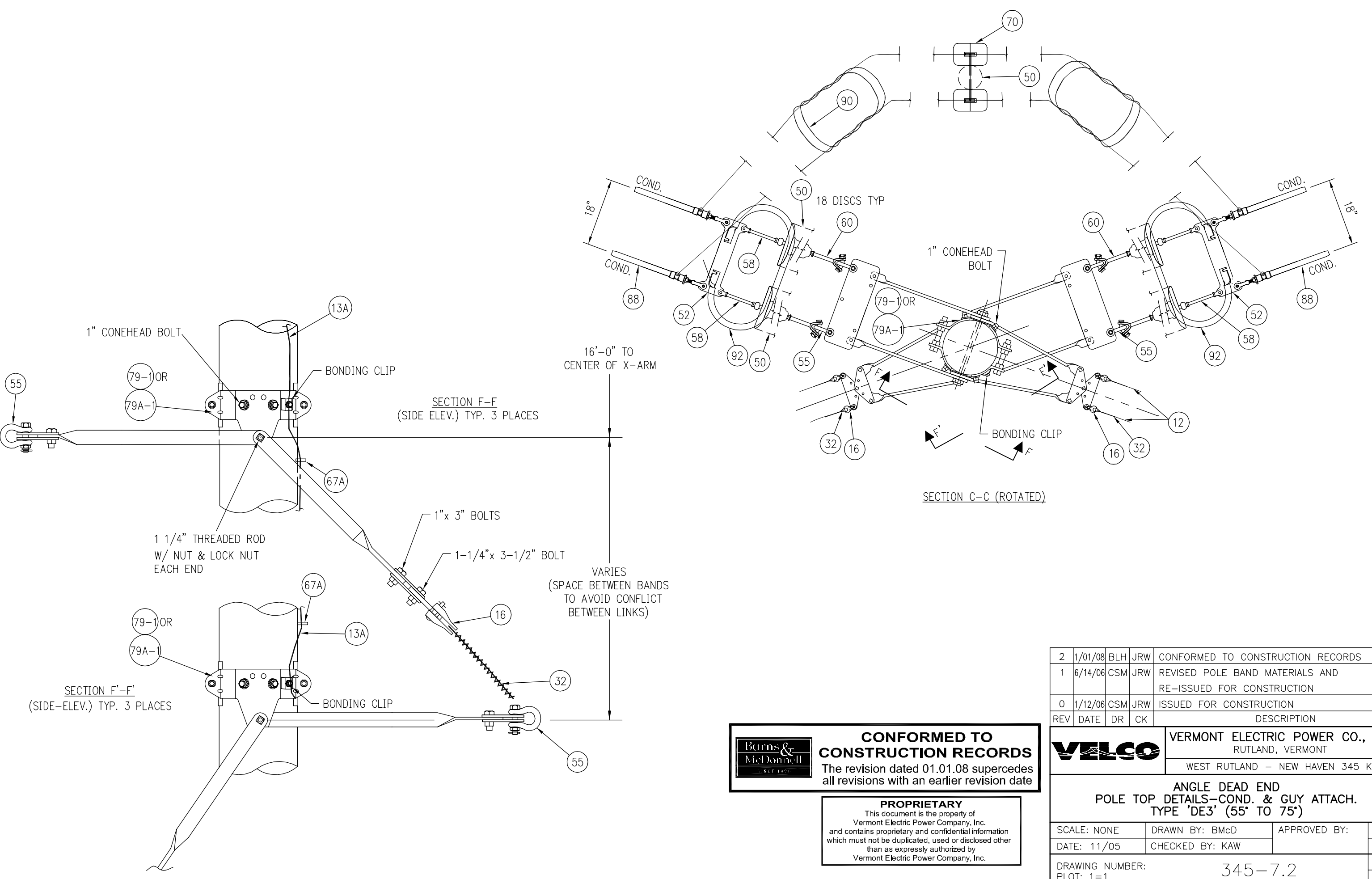
REV	DATE	DR	CK	DESCRIPTION
2	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
1	6/27/06	CSM	JRW	ADDED MARK # 17B AND RE-ISSUED FOR CONSTR.
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

**VELCO** VERMONT ELECTRIC POWER CO., INC.  
 RUTLAND, VERMONT  
 WEST RUTLAND - NEW HAVEN 345 KV

**ANGLE DEAD END POLE TOP DETAILS TYPE 'DE3' (55' TO 75')**

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	6/06
DATE: 11/05	CHECKED BY: KAW		DATE
DRAWING NUMBER:	345-7.1		2
PLOT: 1=1			REV.

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**Burns & McDonnell**  
**CONFORMED TO CONSTRUCTION RECORDS**  
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REV	DATE	DR	CK	DESCRIPTION
2	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
1	6/14/06	CSM	JRW	REVISED POLE BAND MATERIALS AND RE-ISSUED FOR CONSTRUCTION
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

**VELCO** VERMONT ELECTRIC POWER CO., INC.  
 RUTLAND, VERMONT  
 WEST RUTLAND - NEW HAVEN 345 KV

**ANGLE DEAD END  
 POLE TOP DETAILS-COND. & GUY ATTACH.  
 TYPE 'DE3' (55' TO 75')**

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	6/06
DATE: 11/05	CHECKED BY: KAW		DATE
DRAWING NUMBER: 345-7.2		2	
PLOT: 1=1		REV.	

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**BILL OF MATERIALS**

MARK	STOCK NO.	QUANTITY	DESCRIPTION	MANUFACTURE	CATALOG NUMBER
1		3	POLE, WOOD		
5	0000480	1	CROSSARM, WOOD, 345KV, LAM, ASSEMBLY 2 5-1/8"x9"x46'-4"(TYPE F) 2 5-1/8"x9"x33'-4"(TYPE G)	HUGHES	
9	0203410	3	SPACER FITTING 5-1/8"x9" DBL CROSSARM, 14" SEPERATION, ADJUSTABLE	HUGHES	3414.10WV-140
11		4	PLATE, POLE, ARM F/5-1/8"x9" DBL X-ARM, 14" SEPERATION, W/2 7/8" WASHERHEAD BOLTS	HUGHES	A2173-A
12		1500	GUY STRAND, 1/2"EHS-7 STRAND (FT)		
13A		470	BONDING WIRE, #2 COPPER, SOLID (FT)		
14		7	PLATE,POLE EYE,7/8"BOLT,6"BOLT SP,SGL EYE,7/8" PIN	MACLEAN	EPR-77S-7
16	0201520	18	THIMBLE CLEVIS, 20K	MACLEAN	CT-88H
19		10	WASHER, SQ, CURVED, 4"x4",FOR 7/8" BOLT	JOSLYN	P144B
20	0204650	2	WASHER, ROUND, 2", FOR 3/4" BOLT	HUGHES	RW2-70
20A		4	WASHER, ROUND, 3", FOR 7/8" BOLT	HUGHES	RW3-80
21		14	WASHER RND 6" FOR 1" ANCHOR ROD	JOSLYN	P85A-1
22		22	WASHER, COIL, DOUBLE SPRING, FOR/7/8" BOLT	HUGHES	SLW2-80
23	0200110	2	WASHER, COIL, DOUBLE SPRING, FOR/3/4" BOLT	HUGHES	SLW2-70
25		2	BOLT, DBL ARM, EYE BOLT, W/2 NUTS, 3/4"xxx"	JOSLYN	J96XX
27		14	BOLT, MACHINE, 7/8"xxx", W/NUT	HUGHES	B8XX
31	0000040	2	PLATE, CROSSARM SPLICE, 345KV 2'-0", W/2 BOLTS	HUGHES	A1956.1
32	0203860	32	GUY GRIP, DEADEND, GALV, 1/2" BLUE 7W	HELICAL	HG212-1/2
33A		2	CONNECTOR, GROUND CLAMP, BRONZE FOR OPTICAL WIRE SUSPENSION CLAMP, SX-48/33/520	ANDERSON	GTCL-23A
34A		1	L-TAP, 3/8" GALV. TO #2 SOLID CU	HELICAL	
35A		3	L-TAP, 1/2" GALV. TO #2 SOLID CU	HELICAL	
36		2	L-TAP, #2 SOLID CU TO #2 SOLID CU	HELICAL	
41		2	TURNBUCKLE, CLEVIS-CLEVIS, 3/4" x 9", 28K	HUGHES	AS2545-A
43	0204530	6	CLIP, GRND WIRE BONDING, #2 CU TO 7/8" BOLT	HUGHES	2727.8
44		14	CLAMP, BONDING, GUY-GROUND, FOR #2 CU TO 1/2"-7 STRAND	CHANCE	6484
46A		2	CLAMP, SHIELD WIRE, SUSP. W/ CLEVIS EYE 3/8"EHS-7 STRAND	MACLEAN	FS-46-C
48	0101850	6	CLAMP, COND, FORMULA, SUSPENSION, 1.2"MAX DIA, 15"L, 23K, W/90° Y-CLEVIS EYE FITTING F/954MCM 45/7ACSR CORONA FREE	MACLEAN	ACFS-120-15-23-RYCE
50		267	INSULATOR, SUSP, 30K M&E, 5-3/4"x10", BALL & SOCKET, GRAY	LAPP	5960A-70
51		5	PLATE, YOKE, TRI, 18" SPCG, 15/16" HOLES, 40K ULT, 5/8" THICK	MACLEAN	ASM-6229-3
52	0204130	6	PLATE, YOKE, DOGBONE, 18" SPCG, 15/16" HOLES, 40K LT, 5/8" THICK, GALV. W/CORONA RING MOUNTING HOLES	MACLEAN	M6606-4A
54	0201600	3	OVAL-EYE BALL, GALV, FORGED STEEL, 30K, 3-23/32" LONG	ANDERSON	BE-30
55		12	SHACKLE, ANCHOR, BNK, 80K, 1-1/2" W, W/1" BOLT NUT & COTTER	MACLEAN	ASH-78-BC
56	0206010	5	SHACKLE, ANCHOR, BNK, 35K, W/ 3/4" BOLT NUT & COTTER KEY	ANDERSON	AS-35-BNK
57	0207860	3	SOCKET, CLEVIS, 4-1/2" L, 13/16"W, 2"D, 5/8"P, 30K	MACLEAN	SCL-55B
58		12	SOCKET CLEVIS, HOT LINE, 35K, 10"L	MACLEAN	SCHL-55A
60		12	BALL Y-CLEVIS, HOT LINE, 35K, 10-1/8"L	MACLEAN	YCBHL-65A
65A		2	GROUND ROD, COPPER CLAD, 3/4" X 10'	BLACKBURN	7510
66A		2	EXOTHERMIC WELD, #2 SOLID CU TO 3/4" CU ROD	ERICO/CADWELD	
67A		60	STAPLE, GROUND WIRE, COPPERCLAD, 1-1/2"x3/8", ROLLED POINT	CHANCE	9167
70	0202550	6	WEIGHT, HOLD DOWN,150#, W/ HARDWARE, FOR FORMULA CLAMP 954kCM ACSR 45/7,	MACLEAN	ASM-389-150
71	0205180	14	ANCHOR, LOG, 8"x8"x8'		
72		14	ANCHOR ROD, 1"x10'-0" LONG, HOT DIP GALV, THIMBLE EYE	CHANCE	5340

**BILL OF MATERIALS**


MARK	STOCK NO.	QUANTITY	DESCRIPTION	MANUFACTURE	CATALOG NUMBER
73	0205950	14	GUY MARKER, FULL RND, YEL, 84"x 1.5", 3/16-1/2" W/PIGTAIL POLYETHYLENE	CHANCE	84FRPM-YEL
79-1		AR	POLE BAND, EXTRA HEAVY DUTY (SPECIAL NO. 3340 POLE BAND), ASSEMBLY INCLUDES: 1 BONDING CLIP (#2727.8) W/LOCK NUT, 2 TWISTED LINKS (#B1784.1A), 2 TWISTED LINKS (#3341.1A), 1 DOUBLE YOKE PLATE (#3341.1B), 1 YOKE PLATE (#3341.1C), 1 DOUBLE YOKE PLATE (B1784.1B) (POLE DIA. 12"-17")	HUGHES	B1784-A.6
79A-1		AR	POLE BAND, EXTRA HEAVY DUTY (SPECIAL NO. 3340 POLE BAND), ASSEMBLY INCLUDES: 1 BONDING CLIP (#2727.8) W/LOCK NUT, 2 TWISTED LINKS (#B1784.1A), 2 TWISTED LINKS (#3341.1A), 1 DOUBLE YOKE PLATE (#3341.1B), 1 YOKE PLATE (#3341.1C), 1 DOUBLE YOKE PLATE (B1784.1B) (POLE DIA. 17"-21")	HUGHES	B1784-A.7
88		12	COMPRESSION DEADEND W/ADJUSTABLE CLEVIS FITTING 954MCM45/7ACSR	ALCOA	C43648
89		2	BOLTED DEAD END, OPTICAL WIRE, SX-48/33/520	ALCOA	ODE47/34/520
89A		2	LINK EXTENSION, OPTICAL WIRE, 5" C-C	ALCOA	ODELP05
90	0101950	6	SPACER, CONDUCTOR, 18" BUNDLE, 1.141 to 1.196"	PLP	SU-MS-3850
91		3	ANCHOR POLE, 4-SECTION, W/ 7/8"xxx" THREADED RODS, W/ 4 NUTS, 4 LOCKNUTS & LAG SCREWS	HUGHES	A1895-3-XX
92	0202770	6	CORONA RING	MACLEAN	ASM-516-5
93		2	CLEVIS Y-CLEVIS, 90° TWIST, 30K	ANDERSON	YCC-30-90
100		6	NUT, SQUARE, 7/8"	HUGHES	N80
101		6	LOCKNUT, SQUARE, 7/8"	HUGHES	MF80

**MATERIAL REQUIRED FOR ALTERNATE SHIELD WIRE GUYING**

17	0203470	1	PLATE, GUY, DBL, ASSEMBLY, INCLUDES: 2 LINKS (#3157); 2 ROLLERS (#28083); 1 BOLT 3/4"x3" BNK; 1 BOLT 1"x4" BNK		
17B		1	CLEVIS, EYE, ESTENSION LINK	ANDERSON	CEEL-093-06.5

**MATERIAL USED AS REQUIRED**

68	0204390	AR	POLE ROOF, NON METALLIC	OSMOSE	70-110-020-016
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REV	DATE	DR	CK	DESCRIPTION
2	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
1	6/27/06	CSM	JRW	ADDED MARK 17B, REVISED QTY FOR MARK 19, REVISED MATERIAL FOR MARK 20A, UPDATED BAND MATERIALS AND RE-ISSUED FOR CONSTR.
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

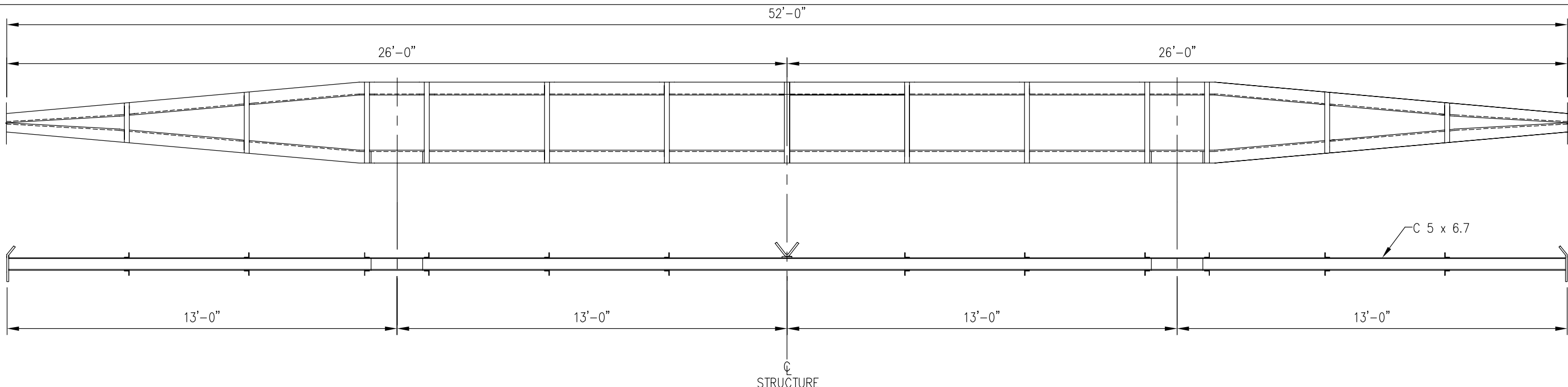

**VERMONT ELECTRIC POWER CO., INC.**  
 RUTLAND, VERMONT  
 WEST RUTLAND - NEW HAVEN 345 KV

**ANGLE DEAD END BILL OF MATERIALS TYPE 'DE3' (55' TO 75')**

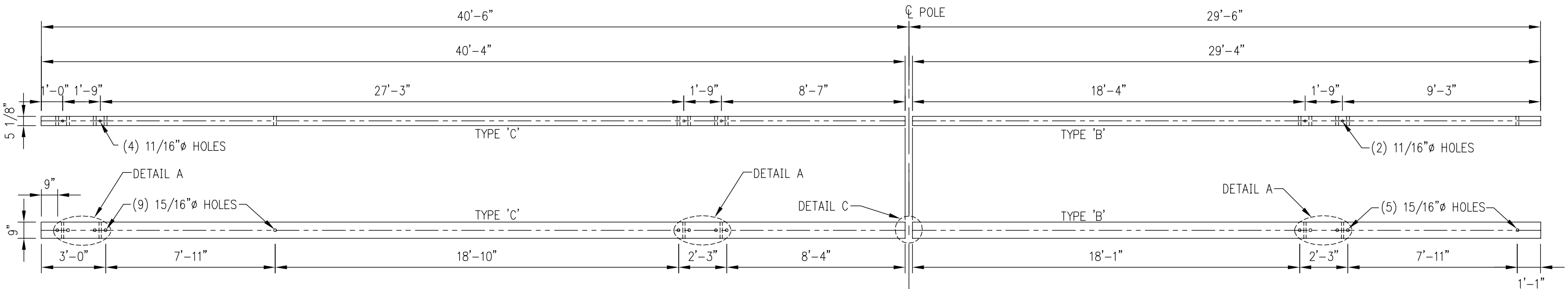
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DATE: 11/05	CHECKED BY: KAW		DATE
DRAWING NUMBER: PLOT: 1=1	345-7.3		2 REV.

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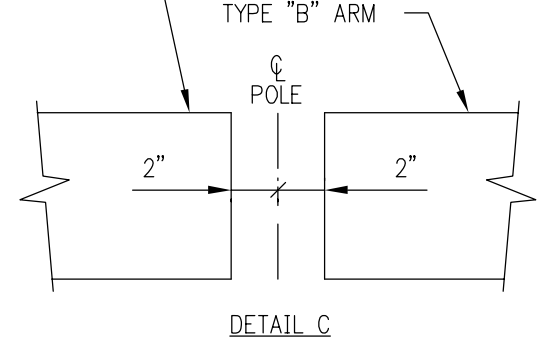
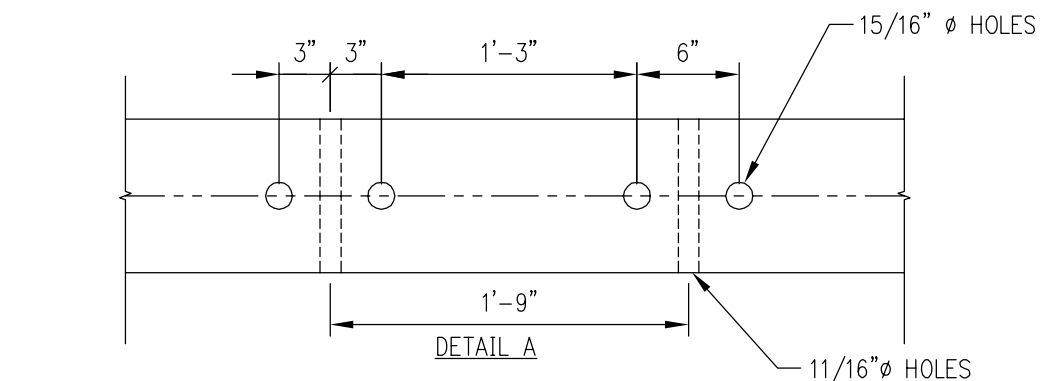




CROSSARM TYPE 'A' (A588 WEATHERING STEEL)  
FOR STRUCTURE TYPE 'A' (DWG. #345-1.0)



CROSSARM TYPE 'C' & 'B'  
FOR STRUCTURE TYPE 'SA1' (DWG. #345-2.0)



**Burns & McDonnell**  
SINCE 1856

**CONFORMED TO CONSTRUCTION RECORDS**  
The revision dated 01.01.08 supercedes all revisions with an earlier revision date

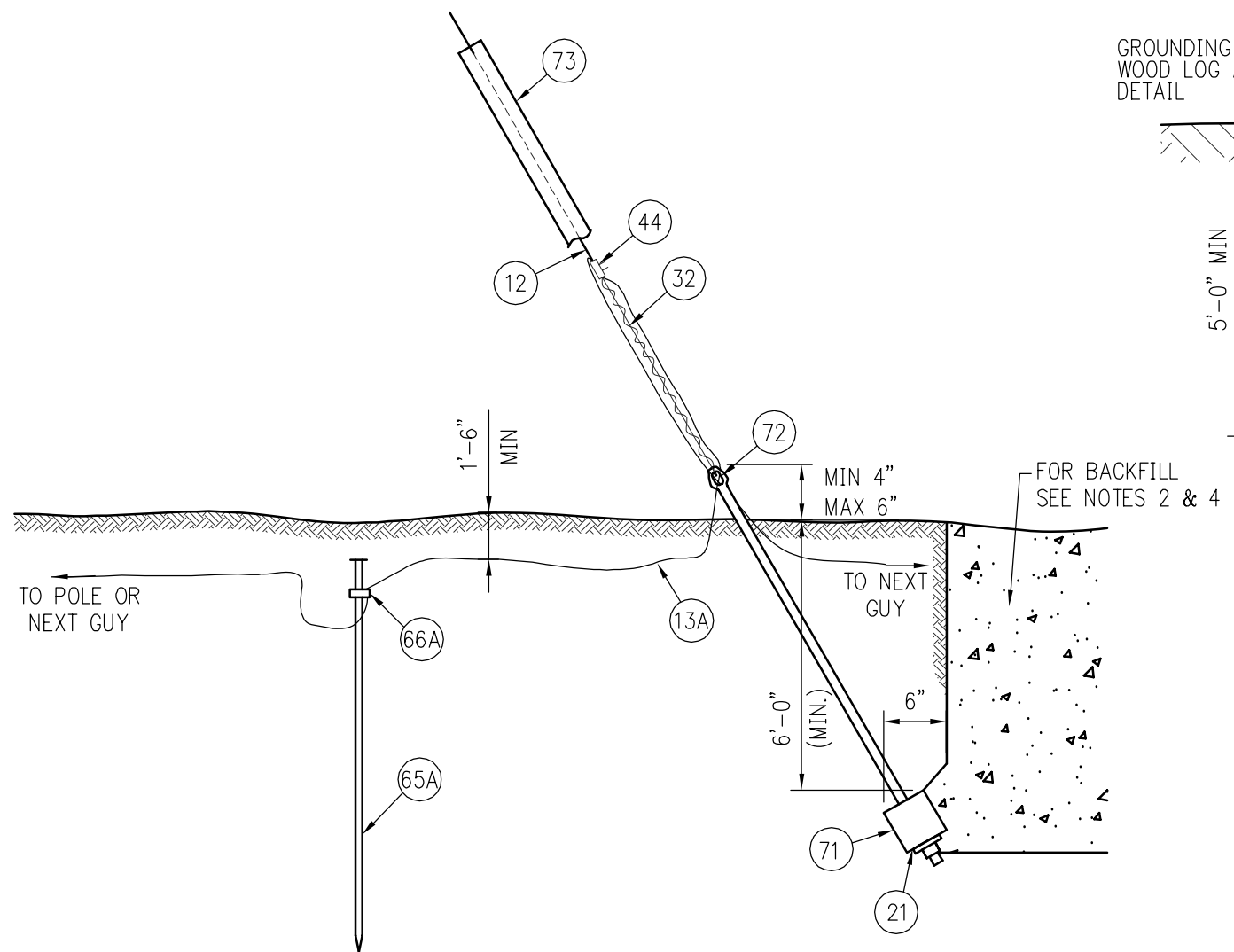
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REV	DATE	DR	CK	DESCRIPTION
1	1/01/08	JAH	JRW	CONFORMED TO CONSTRUCTION RECORDS
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

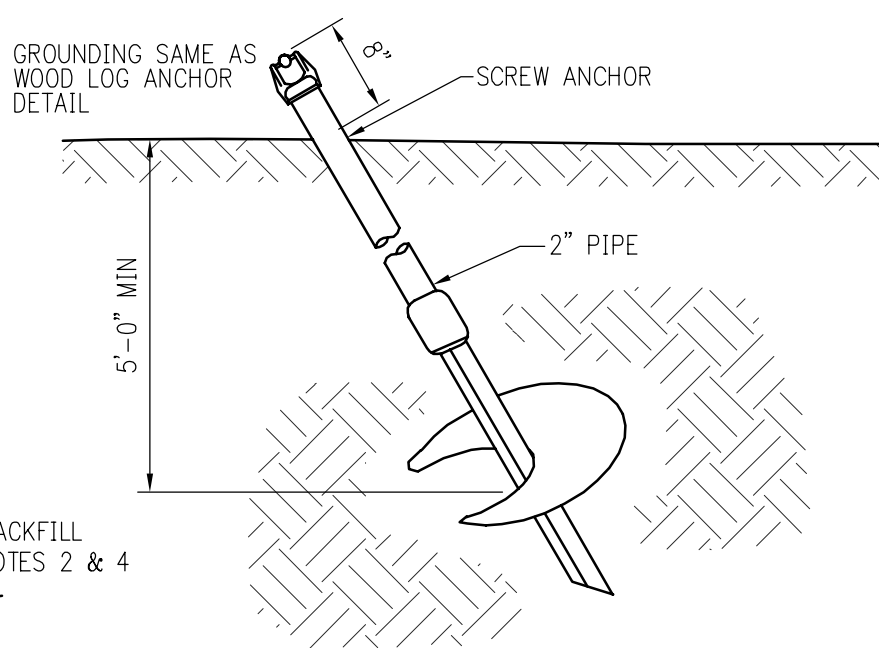
**VELCO** VERMONT ELECTRIC POWER CO., INC.  
RUTLAND, VERMONT  
WEST RUTLAND - NEW HAVEN 345 KV

CROSSARM DETAILS			
SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	
DATE: 11/05	CHECKED BY: KAW		DATE
DRAWING NUMBER: 345-9.0			1
PLOT: 1=1			REV.

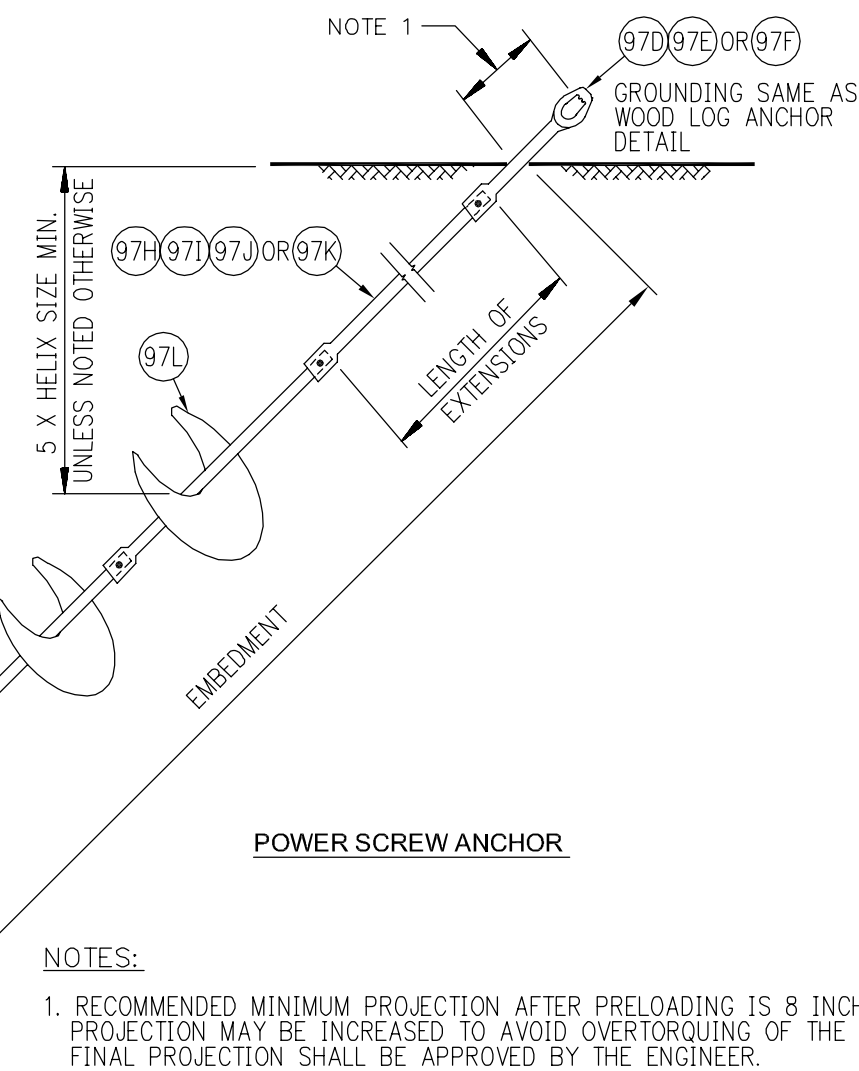
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**WOOD LOG ANCHOR**



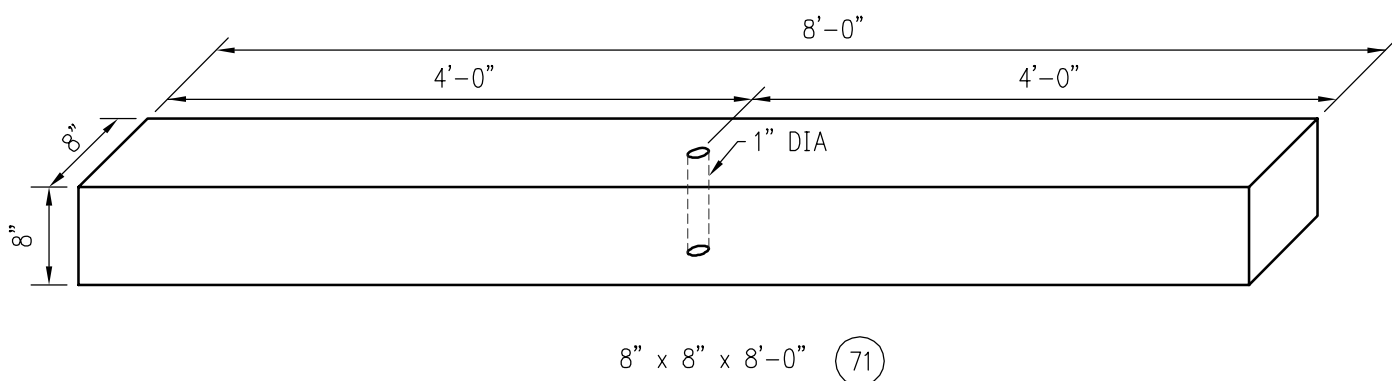
**SWAMP ANCHOR**  
SWAMP ANCHORS TO BE INSTALLED BY HAND & USED FOR STRUCTURE STABILIZATION ONLY.



**POWER SCREW ANCHOR**

**NOTES:**

1. RECOMMENDED MINIMUM PROJECTION AFTER PRELOADING IS 8 INCHES. PROJECTION MAY BE INCREASED TO AVOID OVERTORQUING OF THE SHAFT. FINAL PROJECTION SHALL BE APPROVED BY THE ENGINEER.
2. CONTRACTOR SHALL INSTALL SCREW ANCHORS IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS.



8" x 8" x 8'-0" (71)

- NOTES:**
1. FOR INDIVIDUAL STRUCTURE GUYING AND GROUNDING DETAILS, SEE DRAWINGS #345-10.2 AND #345-11.0
  2. SET ANCHOR LOG FIRMLY AGAINST UNDERCUT SOIL AND COMPACT IN 8" LIFTS TO 90% OF SURROUNDING EARTH.
  3. WHEN BACKFILLING ANCHOR HOLES, A 1000 LB TENSION SHALL BE MAINTAINED ON ANCHOR ROD DURING BACKFILLING OPERATION.
  4. BACKFILL IN AREAS OF SOFT EARTH SHALL BE FRACTURED ROCK 6" OR OVER.
  5. WHEREVER POSSIBLE, THE GROUND WIRE SHALL BE MADE CONTINUOUS THRU JOINTS.

**Burns & McDonnell**  
SINCE 1908

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The revision dated 01.01.08 supercedes all revisions with an earlier revision date

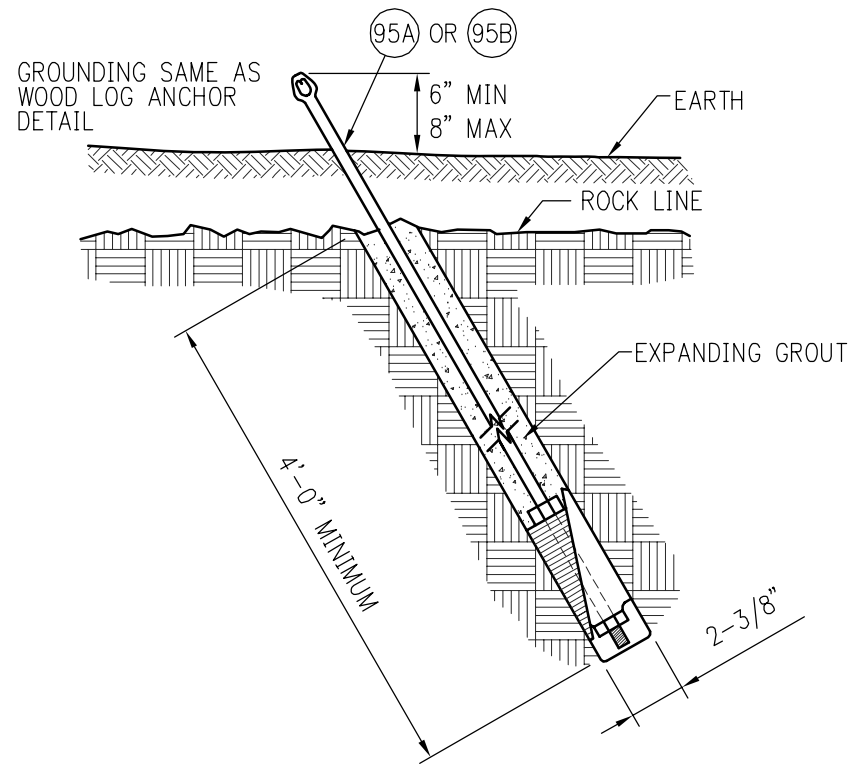
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REV	DATE	DR	CK	DESCRIPTION
1	1/01/08	JAH	JRW	CONFORMED TO CONSTRUCTION RECORDS
0	1/12/06	CJM	JRW	ISSUED FOR CONSTRUCTION

**VELCO** VERMONT ELECTRIC POWER CO., INC.  
RUTLAND, VERMONT  
WEST RUTLAND - NEW HAVEN 345

**ANCHOR AND GUY GROUNDING DETAILS**

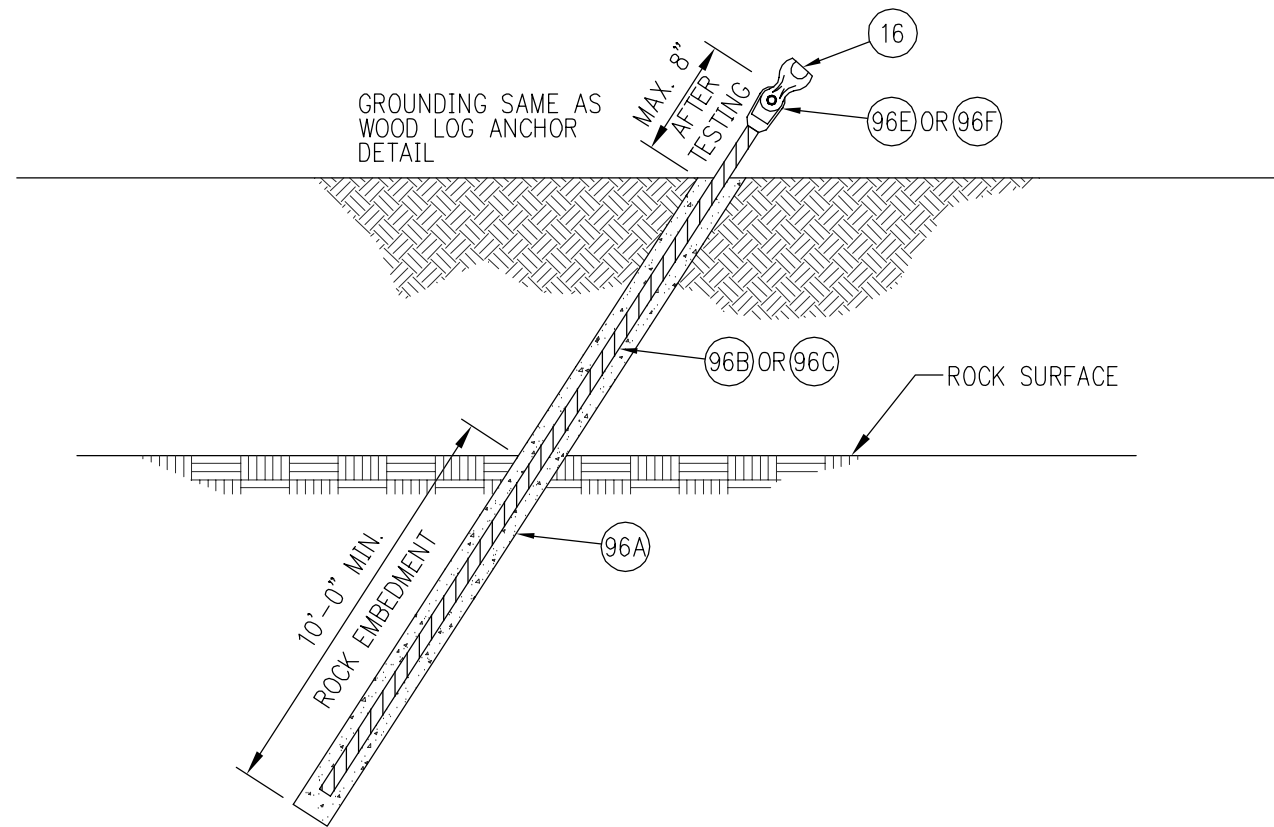
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DATE: 11/05	CHECKED BY: KAW		DATE
DRAWING NUMBER: 345-10.0			1
PLOT: 1=1			REV.



**EXPANDING ROCK ANCHOR**

**NOTES:**

1. ROCK ANCHORS TO BE INSTALLED BY TWO MEN & A 4' BAR MINIMUM.
2. ALL GROUT TO BE FRESHLY MIXED APPROVED EXPANDING GROUT.
3. ALL GROUT INSTALLATION TO BE THOROUGHLY RODDED TO PREVENT VOIDS.



**GROUTED ROCK ANCHOR**

**NOTES:**

1. ANCHOR CAPACITY FOR ROCK ANCHORS WITH #6 REBAR AND #8 REBAR ARE 20 AND 40 KIPS RESPECTIVELY.
2. DRILL HOLE DIAMETER TO BE DETERMINED BY CONTRACTOR. MINIMUM BOND AREA FOR #6 REBAR AND #8 REBAR SHALL BE 10 SQUARE FEET AND 20 SQUARE FEET RESPECTIVELY.
3. ALL-THREAD RODS AND GROUT SHALL BE INSTALLED PER MANUFACTURES RECOMMENDATION.
4. WILLIAMS FORM CONTACT INFO.  
WILLIAMS FORM ENGINEERING CORP.  
280 ANN STREET  
GRAND RAPIDS, MI 49504  
PHONE : (616) 365-9220

**Burns & McDonnell**  
SINCE 1898

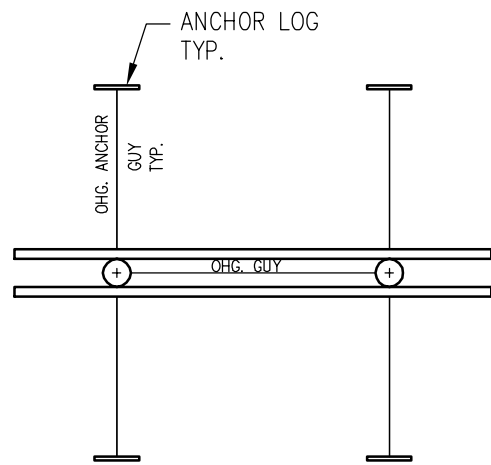
**CONFORMED TO CONSTRUCTION RECORDS**  
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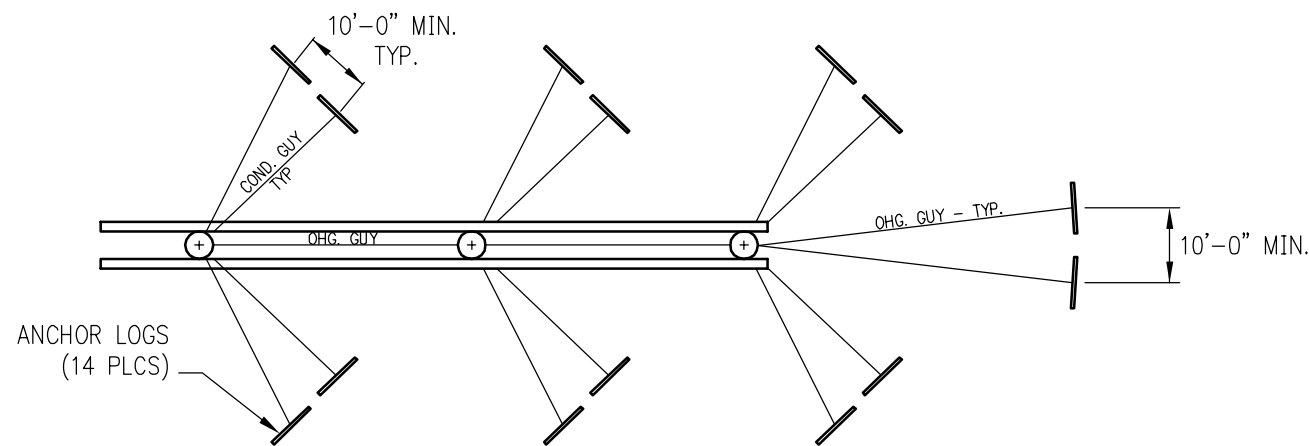
REV	DATE	DR	CK	DESCRIPTION
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0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

**VELCO** VERMONT ELECTRIC POWER CO., INC.  
RUTLAND, VERMONT  
WEST RUTLAND - NEW HAVEN 345KV

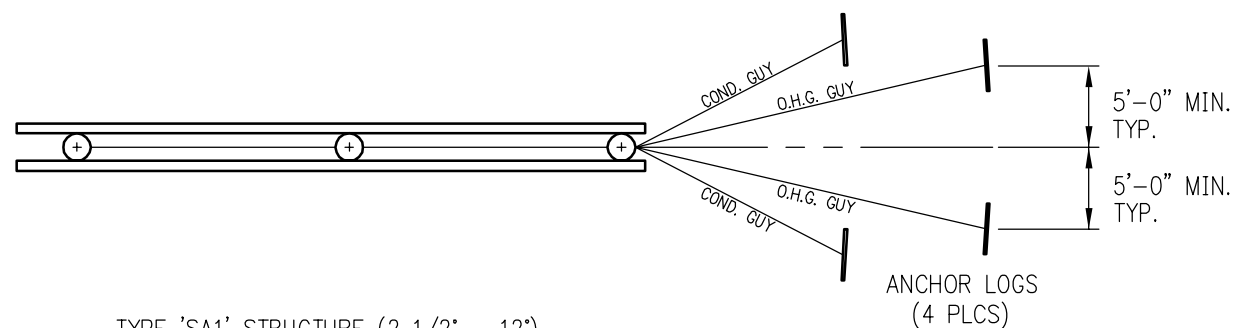
ROCK ANCHOR DETAILS			
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DATE: 11/05	CHECKED BY: KAW	DATE	
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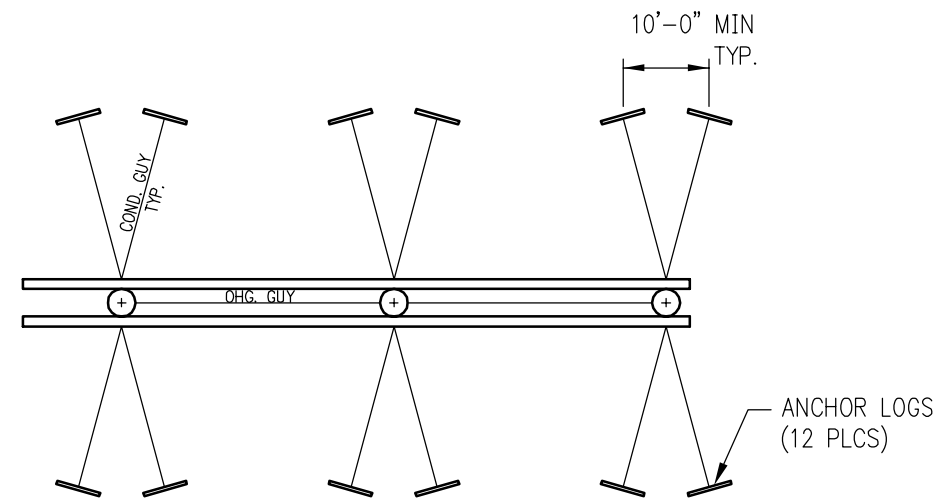
TYPE 'A' STRUCTURE (TANGENT)  
WITH DEAD-END SHIELD WIRE



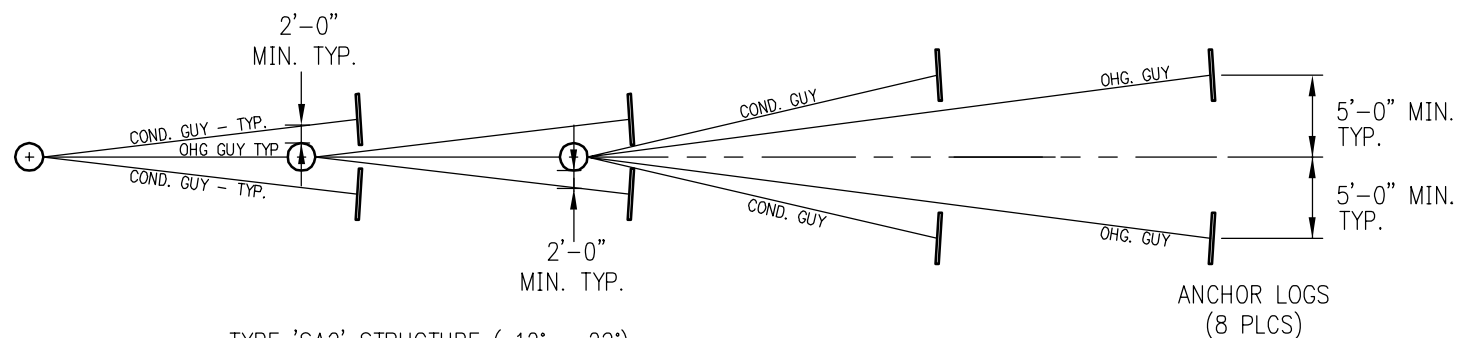
TYPE 'DE2' (35° - 55°)  
TYPE 'DE3' (55° - 75°)  
TYPE 'DE4' (75° - 90°)



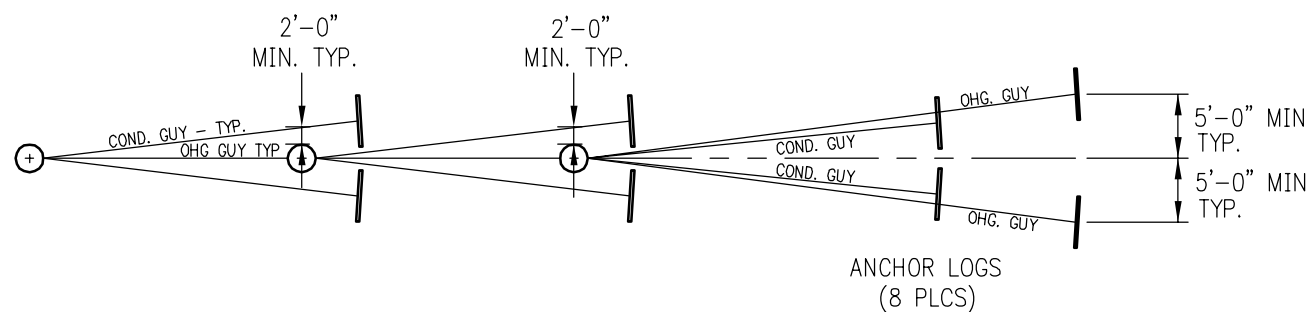
TYPE 'SA1' STRUCTURE (2 1/2' - 12')



TYPE 'DE1' STRUCTURE (DEADEND)



TYPE 'SA2' STRUCTURE (12' - 22')



TYPE 'SA3' STRUCTURE (22' - 35')

- NOTES:  
1. FOR ANCHOR DETAILS, SEE DWG. #345-10.0 & #345-10.1  
2. FOR METHOD OF GUY GROUNDING, SEE DWG. #345-11.0

**Burns & McDonnell**  
CONFORMED TO CONSTRUCTION RECORDS  
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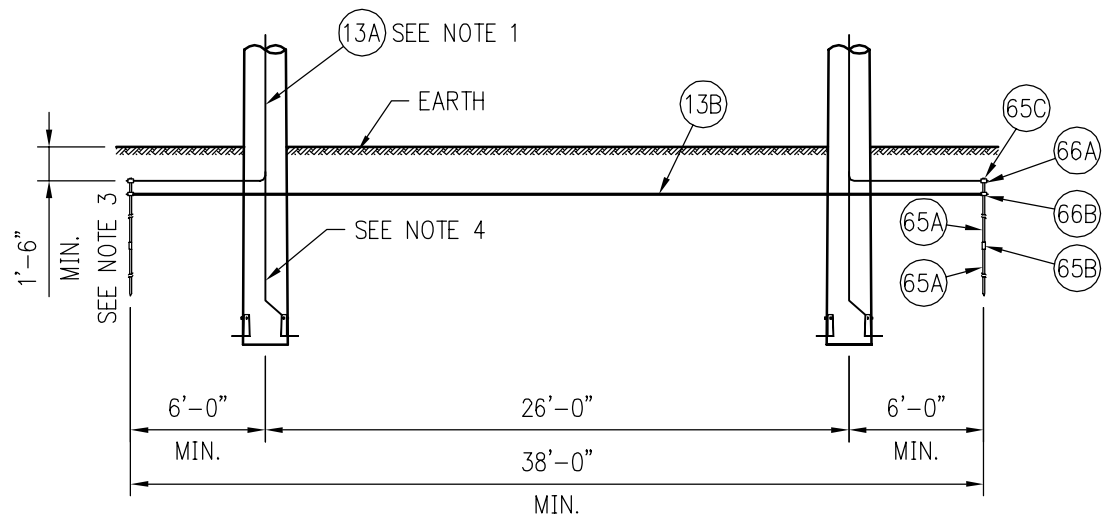
REV	DATE	DR	CK	DESCRIPTION
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0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

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RUTLAND, VERMONT  
WEST RUTLAND - NEW HAVEN 345 KV

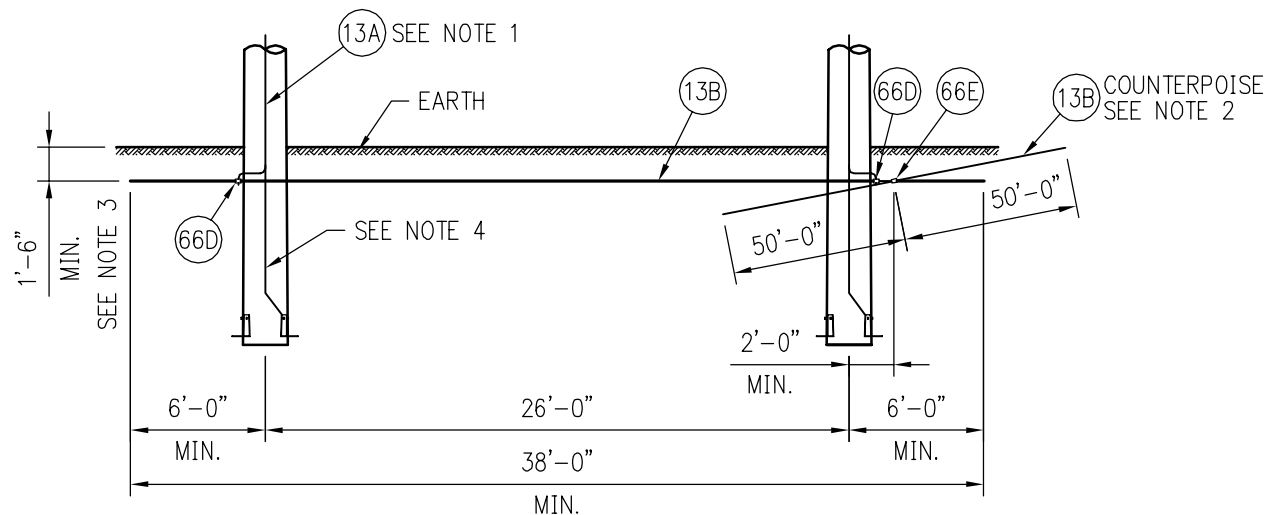
METHOD OF POLE GUYING

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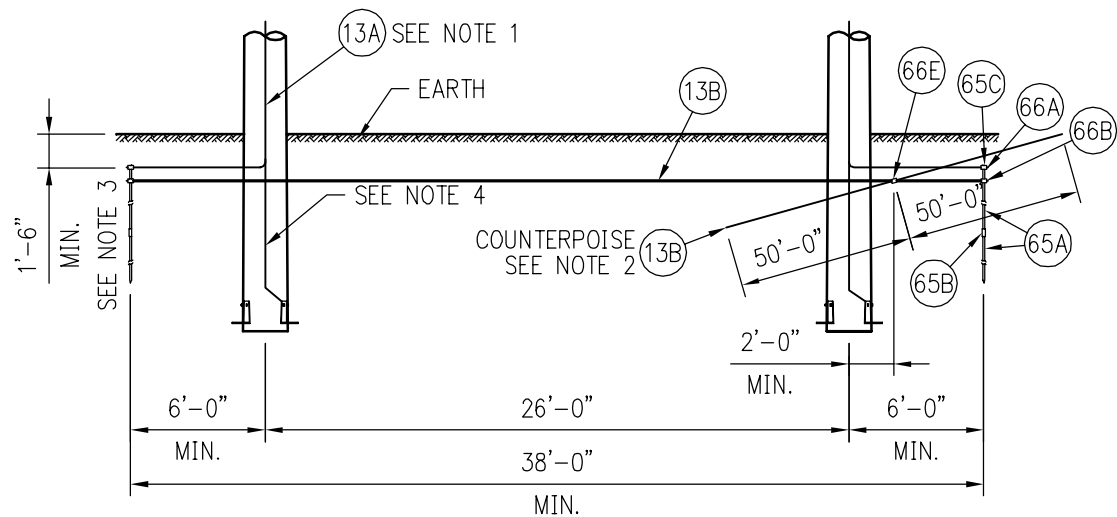
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TYPE A  
GROUND RODS



TYPE B  
COUNTERPOISE



TYPE C  
GROUND RODS & COUNTERPOISE

BILL OF MATERIALS

MARK	STOCK NO.	QUANTITY	DESCRIPTION	MANUFACTURE	CATALOG NUMBER
TYPE A					
13A		N/A	BONDING WIRE, #2 COPPER, SOLID (FT)		
13B		38	GROUND WIRE, 7 NO. 8 COPPERWELD (FT)		
65A		4	GROUND ROD, COPPER CLAD, 3/4" x 10'	BLACKBURN	7510
65B	0202330	2	COUPLER, GROUND ROD, BRONZE 3/4"	E&J DEMARK	GRC-34B
65C	0202340	AR	DRIVE HEAD, GROUND ROD, 3/4"	E&J DEMARK	DH-34
66A		2	EXOTHERMIC WELD, #2 SOLID CU TO 3/4" CU ROD	ERICO/CADWELD	
66B		2	EXOTHERMIC WELD, 7 NO. 8 COPPERWELD TO 3/4" CU ROD	ERICO/CADWELD	
TYPE B					
13A		N/A	BONDING WIRE, #2 COPPER, SOLID (FT)		
13B		138	GROUND WIRE, 7 NO. 8 COPPERWELD (FT)		
66D		2	EXOTHERMIC WELD, #2 SOLID CU TO 7 NO. 8 COPPERWELD	ERICO/CADWELD	
66E		1	EXOTHERMIC WELD, 7 NO. 8 COPPERWELD TO 7 NO. 8 COPPERWELD	ERICO/CADWELD	
TYPE C					
13A		N/A	BONDING WIRE, #2 COPPER, SOLID (FT)		
13B		138	GROUND WIRE, 7 NO. 8 COPPERWELD (FT)		
65A		4	GROUND ROD, COPPER CLAD, 3/4" x 10'	BLACKBURN	7510
65B	0202330	2	COUPLER, GROUND ROD, BRONZE 3/4"	E&J DEMARK	GRC-34B
65C	0202340	AR	DRIVE HEAD, GROUND ROD, 3/4"	E&J DEMARK	DH-34
66A		2	EXOTHERMIC WELD, #2 SOLID CU TO 3/4" CU ROD	ERICO/CADWELD	
66B		2	EXOTHERMIC WELD, 7 NO. 8 COPPERWELD TO 3/4" CU ROD	ERICO/CADWELD	
66E		1	EXOTHERMIC WELD, 7 NO. 8 COPPERWELD TO 7 NO. 8 COPPERWELD	ERICO/CADWELD	

NOTES:

- BONDING WIRE QUANTITY FOR STRUCTURE SHALL BE AS INDICATED ON STRUCTURE DRAWING.
- COUNTERPOISE GROUND WIRE SHALL BE 100 FOOT IN LENGTH AND SHALL BE BURIED A MINIMUM OF 1'-6" BELOW GRADE PARALLEL TO THE RIGHT-OF-WAY.
- INCREASE DEPTH TO 3'-0" IN AREAS WHERE FARMING/PLOWING COULD OCCUR.
- EXTEND GROUND WIRE TO BASE OF POLE AND ATTACH TO ANCHOR PLATE GROUND LUG.

**Burns & McDonnell**  
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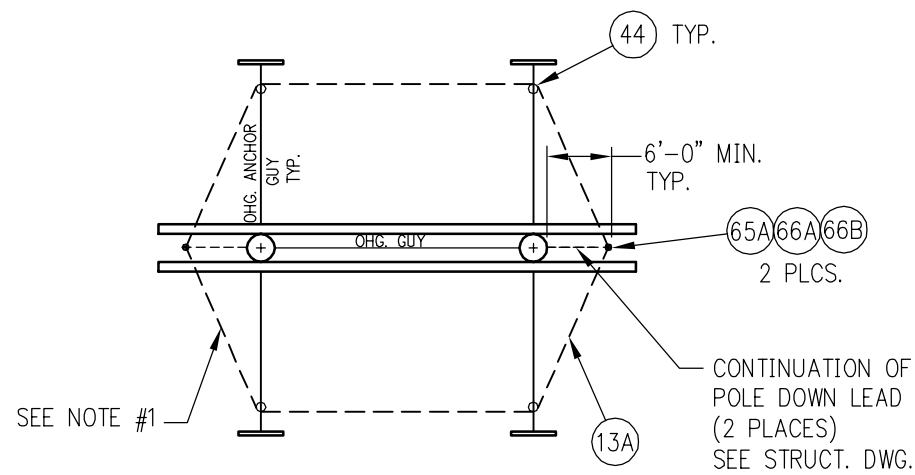
REV	DATE	DR	CK	DESCRIPTION
1	1/01/08	JAH	JRW	CONFORMED TO CONSTRUCTION RECORDS
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

**VELCO** VERMONT ELECTRIC POWER CO., INC.  
 RUTLAND, VERMONT  
 WEST RUTLAND - NEW HAVEN 345 KV

2-POLE GROUNDING DETAILS  
 TYPE A, B & C

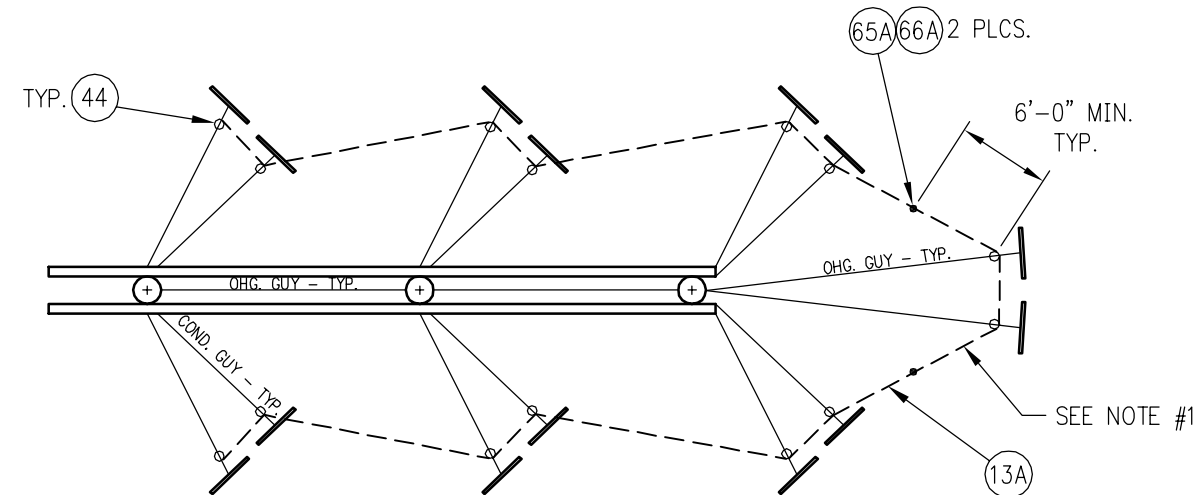
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DATE: 11/05	CHECKED BY: KAW		DATE
DRAWING NUMBER: 345-11.0		1	REV.
PLOT: 1=1			

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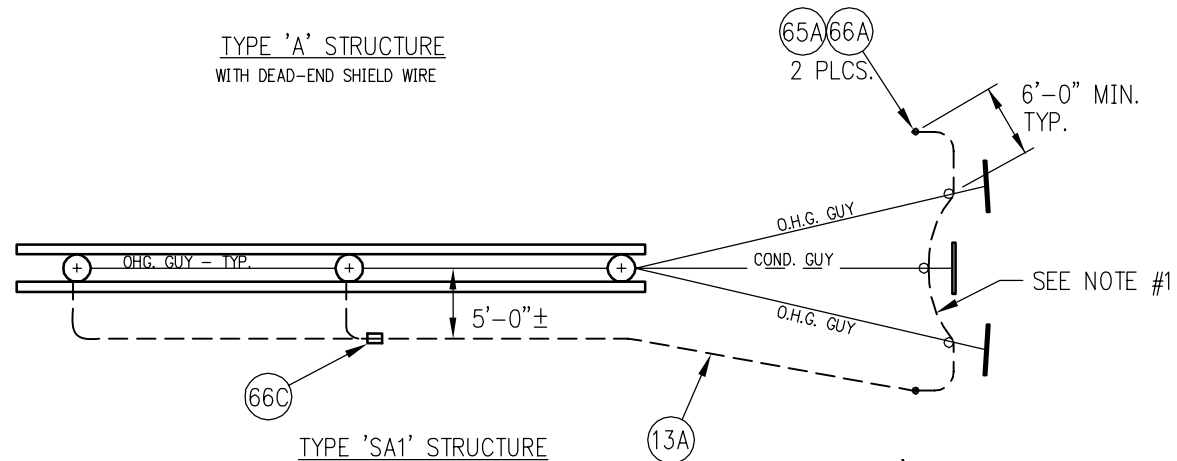


TYPE 'A' STRUCTURE  
WITH DEAD-END SHIELD WIRE

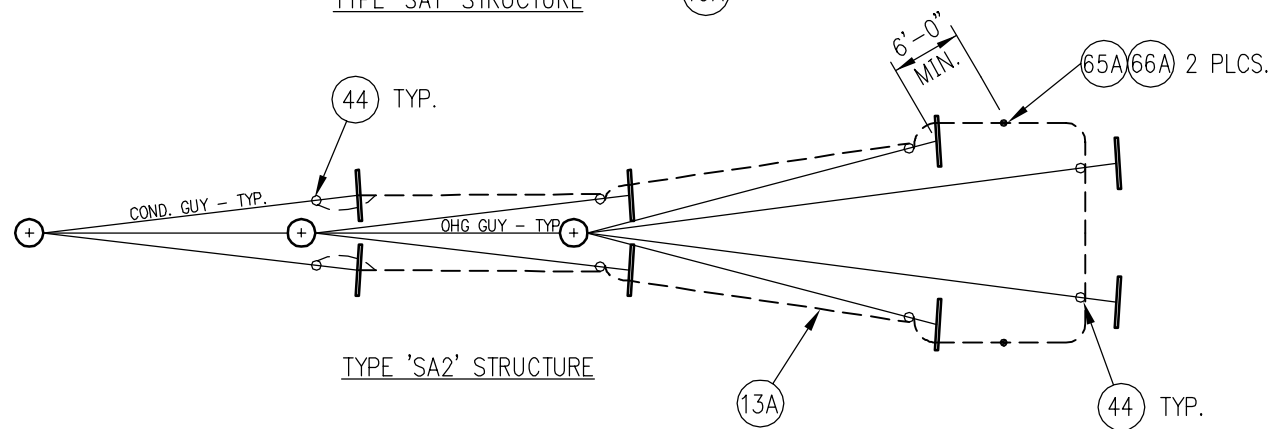
- NOTES:
- DENOTES CONTINUOUS GROUNDING WIRE BURIED 1'-6" MIN. BELOW GRADE
  - GROUND RODS TO BE DRIVEN IN UNDISTURBED EARTH AT A MIN. DISTANCE OF 6'-0" FROM POLES AND ANCHORS.
  - FOR GROUNDING DETAILS, ITEM DESCRIPTION & QUANTITY SEE DWG. #345-10.0 & SPECIFIC STRUCTURE B/M.
  - LOCATION OF BURIED COUNTERPOISE TO STRUCTURE GROUND CONNECTION TO BE AS REQUIRED BY FIELD CONDITIONS.



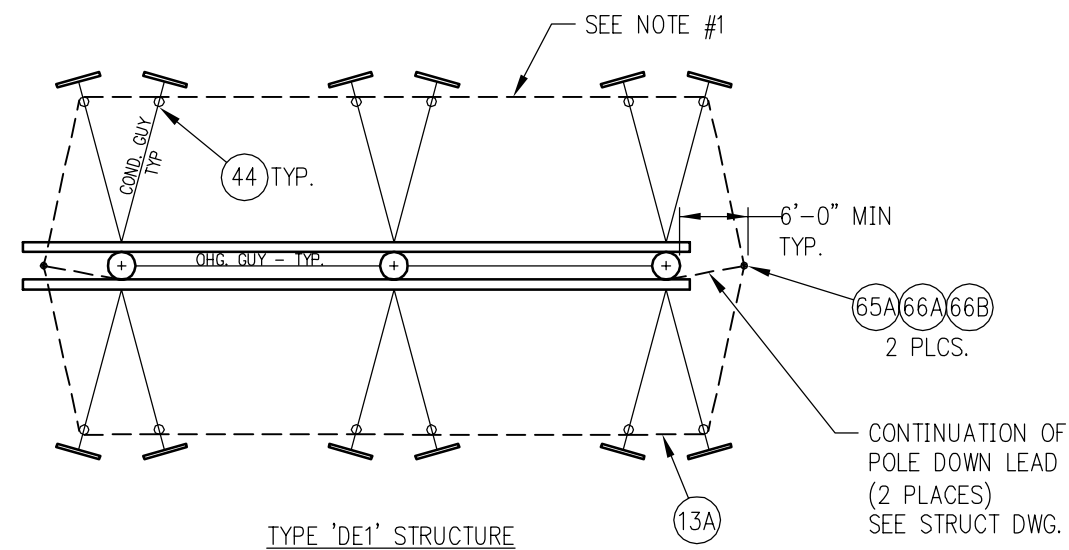
TYPE 'DE2', 'DE3', & 'DE4' STRUCTURES



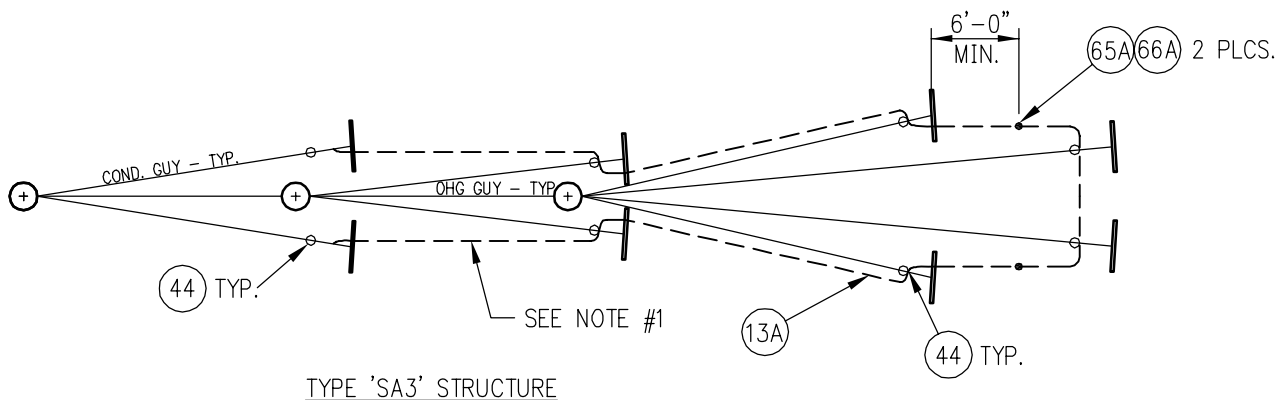
TYPE 'SA1' STRUCTURE



TYPE 'SA2' STRUCTURE



TYPE 'DE1' STRUCTURE



TYPE 'SA3' STRUCTURE

**Burns & McDonnell**  
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0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

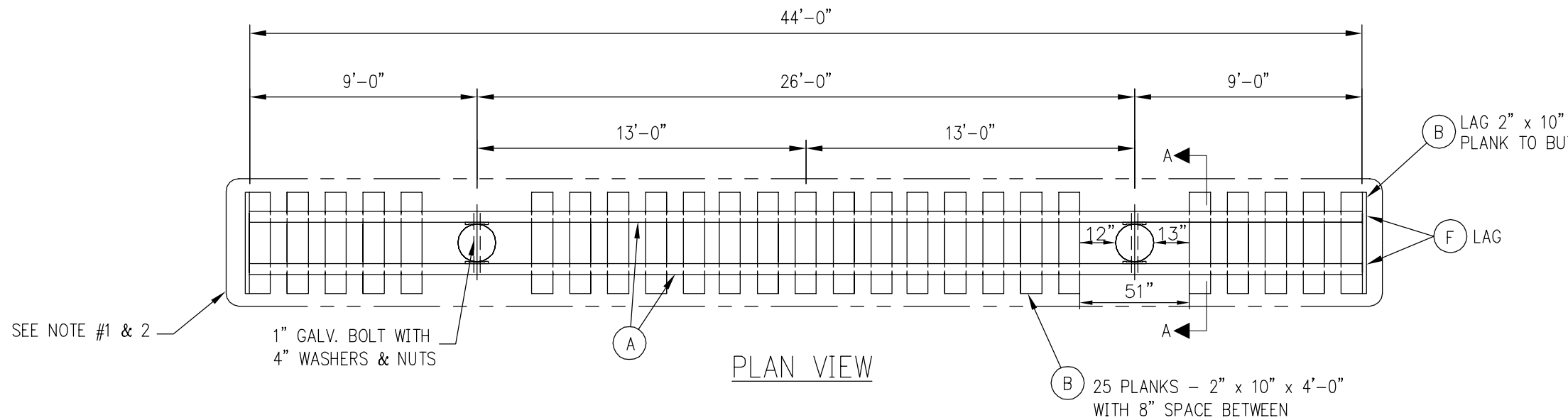
**VELCO** VERMONT ELECTRIC POWER CO., INC.  
 RUTLAND, VERMONT  
 WEST RUTLAND - NEW HAVEN 345 KV

**METHOD OF POLE AND GUY GROUNDING**

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	
DATE: 11/05	CHECKED BY: KAW		DATE

DRAWING NUMBER: 345-11.1  
 PLOT: 1=1

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SEE NOTE #1 & 2

1" GALV. BOLT WITH  
4" WASHERS & NUTS

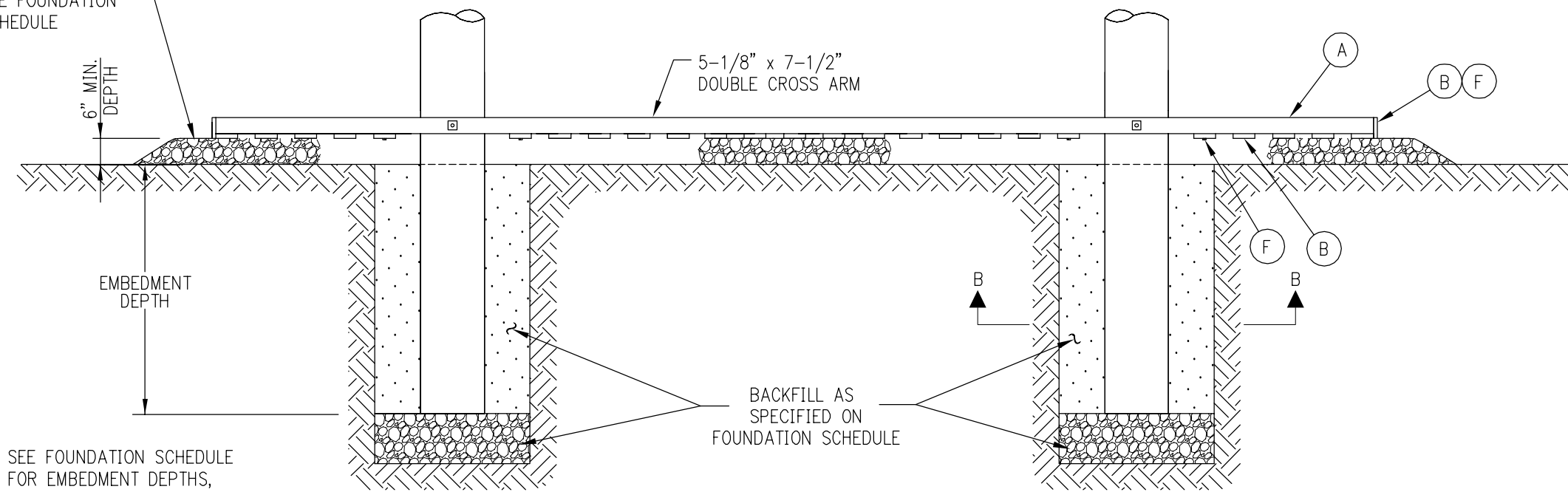
PLAN VIEW

(B) 25 PLANKS - 2" x 10" x 4'-0"  
WITH 8" SPACE BETWEEN

(B) LAG 2" x 10" x 4'-0"  
PLANK TO BUTT

(F) LAG

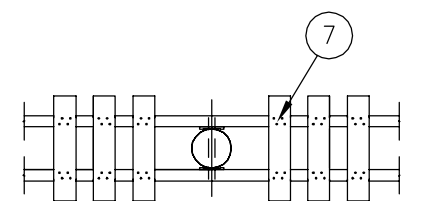
CRUSHED STONE  
NOTE #1 & 2  
SEE FOUNDATION  
SCHEDULE



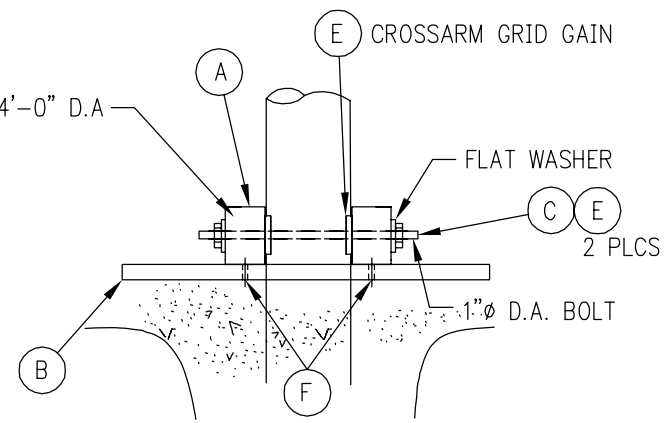
ELEVATION VIEW

SEE FOUNDATION SCHEDULE  
FOR EMBEDMENT DEPTHS,  
EXCAVATION, AND DIMENSIONS

BACKFILL AS  
SPECIFIED ON  
FOUNDATION SCHEDULE



SECTION B-B



SECT. A-A

BILL OF MATERIALS				
MARK	MNF	MNF #	QUAN.	DESCRIPTION
A	HUGHES		2	CROSSARM, LAMINATED, 5-1/8"x 7-1/2"x 44'-0"
B	HUGHES		27	PLANK, WOOD, 2"x 10"x 4' TREATED
C	HUGHES	TR10XX-F	2	BOLT, DBL. ARMING, 1"x XX" w/ 2 NUTS
D	HUGHES	SW4-100	4	WASHER, FLAT, SQ, 4" x 1/4" F/1" BOLT
E	HUGHES	1262-B	4	GRID GAIN, 6-3/4"x 4"x 9/16" w/ 1-1/16" HOLE
F	JOSLYN	J8723	216	LAG SCREW, 1/4"x 3", GIMLET POINT

NOTES:

1. SET BOG SHOE ON TOP OF GROUND ON CRUSHED STONE MAT.
2. STONE SURFACE TO EXTEND BEYOND PLANKS.
3. CROSS MEMBERS TO BE 5-1/8" x 7-1/2" x DOUBLE CROSS ARM.
4. BOG SHOE MAY BE INSTALLED AT OR JUST BELOW GRADE IN AREAS WHERE MOWING OCCURS OR AT LAND OWNER REQUEST

**Burns & McDonnell**  
SINCE 1898

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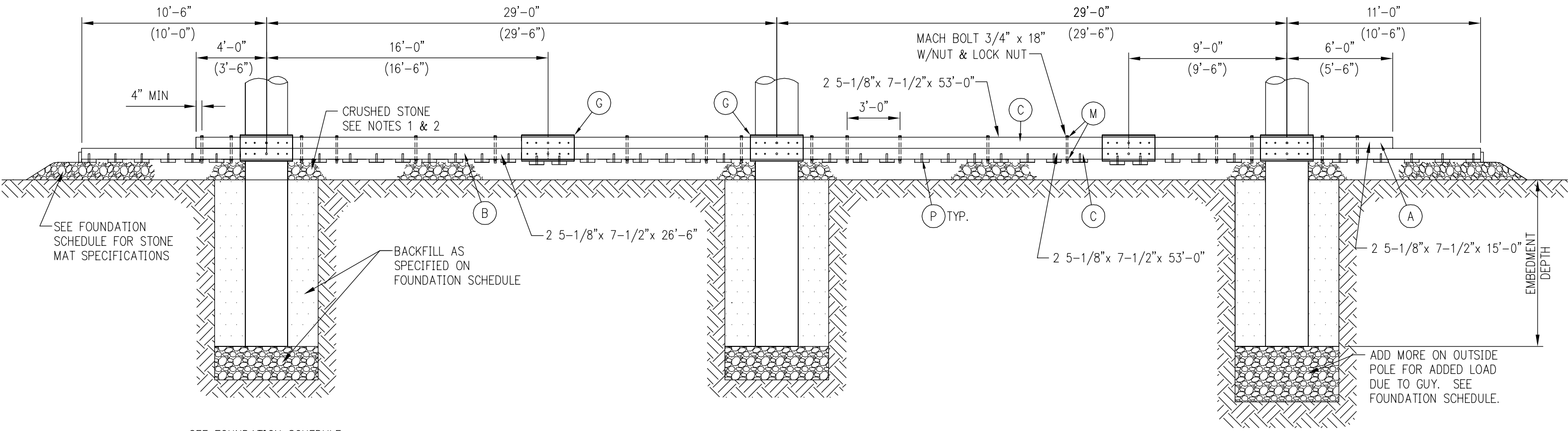
REV	DATE	DR	CK	DESCRIPTION
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0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

**VELCO** VERMONT ELECTRIC POWER CO., INC.  
RUTLAND, VERMONT  
WEST RUTLAND - NEW HAVEN 345 KV

**FOUNDATIONS AND BOG SHOE PLATFORM FOR 2 POLE STRUCTURE**

SCALE: NONE	DRAWN BY: BMCD	APPROVED BY:
DATE: 11/05	CHECKED BY: KAW	DATE:
DRAWING NUMBER: 345-13.0		1
PLOT: 1=1		REV.

FILE: N:\velco\36445-WR-NH-EP\Cadd\STANDARD\_POLES\345KV\345-13.0.dwg 02-07-2006 13:13 DSM BMD



SEE FOUNDATION SCHEDULE FOR EMBEDMENT DEPTHS, EXCAVATION, AND DIMENSIONS

ELEVATION VIEW

NOTES:

1. SET BOG SHOE ON TOP OF GROUND ON CRUSHED STONE MAT.
2. STONE SURFACE TO EXTEND BEYOND PLANKS.
3. CROSSARM MEMBERS TO BE 5-1/8" x 7-1/2" x SPECIFIED LENGTHS.
4. ALL WOOD MEMBERS TO BE DRILLED IN FIELD.
5. 5-1/8" x 7-1/2" CROSSARMS TO BE BOLTED TOGETHER WITH 3/4" BOLTS ON 4'-6" CENTERS, EXCEPT AS INDICATED.
6. DIMENSIONS IN PARENTHESES ARE FOR A 29'-6" POLE SPACING.
7. BOG SHOE MAY BE INSTALLED AT OR JUST BELOW GRADE IN AREAS WHERE MOWING OCCURS OR AT LAND OWNER REQUEST

BILL OF MATERIALS

MARK	STOCK NO.	QUANTITY	DESCRIPTION	MANUFACTURER	CATALOG NUMBER
A		2	CROSSARM, WOOD, LAM, 5-1/8"x7-1/2"x15'-0"	HUGHES	
B		2	CROSSARM, WOOD, LAM, 5-1/8"x7-1/2"x26'-6"	HUGHES	
C		4	CROSSARM, WOOD, LAM, 5-1/8"x7-1/2"x53'-0"	HUGHES	
D		23	PLANK, WOOD, TREATED, 2"x 10"x 5'-0"		
E		21	PLANK, WOOD, TREATED, 2"x 10"x 6'-0"		
G		10	PLATE, SPLICE & CROSSARM ATTACHMENT TO POLE, CHANNEL, STEEL, MC 18" x4" x42.7, 3'-0" LONG, WITH 8 3/4" HOLES AND 2 15/16" HOLES, PER VELCO DWG #345-14.1		
H		32	BOLT, MACHINE, GALV, 5/8" x8"	HUGHES	B68-4
I		36	BOLT, MACHINE, GALV, 3/4" x18"	HUGHES	B718-6
F		48	SCREW, LAG, 5/8" x5", FETTER DRIVE REG. POINT	JOSLYN	J8765
J		6	ROD, THREADED, GALV, 7/8" xXX", W/ 2 NUTS	HUGHES	TR8XX-F
K		12	GAIN, GRID, 6-3/4" x4", W/ HOLE F/7/8" BOLT	HUGHES	1261-A
L		32	WASHER, SQUARE, FLAT, 3"x3"x1/4", W/HOLE F/5/8" BOLT	HUGHES	SW3-60
M		72	WASHER, SQUARE, FLAT, 3"x3"x1/4", W/HOLE F/3/4" BOLT	HUGHES	SW3-70
N		32	NUT, LOCK, SQ., GALV., FOR 5/8" BOLT	HUGHES	MF60
O		12	NUT, LOCK, SQ., GALV., FOR 7/8" BOLT	HUGHES	MF80
P		352	SCREW, LAG, 1/4"x3", GIMLET POINT	JOSLYN	J8723

**Burns & McDonnell**  
**CONFORMED TO CONSTRUCTION RECORDS**  
 The revision dated 01.01.08 supercedes all revisions with an earlier revision date

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1	1/01/08	JAH	JRW	CONFORMED TO CONSTRUCTION RECORDS
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION
REV	DATE	DR	CK	DESCRIPTION

**VELCO** VERMONT ELECTRIC POWER CO., INC.  
 RUTLAND, VERMONT  
 WEST RUTLAND - NEW HAVEN 345 KV

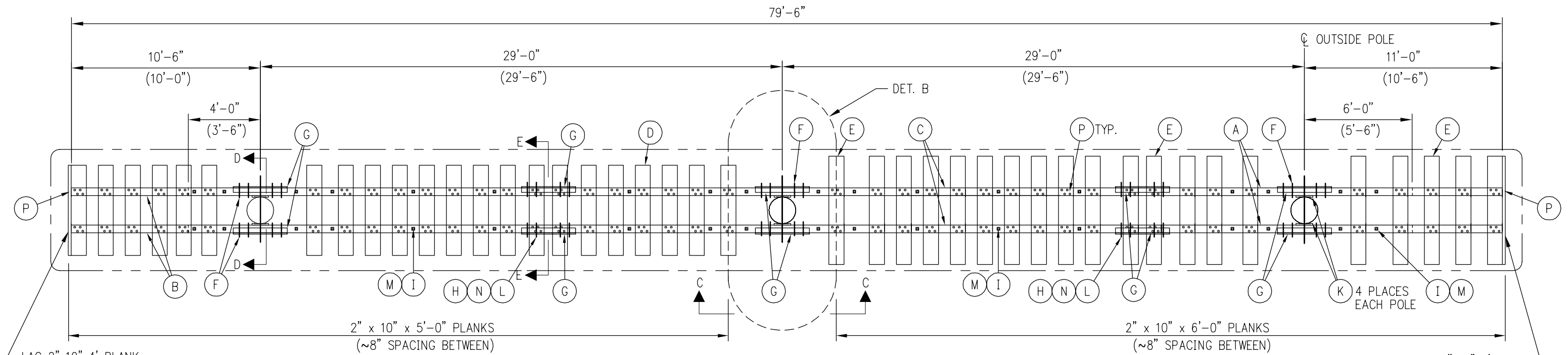
**BOG SHOE PLATFORM FOR 3 POLE STRUCTURE**  
**29'-0" & 29'-6" POLE SPACING**

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:
DATE: 11/05	CHECKED BY: KAW	DATE:

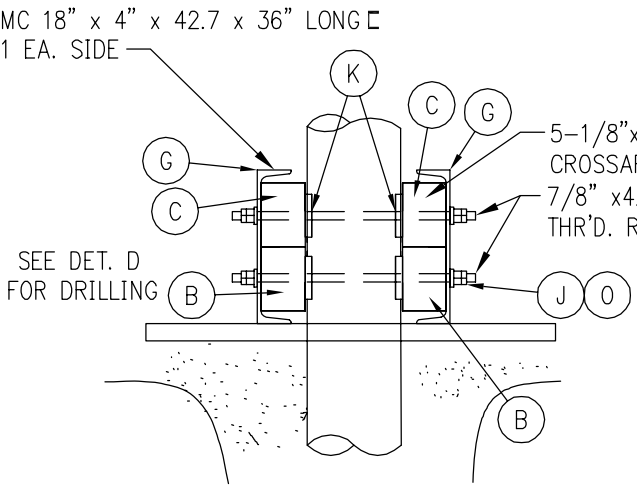
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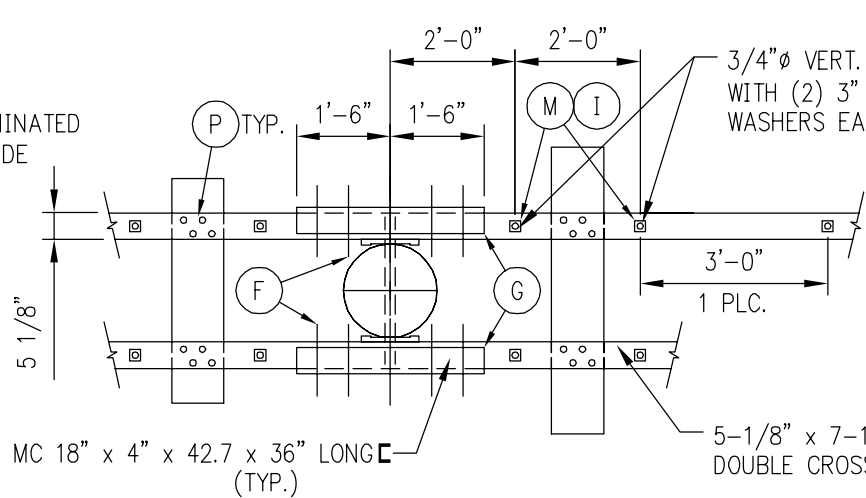




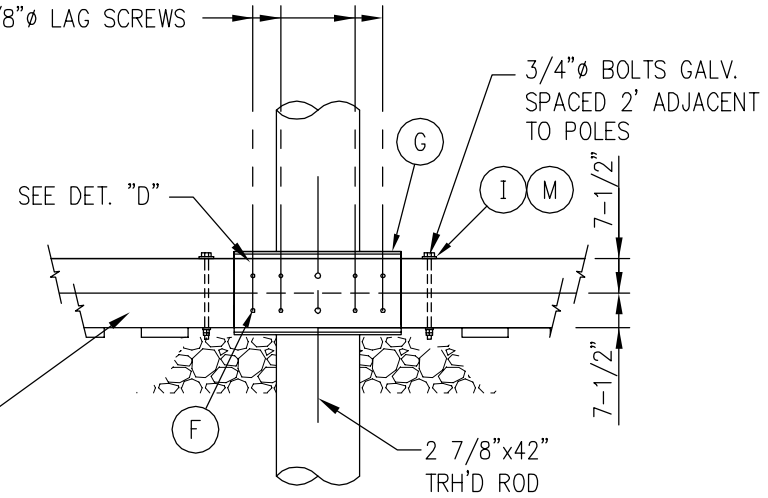
PLAN VIEW



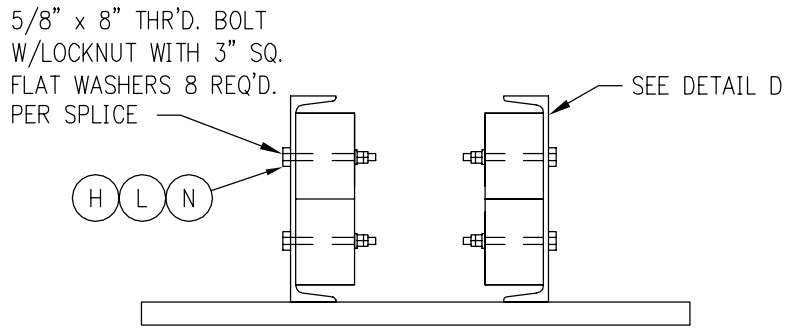
SECT. D-D



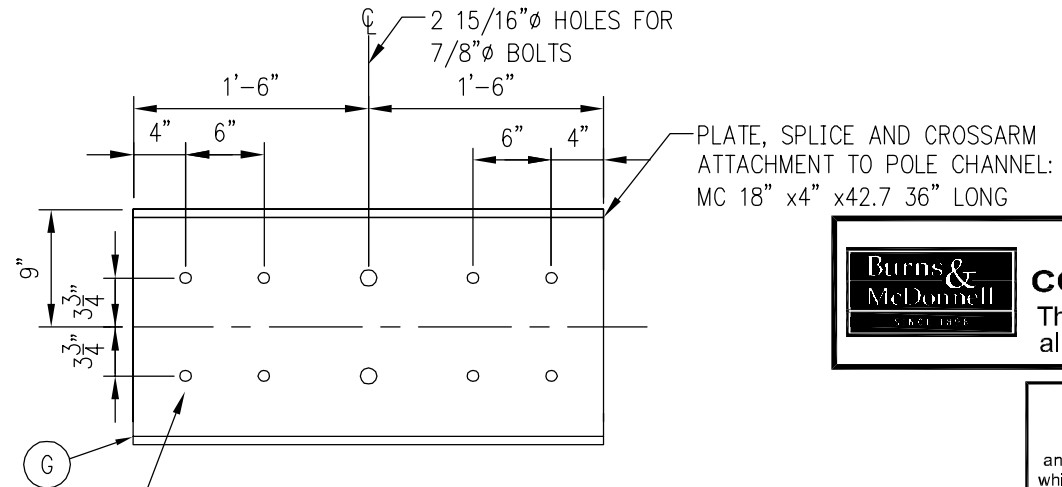
DET. B



SECT. C-C



SECT. E-E



DET. D

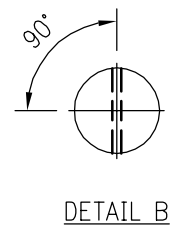
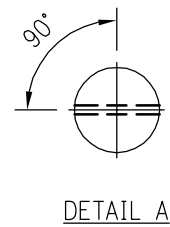
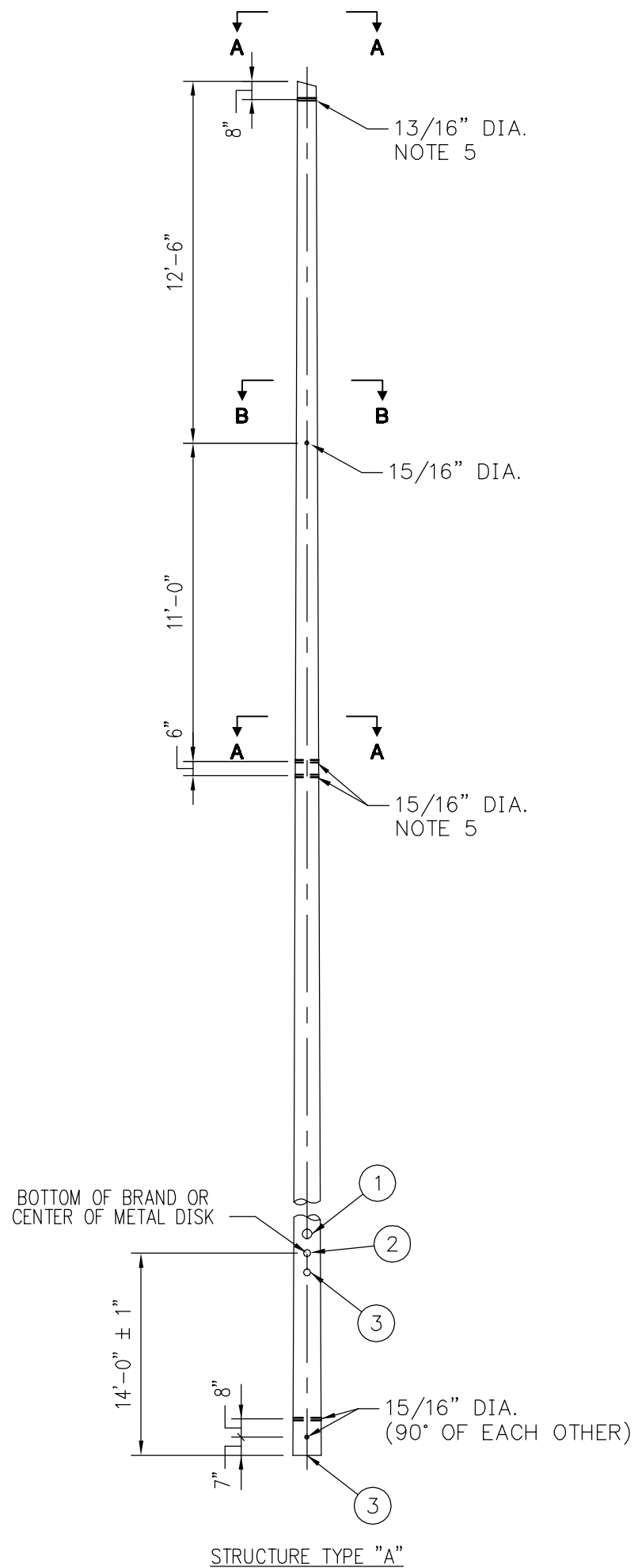
**CONFORMED TO CONSTRUCTION RECORDS**  
 The revision dated 01.01.08 supercedes all revisions with an earlier revision date

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REV	DATE	DR	CK	DESCRIPTION
1	1/01/08	JAH	JRW	ISSUED FOR CONSTRUCTION
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

<b>VELCO</b>		VERMONT ELECTRIC POWER CO., INC. RUTLAND, VERMONT	
WEST RUTLAND - NEW HAVEN 345 KV			
<b>BOG SHOE PLATFORM FOR 3 POLE STRUCTURE</b> 29'-0' & 29'-6" POLE SPACING			
SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	
DATE: 11/05	CHECKED BY: KAW	DATE	
DRAWING NUMBER: 345-14.1		1 REV.	



**NOTES:**

1. POLES AND TREATMENT SHALL CONFORM TO RUS SPECIFICATIONS ON WOOD POLES.
  2. ALL POLES TREATED FULL LENGTH MUST BE BORED (EXCEPT WHERE OTHERWISE SPECIFIED) AND ROOFED BEFORE TREATMENT.
  3. PROVIDE SLOPED ROOFS AT AN ANGLE OF 15°.
  4. POLES IN EACH STRUCTURE SHALL BE MATCHED IN SIZE, STRENGTH AND STRAIGHTNESS.
  5. THRU BOLT HOLES MUST BE PARALLEL AND IN THE SAME PLANE.
- ① MANUFACTURES MARK AND DATE OF TREATMENT.  
(IF INSURED WARRANTED, BRAND "IW")
- ② BRAND WITH SPECIES, PRESERVATIVE CODE AND RETENTION.
- ③ BRAND WITH PROPER LENGTH AND CLASS.

**Burns & McDonnell**  
SINCE 1898

**CONFORMED TO CONSTRUCTION RECORDS**

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1	1/01/08	JAH	JRW	CONFORMED TO CONSTRUCTION RECORDS
0	1/12/06	CJM	JRW	ISSUED FOR CONSTRUCTION

**VELCO** VERMONT ELECTRIC POWER CO., INC.  
RUTLAND, VERMONT  
WEST RUTLAND - NEW HAVEN

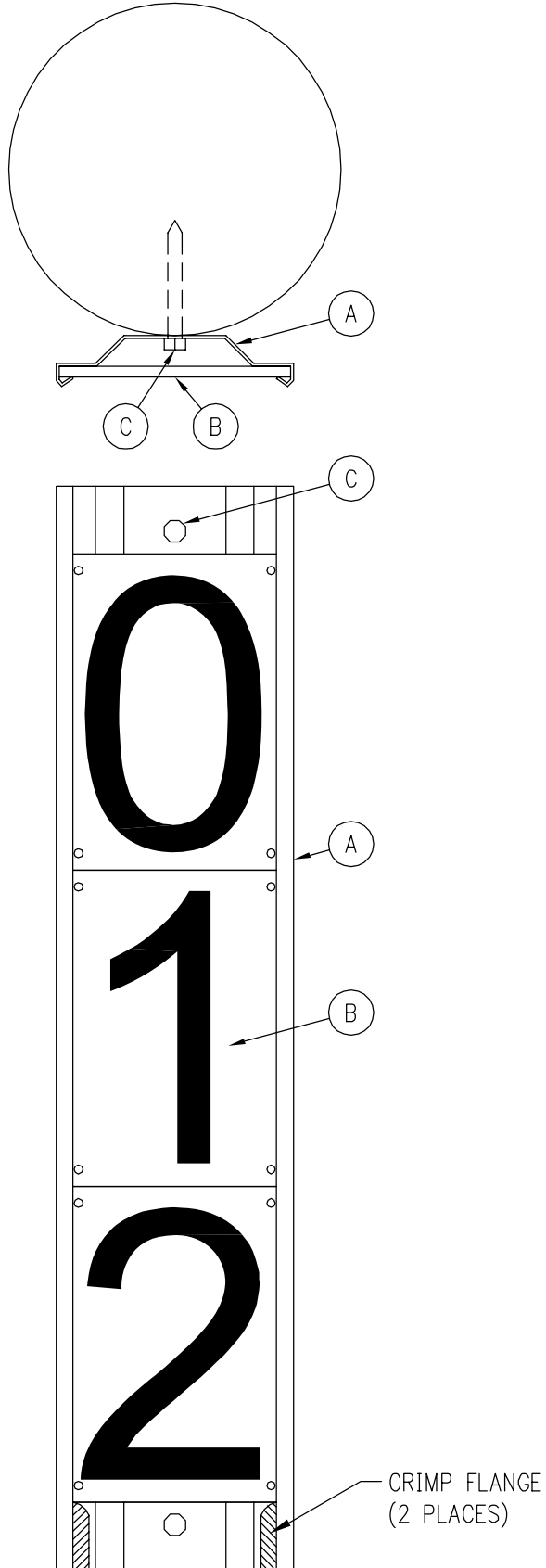
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DATE:	CHECKED BY:	DATE

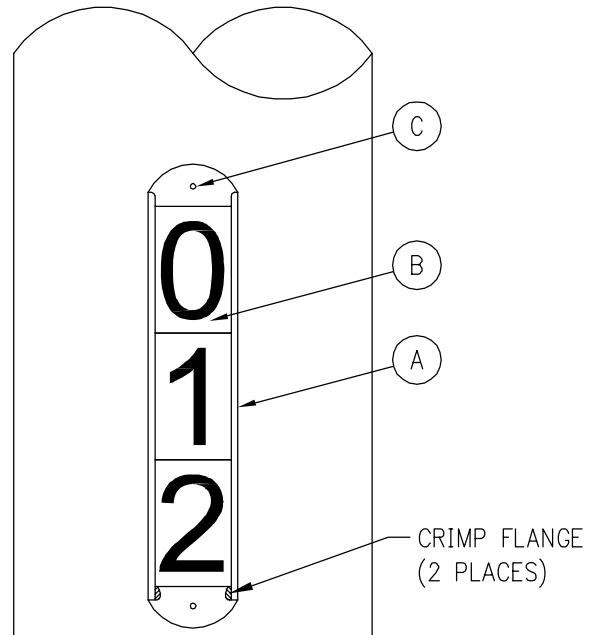
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PLOT: 1=1

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REV.

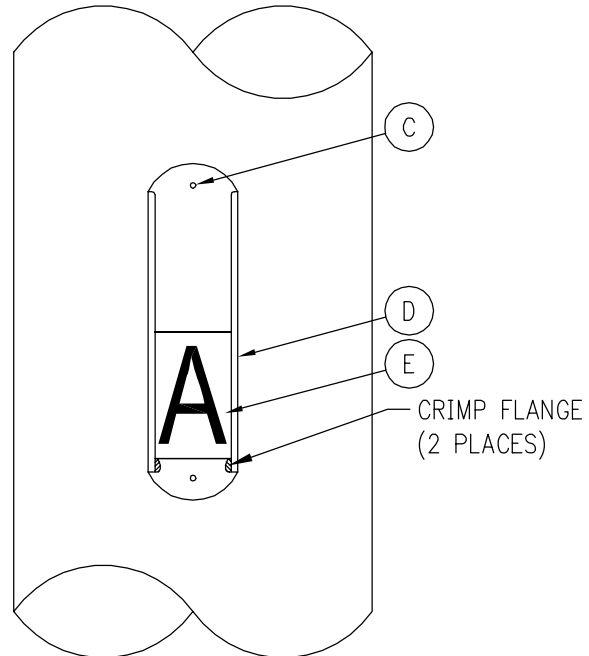
BILL OF MATERIALS					
MARK	STOCK NO.	QUANTITY	DESCRIPTION	MANUFACTURER	CATALOG NUMBER
AERIAL PATROL SIGN					
A		2	BRACKET, SIGN MOUNTING, 3 6" CHARACTERS, VERTICAL	TECH PRODUCTS	AHE603VP
B		6	CHARACTER, NUMBER, 6", BLACK W/ YELLOW BACKGROUND	TECH PRODUCTS	EL6KYxxx
C		4	LAG SCREW, 1/4" x 2" W/ NEOPRENE BACKED STEEL WASHER	JOSLYN	J26486.1
STRUCTURE NUMBER SIGNS					
A		1	HOLDER, TAG, ALUMINUM, 3 2" CHARACTERS, VERTICAL	TECH PRODUCTS	AH203VP
B		3	CHARACTER, NUMBER, 2" BLACK W/ YELLOW BACKGROUND	TECH PRODUCTS	EL2KYxxx
C		AR	NAIL, ALUMINUM, SPIRAL SHANK	TECH PRODUCTS	NALSP15
D		AR	HOLDER, TAG, ALUMINUM, 2 2" CHARACTERS, VERTICAL	TECH PRODUCTS	AH202VP
E		AR	CHARACTER, LETTER, 2" BLACK W/ YELLOW BACKGROUND	TECH PRODUCTS	EL2KYx



AERIAL PATROL SIGN



SN #1



SN #2

STRUCTURE NUMBER SIGNS

**Burns & McDonnell**  
SINCE 1938

**CONFORMED TO CONSTRUCTION RECORDS**  
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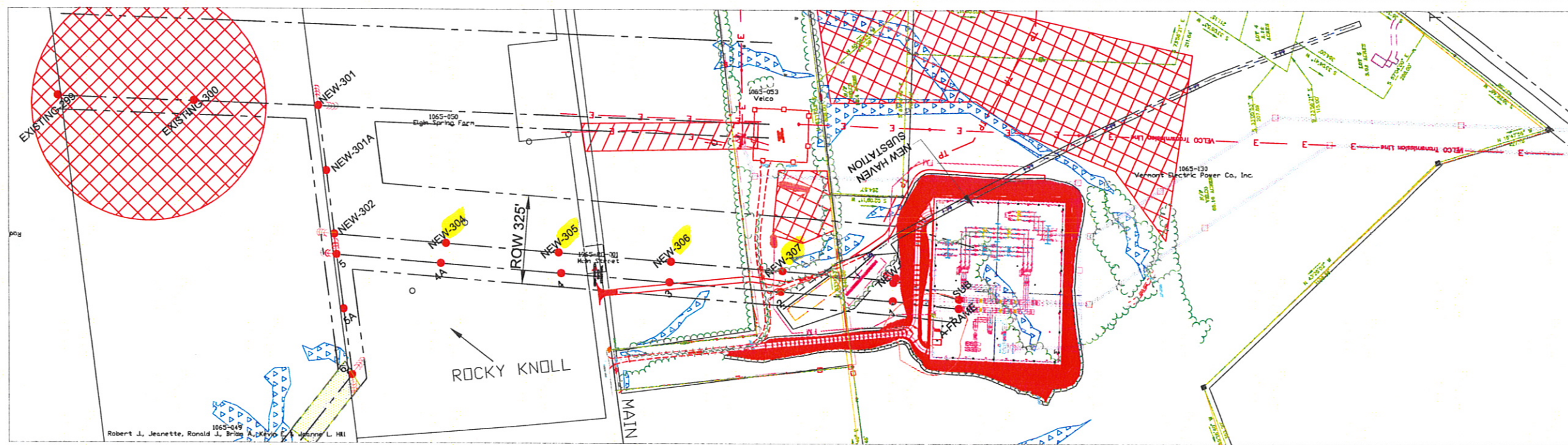
REV	DATE	DR	CK	DESCRIPTION
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0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

**VELCO** VERMONT ELECTRIC POWER CO., INC.  
RUTLAND, VERMONT  
WEST RUTLAND - NEW HAVEN 345KV

**AERIAL PATROL & STRUCTURE NUMBER SIGNS**

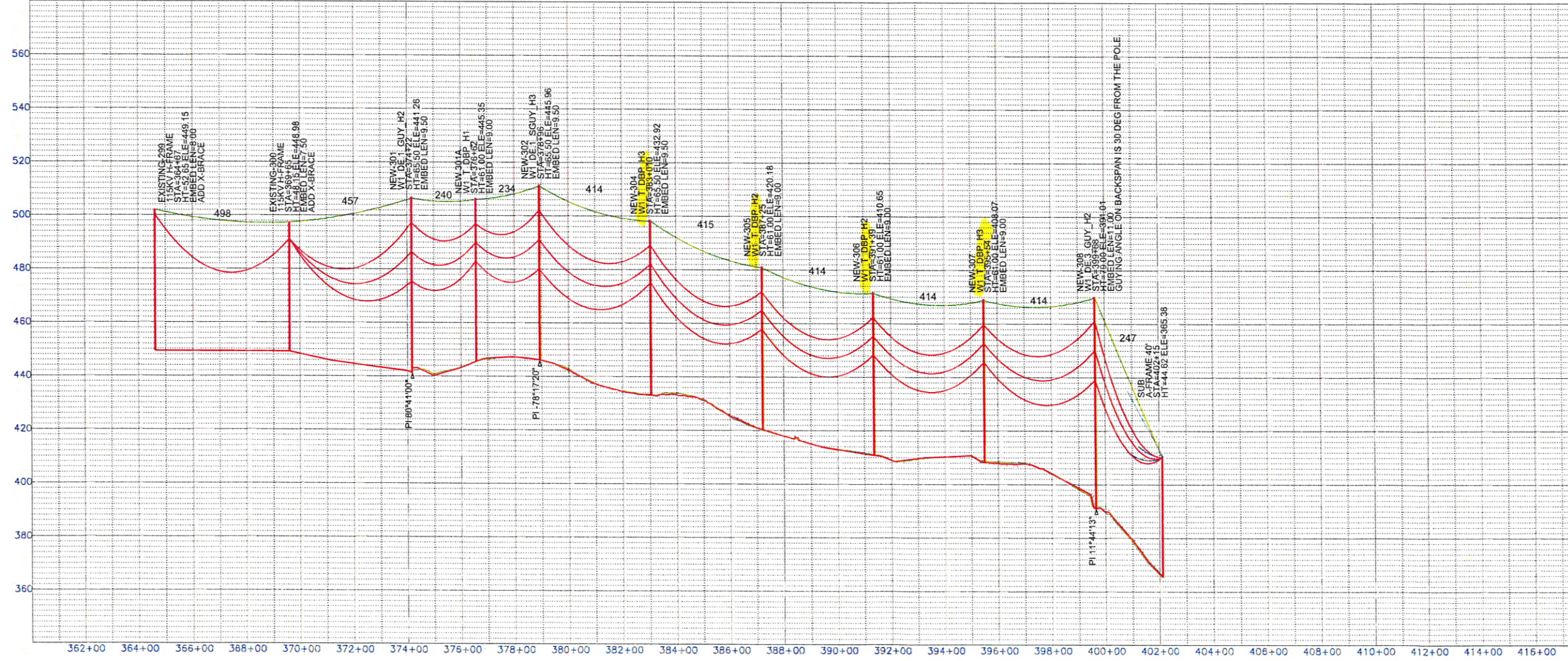
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PLOT: 1=1			REV.

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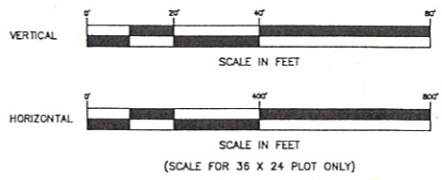


**LEGEND**

- 115KV STRUCTURES
- GUY ANCHOR
- ▨ ARCHEOLOGICAL SITE
- ▨ ARCHEOLOGICAL SENSITIVE
- ▭ R.I.N.A.
- ▨ WETLANDS
- ▲ VSWI
- ROADS
- - - RAILROAD
- RTE
- STREAM
- ▨ SELECTIVE CLEARING
- PROPERTY LINE
- GMP STRUCTURES
- - - EDGE T-LINE
- - - RIGHT-OF-WAY
- - - EDGE RR RIGHT-OF-WAY



← NORTH



**NOTES:**  
 1) CONDUCTOR SAG SHOWN AT 212° F  
 OPGW SAG SHOWN AT -20° F  
 2) A SOLID PROFILE LINE IS THE CENTERLINE OF CONSTRUCTION  
 - - - PROFILE LINE INDICATES 10FT LEFT FACING INCREASING STATIONING  
 - - - PROFILE LINE INDICATES 10FT RIGHT FACING INCREASING STATIONING

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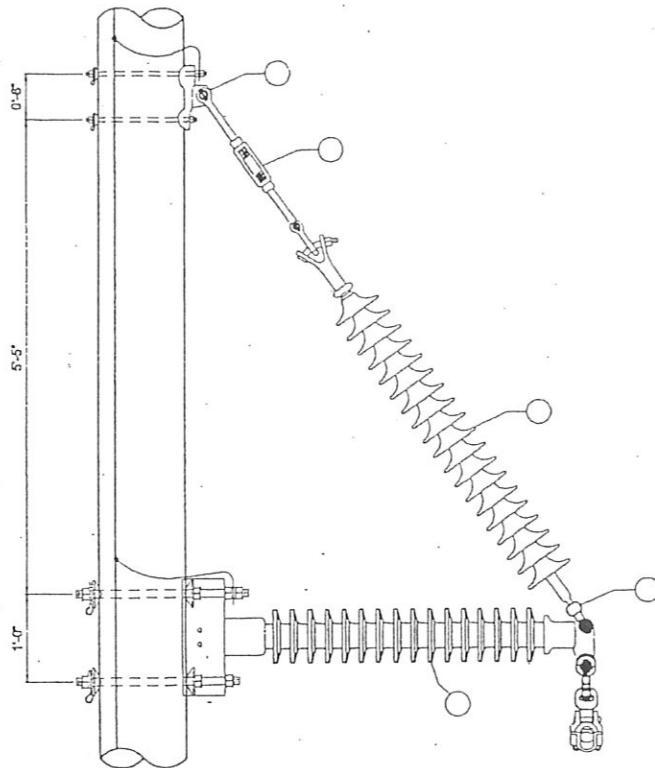
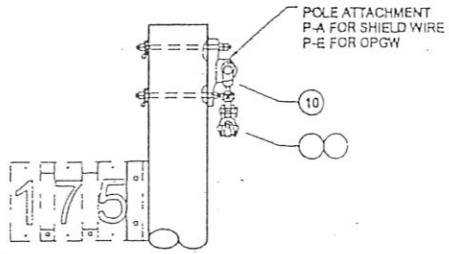
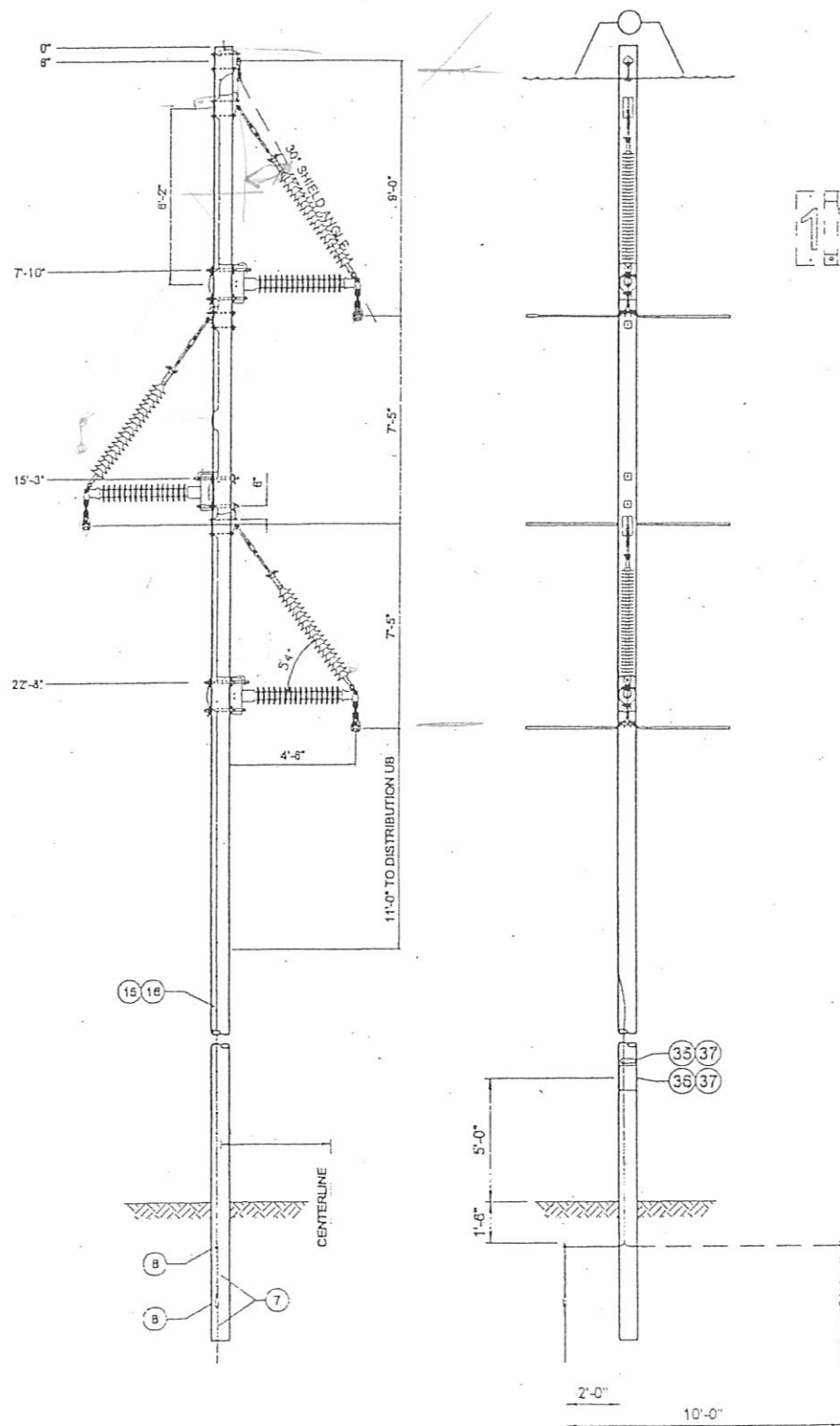


REV	DATE	DR	CK	DESCRIPTION
C	5.30.06	PD	PD	ISSUE FOR PUBLIC SERVICE BOARD REVIEW
F	4.19.06	PD	PD	ISSUE FOR PUBLIC SERVICE BOARD REVIEW
E	2.24.06	PD	PD	ISSUE FOR OPS AND AFFECTED PARTY REVIEW
D	2.08.06	PD	PD	ISSUE FOR PRELIMINARY OPS REGULATORY REVIEW
C	2.24.05	PD	PD	ISSUE FOR PRELIMINARY REGULATORY REVIEW
B	2.14.05	PD	PD	PRELIMINARY FOR REVIEW MEETING
A	11.8.05	PD	PD	PRELIMINARY SPOOTING FOR FIELD REVIEW

<b>VERMONT ELECTRIC POWER CO., INC.</b> RUTLAND, VERMONT NEW HAVEN - QUEEN CITY	<b>POWER ENGINEERS</b> 14220 LAKE ROAD ST. LOUIS, MO 63017	
<b>NEW HAVEN - QUEEN CITY 115KV LINE PLAN &amp; PROFILE</b>		
SCALE: AS SHOWN	DRAWN BY: PD	APPROVED BY: -
DATE: 5/30/06	CHECKED BY: PD	DATE: -
DRAWING NUMBER: PLOT: 1-1	L023-23X	
DESIGNED: BRH (PE)	CHECKED: MAT (PE)	DATE REV. C

FILE: NH-OC-PP-015





SPAN LENGTH LIMITS (FT)		
GALLOPING CLEARANCE	1272 ACSR	1272 ACSR WITH LWB 477 ACSR
R-S LIMIT	440	-
MAX SPAN	440	-
INSULATOR STRENGTH (MCL)=9000 LB	-	-
WEIGHT SPAN LIMIT	-	-

\* LIMITED BY SHIELD WIRE TO TOP PHASE

POLE	1	WOOD POLE SEE PLAN AND PROFILE	1	1
INSULATOR	2	504-6318 PLATE POLE EYE 20KLB 1 MTG HOLE 15/16" D	3	3
	3	504-7561 SHACKLE ANCHOR 30000# GALV	6	6
	4	504-5922 LINK-CNCTG 3/8X3/8 IN. 2 HOLE 15/16 IN D 3/8X2X9-1/2	3	3
	5	502-5135 INSUL. SUSP DE 138KV COMP 30/15K 67 3-68" LG Y-CLV BALL	3	3
	6	504-3373 CLEVELIS-SOCKET 30KLB	3	3
	7	502-3802 INSUL. LINEPOST 138KV HORIZ COMP. 2H BLADE	3	3
GROUNDING	8	513-4062 CLIP-BONDING GRD WIRE 3/4" OVER NUT	1	-
	9	513-4061 CLIP-BONDING GRD WIRE 5/8" OVER NUT	1	1
	10	513-4053 CLIP-BONDING GRD WIRE 7/8" BOLT OVER NUT	6	6
	11	513-4441 CONN-CU 6SOL-4STR/4SOL-4STR	2	-
	12	513-9562 CONN-WEDGE BLUE 3/0-1/0 TO 6 ACSR 4-6 SOL CU	2	-
	13	513-9542 CARTRIDGE-BLUE WEDGE CONNECTOR	2	-
	14	513-9264 CONDUCTOR-COPPER 4 SOL BARE SD	4	-
	15	503-5201 CONDUCTOR-COPPER 4 SOL BARE HD	70	70
	16	513-8829 STAPLE-WIRE 3/8 X 1-3/4 X 148 DEEP CLEATED	50	50
	17	513-4010 CLAMP-GROUND ROD 5/8" 8-1/2 STR	1	1
	18	504-5461 ROD-GROUND THREA DLESS 5/8" X 8' CU CLAD	2	2
	19	513-5590 COUPLING-GROUND ROD 5/8" CU CLAD	1	1
HARDWARE	20	504-3366 CLEVELIS-Y BALL 30KLB BOLT, NUT, COTTER	4	3
	21	504-8053 SUPPORT-SHIELD WIRE 3/4X1/4"	1	-
	22	513-5951 HOOK-GUY SOL BOLT 15/16" HOLE 30KLB	2	-
	23	513-6163 NUT-MACH BOLT 3/4" SQ GALV	1	-
	24	513-6303 NUT-LOCK SQ M F 3/4" GALV	1	-
	25	504-8055 BRACKET-SHIELD WIRE TRUNNION CLAMP	-	1
	26	513-2718 BOLT-MACH 5/8X12" GALV SQ HD W/NUT	-	2
	27	513-6162 NUT-MACH BOLT 5/8" SQ GALV	-	1
	28	513-6302 NUT-LOCK SQ M F 5/8" GALV	-	2
	29	513-9140 WASHER-SQ 2-1/4" 11/16" H GALV	-	2
	30	513-2762 BOLT-MACH 7/8X18" GALV SQ HD (FOR CL HI POLE)	5	5
	31	513-2763 BOLT-MACH 7/8X20" GALV SQ HD (FOR CL HI POLE)	4	4
	32	513-9021 WASHER-CRVD 4" SQ 15/16" H GALV OR ALUM	8	9
	33	513-6164 NUT-MACH BOLT 7/8" SQ GALV	6	6
	34	513-6304 NUT-LOCK SQ M F 7/8" GALV	9	9
SIGNS	35	529-4411 TAG-POLE NUMBER PE 2X6 WAL TRAY NUM & ATC	1	1
	36	513-6760 SIGN-WARNING H V ABOVE KEEP OFF 7X11 ALUM	1	1
	37	513-5094 NAIL-ROOFING 1-1/2" GALV FLT HD	8	8

\*BOLT LENGTH BASED ON CLASS H1 POLE

NOTES:  
1) TYPICAL LAYOUT OF THE "W1-T-DBP" STRUCTURE

**PRELIMINARY**

ISSUED FOR REVIEW AND COMMENTS  
NOT FOR CONSTRUCTION

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**POWER ENGINEERS**

REV	DATE	BY	CHK	DESCRIPTION

VERMONT ELECTRIC POWER CO., INC.  
RUTLAND, VERMONT  
GENERAL SYSTEM

115KV CONSTRUCTION SINGLE CIRCUIT BRIDGED  
POST TANGENT STRUCTURE (U-3)

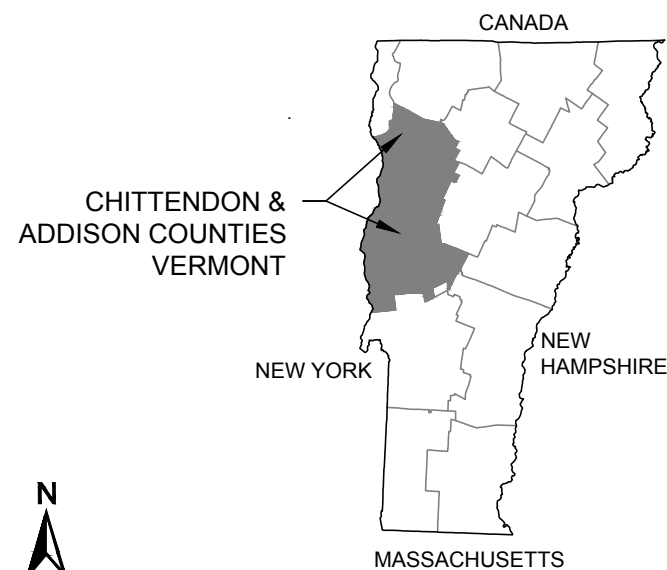
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Checked: PUH (PE)	Checked: PUH (PE)	DATE: 12/12/05	CHECKED BY: PUH	DATE:	
DRAWING NUMBER: 115-SPSCBP-1.0		PLAT: 1-1		REV:	

FILE: 115-SPSCBP-1.0.dwg

APPENDIX D –  
ARK ENGINEERING DESIGN DRAWINGS

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REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM
B	REVISED PER ECO 2015-017	4/1/15	RFA
C	CLIENT REVISIONS	5/16/16	RFA



**VERMONT GAS SYSTEMS, INC.**  
**ADDISON NATURAL GAS PROJECT**  
**ZINC RIBBON INSTALLATION DRAWINGS**  
**CHITTENDON & ADDISON COUNTIES, VERMONT**

PROJECT DRAWING LISTING

DRAWING NO.	SHEETS	REV	TITLE
12144-100	1	C	COVER SHEET
12144-200	1	C	SINGLE STRAND ZINC RIBBON INSTALLATION SECTION VIEW
12144-201	1	C	SINGLE STRAND ZINC RIBBON AND SSD WIRING DETAILS
12144-202	1	C	ZINC RIBBON CROSSING PIPELINE DETAILS
12144-203	2	C	ZINC RIBBON INSTALLATION LOCATIONS
12144-204	1	C	SSD AND COUPON TEST STATION LOCATIONS
12144-300	1	C	CABLE TO PIPELINE CONNECTION DETAILS
12144-301	1	C	CABLE SPLICE INSTALLATION DETAILS
12144-302	1	C	SOLID STATE DECOUPLER (SSD) INSTALLATION DETAILS
12144-303	1	C	COUPON TEST STATION WIRING DETAILS
12144-304	1	C	CATTLE GUARD INSTALLATION DETAIL
12144-400	1	C	MATERIALS LIST

**ISSUED FOR CONSTRUCTION**

CLIENT  SITE VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT		 ARK ENGINEERING & TECH. SERVICES, INC. 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.		TITLE COVER SHEET	
DRAWN BY JRW	DATE 6/18/13	SIZE B	<small>The information contained on this drawing is confidential and is the sole property of ARK Engineering. Transferring this information to a third party or reproducing in part or in full without a written consent from ARK Engineering is prohibited.</small>		DWG. NO. 12144-100
APPROVED BY RFA	DATE 5/16/16	SCALE NTS	CAD FILE NAME 12144-100-1-RC	SHEET 1 OF 1	REV C



4

3

2

1

REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM
B	REVISED PER ECO 2015-017	4/1/15	RFA
C	CLIENT REVISIONS	5/16/16	RFA

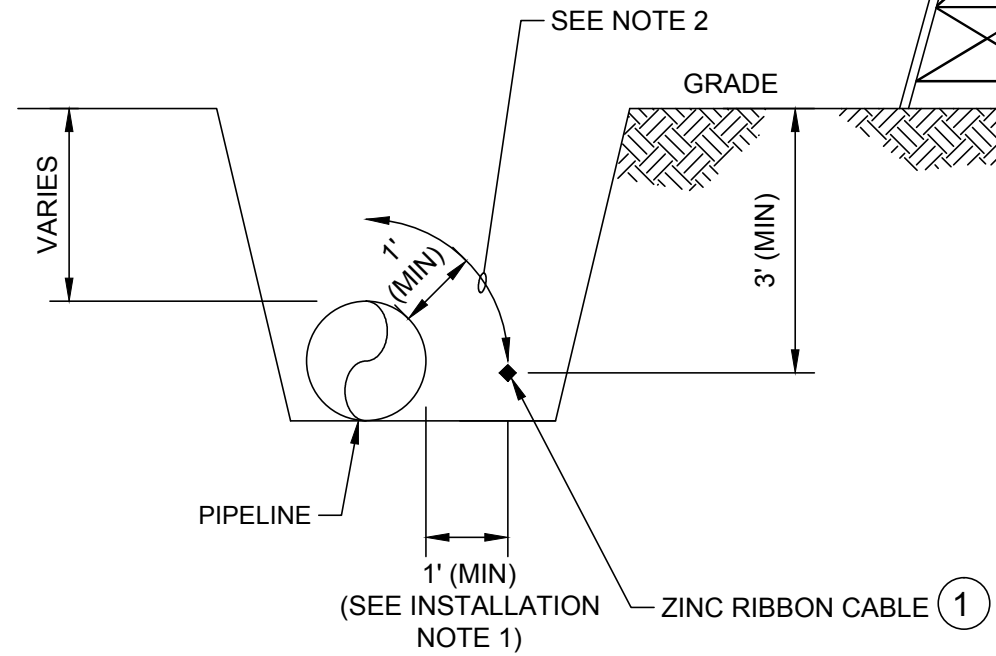
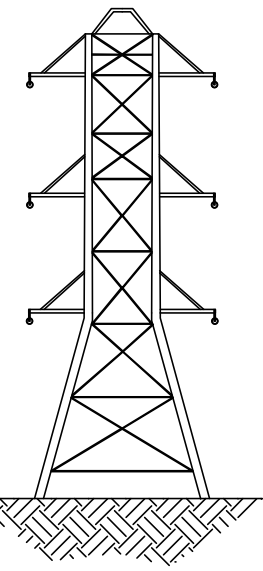
**SAFETY NOTES:**

1. THE PIPELINE AND APPURTENANCES AT OR NEAR THESE LOCATIONS CAN POSSESS POTENTIALLY LETHAL ELECTRICAL SHOCK HAZARDS UNTIL ALL GROUNDING IS INSTALLED.
2. PROCEDURES FOR CONSTRUCTING GROUNDING SYSTEMS SHALL BE REVIEWED WITH A QUALIFIED SAFETY ENGINEER PRIOR TO AND DURING CONSTRUCTION ACTIVITIES.
3. ZINC RIBBON DEPTH AND SPACING ARE MINIMUM REQUIREMENTS. ADDITIONAL DEPTH OF ZINC RIBBON AND ADDITIONAL SPACING FROM THE PIPELINES ARE ACCEPTABLE.

**INSTALLATION NOTES:**

1. HORIZONTAL DISTANCE FROM PIPELINE TO ZINC RIBBON CAN VARY BETWEEN 1' AND 25' FOR SAME TRENCH INSTALLATION.
2. ZINC RIBBON CAN BE INSTALLED BETWEEN 12:00 O'CLOCK AND 3:00 O'CLOCK AT A MINIMUM OF 1' SEPARATION FROM THE PIPELINE.

TYPICAL TRANSMISSION TOWER



**CROSS SECTION 'B'**  
ZINC RIBBON CABLE INSTALLATION  
SINGLE STRAND  
IN SAME TRENCH

**ISSUED FOR CONSTRUCTION**

**CAUTION:**  
ZINC RIBBON MUST NOT TOUCH PIPE.

CLIENT 		ARK ENGINEERING & TECH. SERVICES, INC. 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.		TITLE SINGLE STRAND ZINC RIBBON INSTALLATION SECTION VIEW	
SITE VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT		DRAWN BY JRW	DATE 6/18/13	SIZE B	DWG. NO. 12144-200
PROJECT NO. 12-E-144-AC		APPROVED BY RFA	DATE 5/16/16	SCALE NTS	REV C
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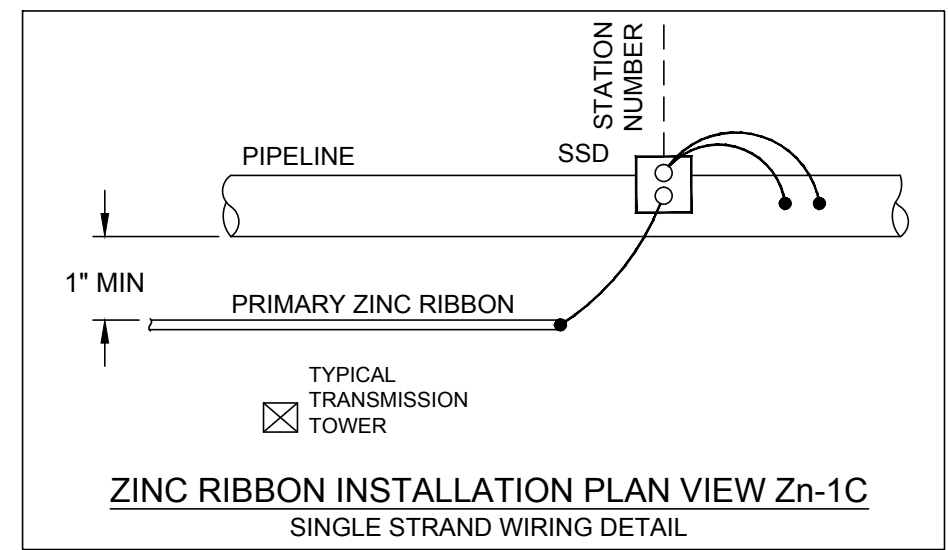
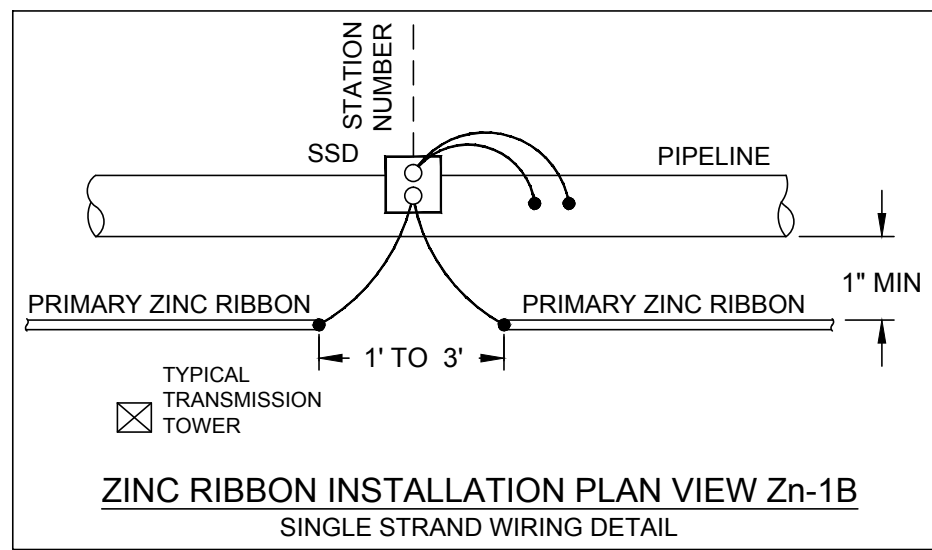
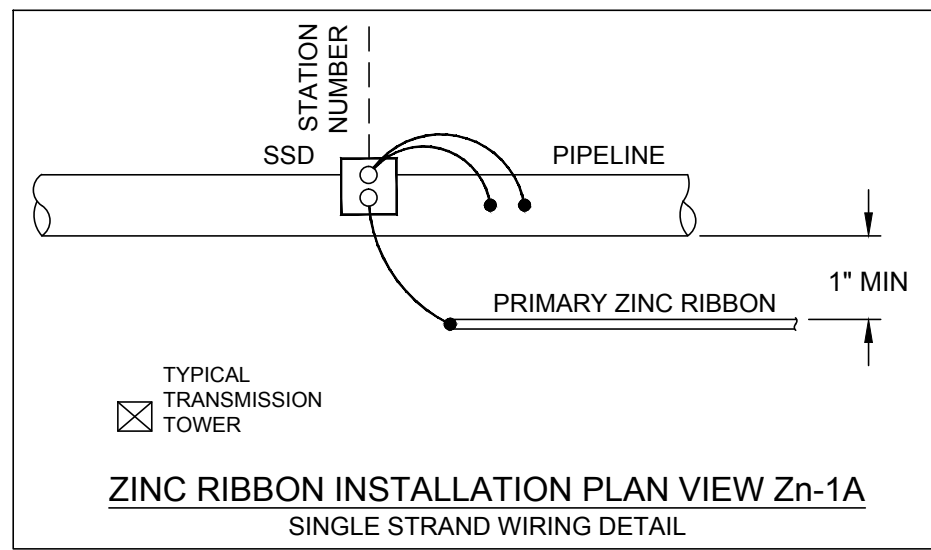
4

3

2

1

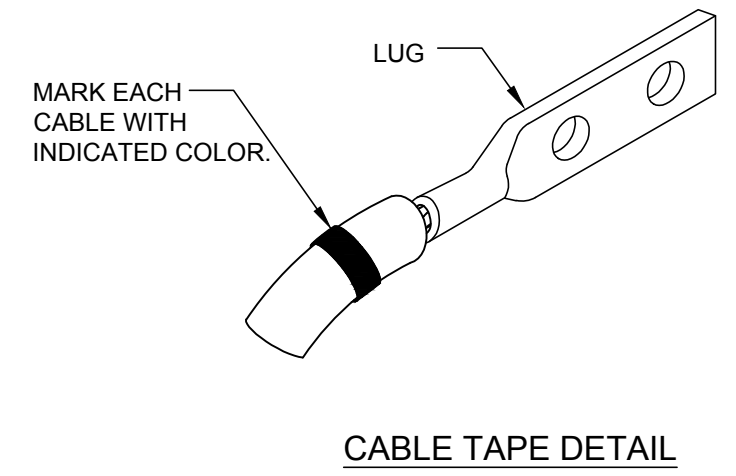
REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM
B	REVISED PER ECO 2015-017	4/1/15	RFA
C	CLIENT REVISIONS	5/16/16	RFA



SOLID STATE DECOUPLER (SSD) WIRING AND LABELING SCHEDULE				
CONNECTIONS TO	CABLE SIZE & INSULATION	SSD TERMINAL	LOCATION	TAPE COLOR
PRIMARY DOWNSTREAM ZINC RIBBON	#2 AWG HMWPE	POSITIVE	BETWEEN TRANSMISSION TOWER & PIPE	RED
PRIMARY UPSTREAM ZINC RIBBON	#2 AWG HMWPE	POSITIVE	BETWEEN TRANSMISSION TOWER & PIPE	GREEN
PIPE	#6 AWG HMWPE	NEGATIVE	TOP	NONE
PIPE	#6 AWG HMWPE	NEGATIVE	TOP	NONE

**NOTES:**

- INSTALL SSD'S AT STATION NUMBERS INDICATED IN TABLE ON DRAWING 12144-204.
- INSTALL ZINC RIBBON CABLE WITH ENDS AT STATION NUMBERS INDICATED IN TABLE ON DRAWING 12144-203. REFERENCE DRAWINGS 12144-300 & 301 FOR WELD DETAILS.
- INSTALL PRIMARY ZINC RIBBON CABLE BETWEEN PIPELINE AND TRANSMISSION TOWER.
- LABEL #2 AWG CABLE WITH TAPE COLOR SHOWN IN TABLE. WRAP TAPE WITHIN 6" OF LUG.
- REFERENCE DRAWING 12144-202 FOR ALL FOREIGN PIPELINE AND FOREIGN UTILITY CROSSINGS.

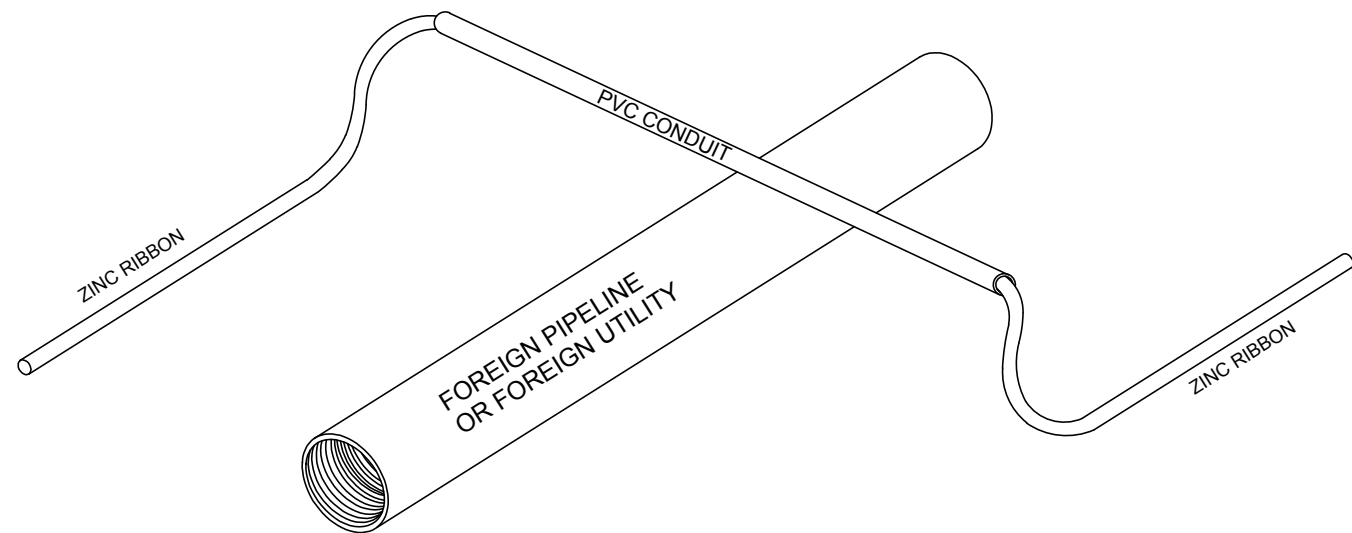


**CAUTION:**  
ZINC RIBBON MUST NOT TOUCH PIPE.

**ISSUED FOR CONSTRUCTION**

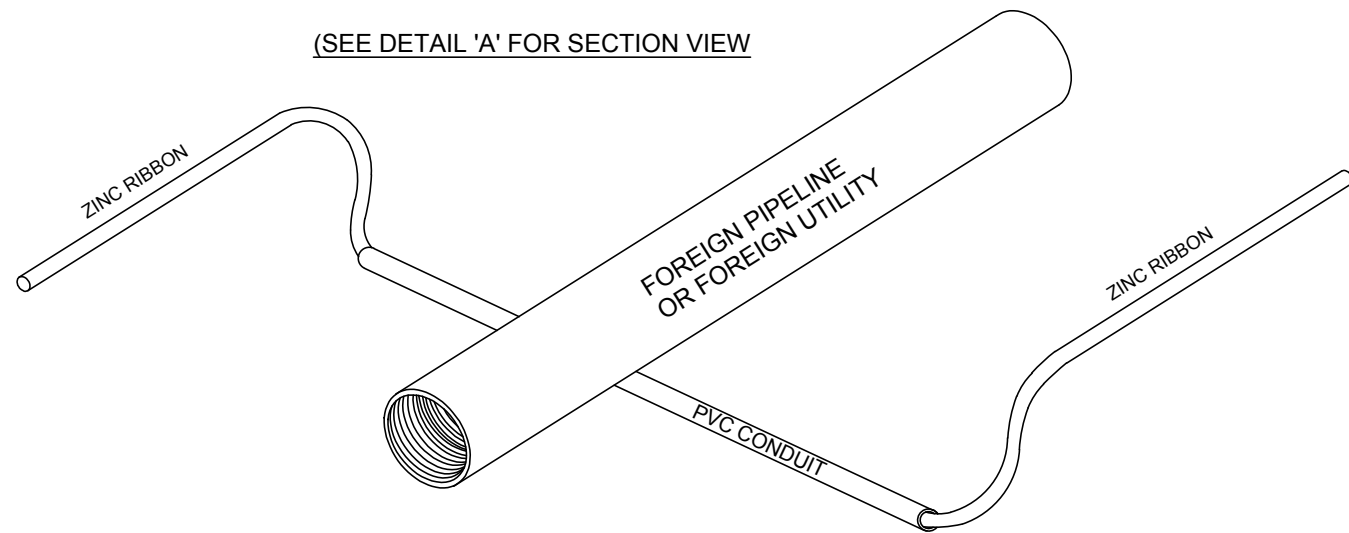
<b>CLIENT</b> 		<b>ARK ENGINEERING &amp; TECH. SERVICES, INC.</b> 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.		<b>TITLE</b> SINGLE STRAND ZINC RIBBON AND SSD WIRING DETAILS	
<b>SITE</b> VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT		<b>DRAWN BY</b> JRW	<b>DATE</b> 6/18/13	<b>SIZE</b> B	<small>The information contained on this drawing is confidential and is the sole property of ARK Engineering. Transferring this information to a third party or reproducing in part or in full without a written consent from ARK Engineering is prohibited.</small>
<b>PROJECT NO.</b> 12-E-144-AC	<b>APPROVED BY</b> RFA	<b>DATE</b> 5/16/16	<b>SCALE</b> NTS	<b>DWG. NO.</b> 12144-201	
<b>CAD FILE NAME</b> 12144-201-1-RC			<b>SHEET</b> 1 OF 1		

REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM
B	REVISED PER ECO 2015-017	4/1/15	RFA
C	CLIENT REVISIONS	5/16/16	RFA



**ZINC RIBBON CROSSING ABOVE  
FOREIGN PIPELINE OR FOREIGN UTILITY**

(SEE DETAIL 'A' FOR SECTION VIEW)



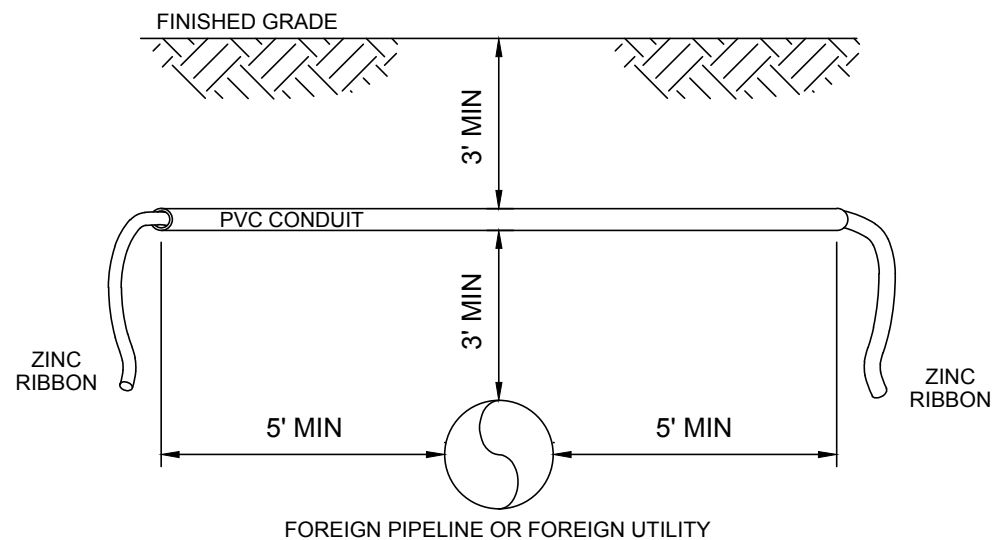
**ZINC RIBBON CROSSING BELOW  
FOREIGN PIPELINE OR FOREIGN UTILITY**

(SEE DETAIL 'B' FOR SECTION VIEW)

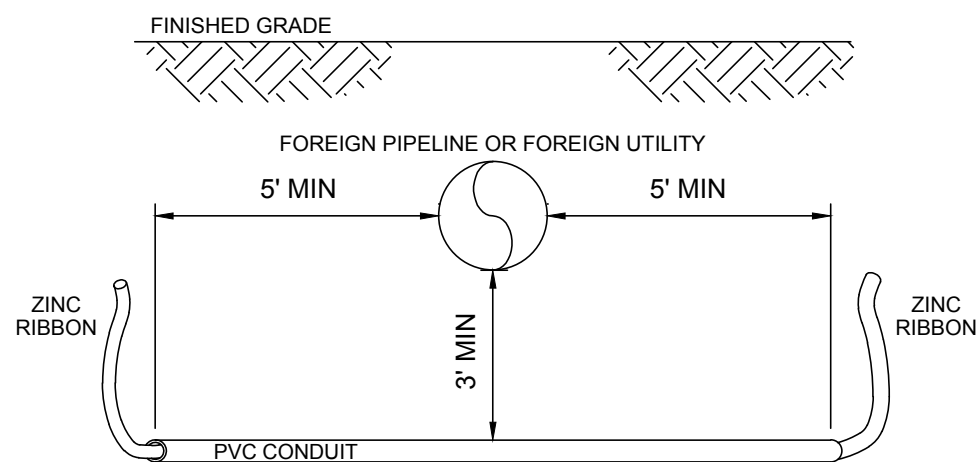
**NOTES:**

- WHERE ZINC RIBBON CROSSES A FOREIGN PIPELINE OR FOREIGN UTILITY INSTALL ZINC RIBBON IN 2" PVC CONDUIT FOR A MINIMUM OF 5' ON BOTH SIDES OF THE CROSSING.
- AT ALL FOREIGN PIPELINE AND FOREIGN UTILITY CROSSINGS, MAINTAIN A MINIMUM OF 3' SEPARATION BETWEEN ZINC RIBBON AND UTILITY, AND A MINIMUM OF 3' BETWEEN ZINC RIBBON AND FINISHED GRADE WHERE NECESSARY, INSTALL ZINC RIBBON BELOW UTILITY TO MAINTAIN CLEARANCES.
- PRIMARY ZINC RIBBON SHOULD BE INSTALLED BETWEEN TRANSMISSION TOWER AND PIPELINE.
- ZINC RIBBON TO REMAIN CONTINUOUS THROUGH PVC PIPING.

**CAUTION:**  
ZINC RIBBON MUST NOT TOUCH PIPE.



**DETAIL 'A'**



**DETAIL 'B'**

**ISSUED FOR CONSTRUCTION**

CLIENT 		ARK ENGINEERING & TECH. SERVICES, INC. 		TITLE <b>ZINC RIBBON CROSSING PIPELINE DETAILS</b>	
SITE VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT		639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.		DWG. NO. <b>12144-202</b>	
PROJECT NO. 12-E-144-AC		DRAWN BY JRW		DATE 6/18/13	
APPROVED BY RFA		DATE 5/16/16		SIZE <b>B</b>	
SCALE NTS		CAD FILE NAME 12144-202-1-RC		SHEET 1 OF 1	



REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM
B	REVISED PER ECO 2015-017	4/1/15	RFA
C	CLIENT REVISIONS	5/16/16	RFA

ZINC RIBBON INSTALLATION LOCATION AND REQUIRED MATERIALS											
SECTION NO.	STATION NO. START	STATION NO. END	DISTANCE FROM START TO END (FT)	NUMBER OF STRANDS	TOTAL LENGTH OF ZINC RIBBON (FT)	NUMBER OF SSD'S	#2 AWG COPPER CABLE SSD TO ZINC RIBBON (FT)	#6 AWG COPPER CABLE SSD TO PIPE (FT)	#6 AWG CABLE TO PIPELINE EXOTHERMIC WELD CONNECTIONS	ZINC RIBBON TO #2 COPPER EXOTHERMIC WELD CONNECTIONS	SSD PEDESTALS
3	451+25	457+05	580	1	580	2	50	200	4	2	2
4	612+60	623+60	1,100	1	1,100	2	50	200	4	2	2
5	700+68	718+87	1,790	1	1,790	2	50	200	4	2	2
6	801+10	819+83	1,860	1	1,860	2	50	200	4	2	2
7	847+85	863+75	1,590	1	1,590	2	50	200	4	2	2
8	888+00	892+75	475	1	475	2	50	200	4	2	2
8A	893+75	906+82	1,425	1	1,425	2	50	200	4	2	2
9A	1040+90	1046+50	560	1	560	2	50	200	4	2	2
9B	1048+70	1063+10	1,440	1	1,440	2	50	200	4	2	2
10	1258+00	1267+25	925	1	925	2	50	200	4	2	2
11	1308+00	1320+40	1,240	1	1,240	2	50	200	4	2	2
12	1379+00	1390+10	1,110	1	1,110	2	50	200	4	2	2
13	1424+50	1437+00	1,250	1	1,250	2	50	200	4	2	2
14	1477+40	1490+73	770	1	770	2	50	200	4	2	2
15	1517+95	1551+35	3,340	1	3,340	3	100	300	6	4	3
17	1580+00	1588+00	800	1	800	2	50	200	4	2	2
18	1641+60	1656+70	1,510	1	1,510	2	50	200	4	2	2

ZINC RIBBON CABLE BASED ON 2,000 FOOT REEL. REFERENCE DRAWING 12144-301 DETAIL B FOR ZINC RIBBON TO ZINC RIBBON EXOTHERMIC WELD WHERE ZINC RIBBON MUST BE SPLICED.

- NOTES:
- NOTE EQUATION CHANGE: 715□71BK □ 716□00AHD FOR SECTION 5.
  - NOTE EQUATION CHANGE: 812□83BK □ 812□96AHD FOR SECTION 6.
  - NOTE EQUATION CHANGE: 896□87BK □ 896□97AHD FOR SECTION 8A.
  - NOTE EQUATION CHANGE: 903□06BK □ 901□77AHD FOR SECTION 8A.
  - NOTE EQUATION CHANGE: 1478□87BK □ 1484□50AHD FOR SECTION 14.

**ISSUED FOR CONSTRUCTION**

CLIENT  SITE VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT		 ARK ENGINEERING & TECH. SERVICES, INC. 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.		TITLE ZINC RIBBON INSTALLATION LOCATIONS	
DRAWN BY JRW	DATE 6/18/13	SIZE B	DWG. NO. 12144-203		REV C
PROJECT NO. 12-E-144-AC	APPROVED BY RFA	DATE 5/16/16	SCALE NTS	CAD FILE NAME 12144-203-1-RC	SHEET 1 OF 2

REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM
B	REVISED PER ECO 2015-017	4/1/15	RFA
C	CLIENT REVISIONS	5/16/16	RFA

ZINC RIBBON INSTALLATION LOCATION AND REQUIRED MATERIALS											
SECTION NO.	STATION NO. START	STATION NO. END	DISTANCE FROM START TO END (FT)	NUMBER OF STRANDS	TOTAL LENGTH OF ZINC RIBBON (FT)	NUMBER OF SSD'S	#2 AWG COPPER CABLE SSD TO ZINC RIBBON (FT)	#6 AWG COPPER CABLE SSD TO PIPE (FT)	#6 AWG CABLE TO PIPELINE EXOTHERMIC WELD CONNECTIONS	ZINC RIBBON TO #2 COPPER EXOTHERMIC WELD CONNECTIONS	SSD PEDESTALS
19	1712+80	1718+00	520	1	520	2	50	200	4	2	2
20	1718+59	1724+01	580	1	580	2	50	200	4	2	2
21	1798+60	1846+00	4,740	1	4,740	4	150	400	8	6	4
22	1873+25	1881+00	775	1	775	2	50	200	4	2	2
22A	1882+75	1888+85	610	1	610	2	50	200	4	2	2
23	1918+11	1939+29	2,118	1	2,118	3	100	300	6	4	3
24	1976+29	1985+59	930	1	930	2	50	200	4	2	2
25	2080+10	2126+90	4,690	1	4,690	4	150	400	8	6	4
26	2129+05	2132+90	385	1	385	2	50	200	4	2	2
TOTAL:					37,113	58	1,600	5,800	116	64	58

ZINC RIBBON CABLE BASED ON 2,000 FOOT REEL. REFERENCE DRAWING 12144-301 DETAIL B FOR ZINC RIBBON TO ZINC RIBBON EXOTHERMIC WELD WHERE ZINC RIBBON MUST BE SPLICED.

**NOTES:**

6. NOTE EQUATION CHANGE: 1713□29BK □ 1713□00AHD FOR SECTION 19.
7. NOTE EQUATION CHANGE: 1719□72BK □ 1719□34AHD FOR SECTION 20.
8. NOTE EQUATION CHANGE: 1830□30BK □ 1830□44AHD FOR SECTION 21.
9. NOTE EQUATION CHANGE: 1877□11BK □ 1877□27AHD FOR SECTION 22.
10. NOTE EQUATION CHANGE: 2087□93BK □ 2088□03AHD FOR SECTION 25.

**ISSUED FOR CONSTRUCTION**



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SCALE NTS	CAD FILE NAME 12144-203-2-RC	SHEET 2 OF 2	

4

3

2

1

REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM
B	REVISED PER ECO 2015-017	4/1/14	RFA
C	CLIENT REVISIONS	5/16/16	RFA



CATTLE GUARD REQUIRED AT THIS LOCATION

SSD LOCATIONS		
SECTION NO.	SSD STATION NO.	SSD WIRING DETAIL
3	451+25	ZN-1A
	457+05	ZN-1C
4	612+60	ZN-1A
	623+60	ZN-1C
5	700+68	ZN-1A
	718+87	ZN-1C
6	801+10	ZN-1A
	819+83	ZN-1C
7	847+85	ZN-1A
	863+75	ZN-1C
8	888+00	ZN-1A
	892+75	ZN-1C
8A	893+75	ZN-1A
	906+82	ZN-1C
9A	1040+90	ZN-1A
	1046+50	ZN-1C
9B	1048+70	ZN-1A
	1063+10	ZN-1C
10	1258+00	ZN-1A
	1267+25	ZN-1C
11	1308+00	ZN-1A
	1320+40	ZN-1C
12	1379+00	ZN-1A
	1390+10	ZN-1C
13	1424+50	ZN-1A
	1437+00	ZN-1C
14	1477+40	ZN-1A
	1490+73	ZN-1C
15	1517+95	ZN-1A
	1531+50	ZN-1B
	1551+35	ZN-1C

SSD LOCATIONS		
SECTION NO.	SSD STATION NO.	SSD WIRING DETAIL
17	1580+00	ZN-1A
	1588+00	ZN-1C
18	1641+60	ZN-1A
	1656+70	ZN-1C
19	1712+80	ZN-1A
	1718+00	ZN-1C
20	1718+59	ZN-1A
	1724+01	ZN-1C
21	1798+60	ZN-1A
	1816+50	ZN-1B
	1831+50	ZN-1B
	1846+00	ZN-1C
22	1873+25	ZN-1A
	1881+00	ZN-1C
22A	1882+75	ZN-1A
	1888+85	ZN-1C
23	1918+11	ZN-1A
	1928+70	ZN-1B
	1939+29	ZN-1C
24	1976+29	ZN-1A
	1985+59	ZN-1C
25	2080+10	ZN-1A
	2095+80	ZN-1B
	2111+40	ZN-1B
	2126+90	ZN-1C
26	2129+05	ZN-1A
	2132+90	ZN-1C

COUPON TEST STATION LOCATIONS	
COUPON TEST STATION NO.	STATION NO.
1	67+40
2	1071+00
3	1513+10
4	1568+00
5	1916+00
6	1940+00
7	1970+00
8	2172+50

ISSUED FOR CONSTRUCTION

CLIENT  SITE VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT		 ARK ENGINEERING & TECH. SERVICES, INC. 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.		TITLE SSD LOCATIONS	
DRAWN BY JRW	DATE 6/18/13	SIZE B	DWG. NO. 12144-204		REV C
PROJECT NO. 12-E-144-AC	APPROVED BY RFA	DATE 5/16/16	SCALE NTS	CAD FILE NAME 12144-204-1-RC	SHEET 1 OF 1

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3

2

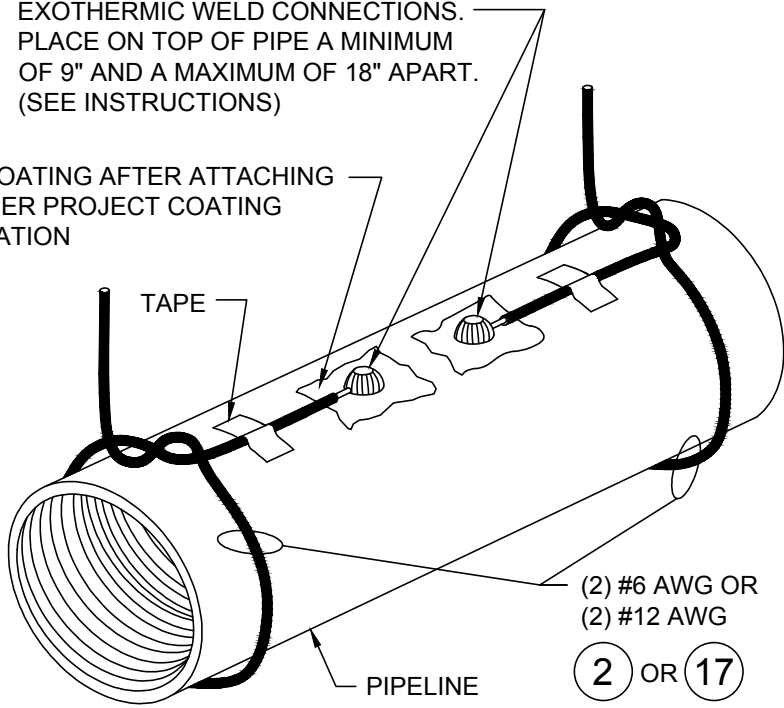
1

**EXOTHERMIC WELD INSTRUCTIONS:**

- FIRST DETERMINE IF THE PIPELINE IS SUITABLE FOR EXOTHERMIC WELDING BY CONDUCTING THE FOLLOWING TESTS:
  - DETERMINE THAT THE PIPELINE SMYS (SPECIFIED MINIMUM YIELD STRENGTH) IS  $\geq 80,000$  PSI.
  - DETERMINE THAT PIPELINE WALL THICKNESS IS  $\frac{1}{8}$ " (0.125") OR GREATER.
  - PERFORM ULTRASONIC TESTING TO PIPELINE TO DETERMINE THAT NO SURFACE OR INTERNAL DEFECTS EXIST.
- FOR EACH CABLE TO PIPELINE CONNECTION (EXOTHERMIC WELD), REMOVE A 3"X3" MAX AREA OF PIPELINE COATING AT THE 12:00 O'CLOCK POSITION ON THE PIPELINE AND BRUSH UNTIL SHINY. ANY ADJACENT CABLE CONNECTIONS SHALL BE NO CLOSER THAN 9" AND NO FURTHER THAN 18".
- PREPARE PIPELINE SURFACE AS SPECIFIED BY PIPELINE COATING MANUFACTURER.
- DETAIL "A" SHOWS POSSIBLE METHOD OF CABLE STRAIN RELIEF FOR NEW PIPE INSTALLATIONS. THIS METHOD IS NOT A REQUIREMENT. OTHER MEANS OF STRAIN RELIEF MAY BE USED.
- STRIP BACK ANY CABLE INSULATION 1"-2" AND TAPE CABLE TO PIPE.
- ENSURE THAT THE PIPELINE WELD AREA AND CABLE ARE CLEAN AND DRY PRIOR TO WELDING.
- USE SPECIFIC WELD MOLD AND WELD METAL AS INDICATED IN DRAWING MATERIALS LIST.
- IF INDICATED, USE COPPER HEAT SLEEVE ON CABLE END TO BE WELDED.
- USE ONLY A 15 GRAM MELDING CHARGE. DO NOT EXCEED.
- PLACE THE METAL RETAINER DISK IN THE SPECIFIED WELD MOLD AND DUMP (DO NOT POUR) WELD METAL POWDER ONTO THE DISK. MAKE SURE THAT ALL OF THE FINE STARTING POWDER IS IN THE MOLD. IF ANY POWDER REMAINS IN THE CARTRIDGE BOTTOM, SQUEEZE OUT INTO MOLD AND BREAK UP.
- CLOSE MOLD LID.
- REPLACE CAP ON EMPTY WELD METAL CARTRIDGE AND PLACE BACK INTO CARTRIDGE PACK BOX UPSIDE DOWN TO KEEP THE REMAINING CARTRIDGES UPRIGHT.
- LAY THE CABLE END ON THE PREPARED PIPE SURFACE USING A SPRING LOADED CHAIN CLAMP TO HOLD CRUCIBLE TIGHT TO PIPELINE.
- USING EYE AND HAND PROTECTION, STAND ON THE OPPOSITE SIDE OF THE CRUCIBLE FROM THE TOUCH HOLE AND IGNITE POWDER WITH SPARK FROM FLINT GUN. CAUTION: POWDER WILL FLASH WHEN IGNITED

EXOTHERMIC WELD CONNECTIONS. PLACE ON TOP OF PIPE A MINIMUM OF 9" AND A MAXIMUM OF 18" APART. (SEE INSTRUCTIONS)

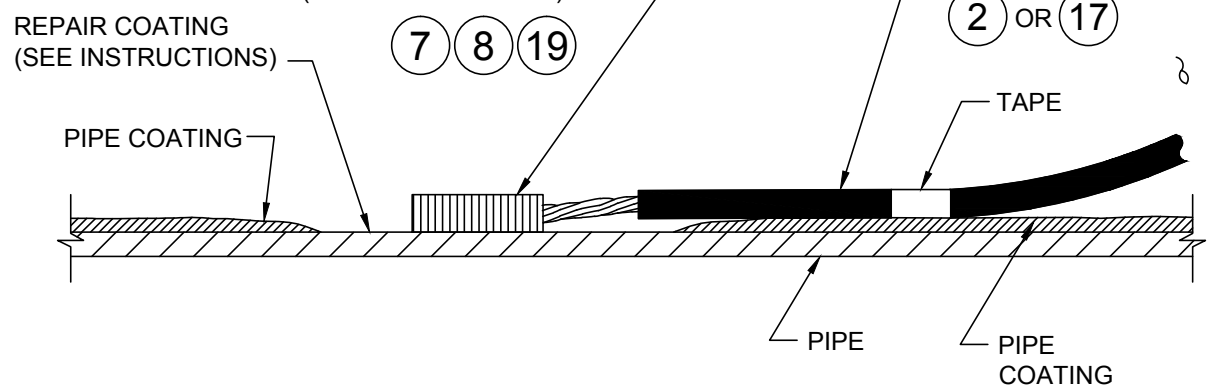
REPAIR COATING AFTER ATTACHING CABLES PER PROJECT COATING SPECIFICATION



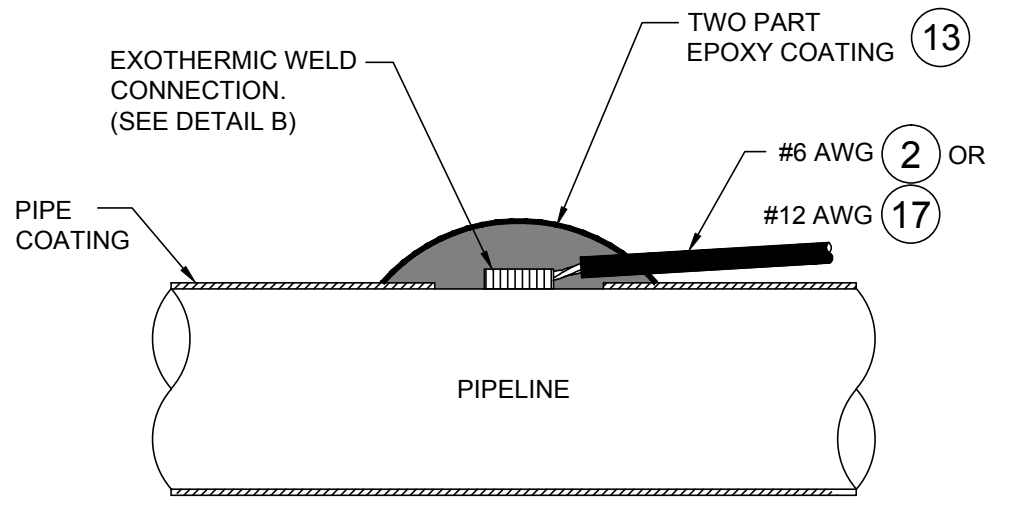
**DETAIL 'A'**  
CABLE TO PIPELINE ATTACHMENT DETAIL

- WHEN WELD HAS SET, REMOVE WELD MOLD AND TEST CONNECTION BY RAPPING SHARPLY WITH A SLAG HAMMER. IF THERE IS ANY INDICATION THAT A COMPLETE WELD HAS NOT BEEN ACHIEVED, REMOVE THE WELD AND RE-APPLY.
- IF WELD IS GOOD, REMOVE ANY SLAG WITH HAMMER AND CLEAN USING A WIRE BRUSH.
- AFTER COMPLETING THE EXOTHERMIC WELD CONNECTION TO THE PIPELINE, ALL COATING DAMAGE IS TO BE CLEANED AND COATED WITH 20 MILS MINIMUM OF TWO PART EPOXY COATING OR VERMONT GAS APPROVED EQUAL.
- REFER TO VERMONT GAS REPAIR SPECIFICATIONS AND PRODUCT DATA SHEET TO DETERMINE IF REPAIR IS ACCEPTABLE.

EXOTHERMIC WELD CONNECTION, FOR #6 AWG USE MOLD #M-102 OR EQUAL, WITH #15CP WELD METAL. FOR #12 AWG USE MOLD #M-102 OR EQUAL AND 38-0200-00 ADAPTER SLEEVE WITH #15CP WELD METAL. (SEE INSTRUCTIONS)



**DETAIL 'B'**  
EXOTHERMIC WELD CONNECTION



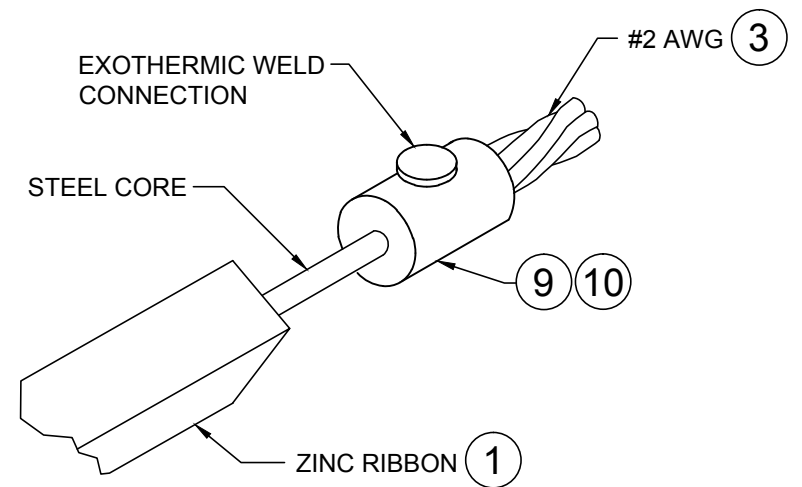
**DETAIL 'C'**  
CORROSION PROTECTION SEAL

REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM
B	REVISED PER ECO 2015-017	4/1/15	RFA
C	CLIENT REVISIONS	5/16/16	RFA

**ISSUED FOR CONSTRUCTION**

CLIENT 		ARK ENGINEERING & TECH. SERVICES, INC. 		TITLE <b>CABLE TO PIPELINE CONNECTION DETAILS</b>	
SITE VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT		639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.		DWG. NO. <b>12144-300</b>	
PROJECT NO. 12-E-144-AC		DRAWN BY JRW		DATE 6/18/13	
APPROVED BY RFA		DATE 5/16/16		SIZE B	
SCALE NTS		CAD FILE NAME 12144-300-1-RC		SHEET 1 OF 1	

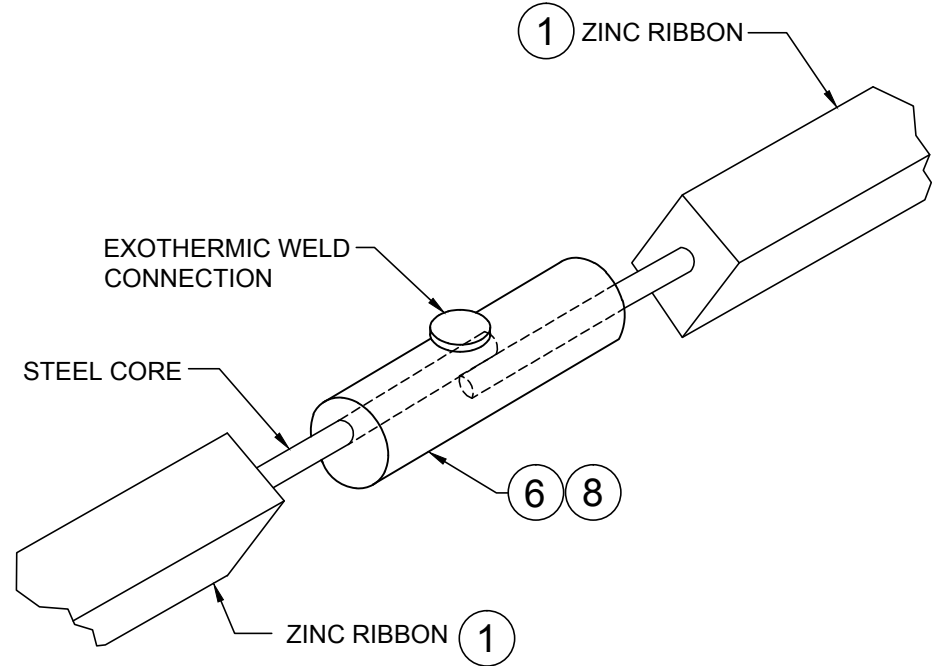
REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM
B	REVISED PER ECO 2015-017	4/1/15	RFA
C	CLIENT REVISIONS	5/16/16	RFA



**DETAIL 'A'**

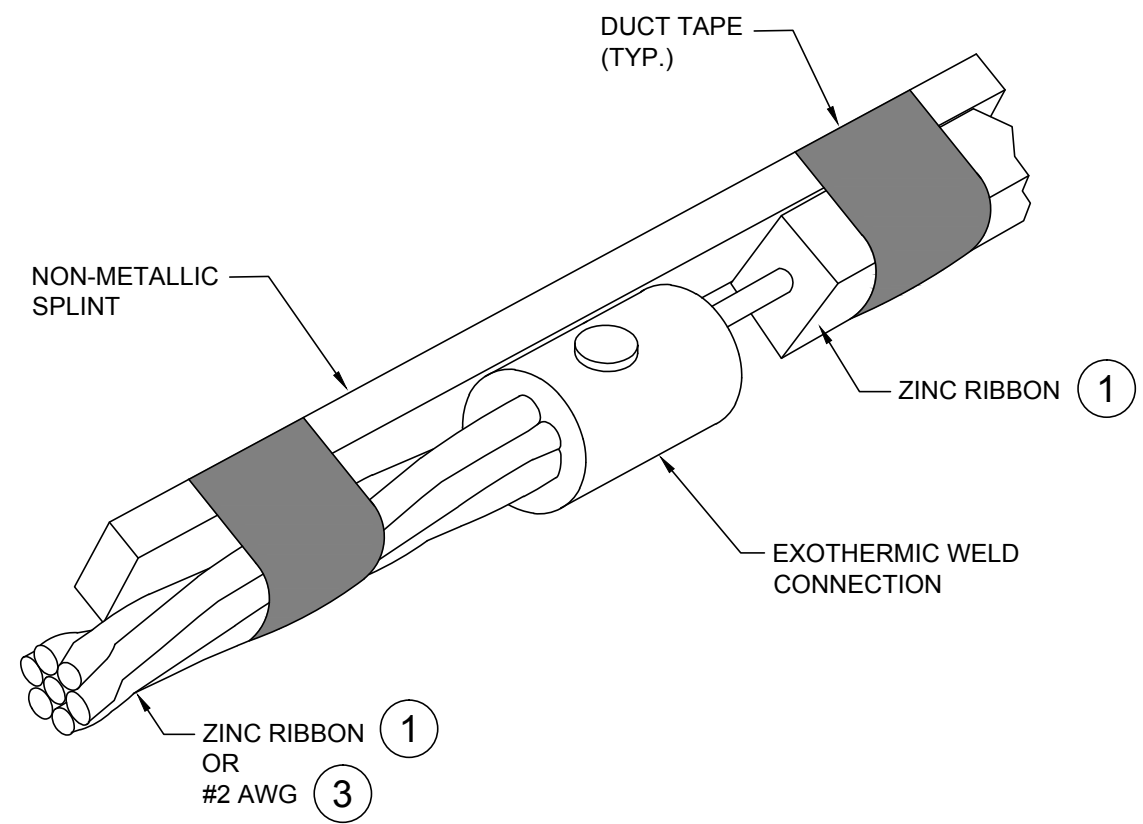
ZINC RIBBON CABLE TO #2 AWG STRANDED COPPER CABLE  
EXOTHERMIC WELD INSTALLATION

DETAIL	MOLD	WELD METAL
'A'	M-11638	32CP
'B'	M-7233	15CP



**DETAIL 'B'**

ZINC RIBBON CABLE TO ZINC RIBBON CABLE  
IN-LINE EXOTHERMIC WELD INSTALLATION



**DETAIL 'C'**

NON-METALLIC SPLINT INSTALLATION

**NOTES:**

- ALL EXOTHERMIC WELD CONNECTIONS ARE TO BE SEALED WITH ROYSTON "SPLICE RIGHT" SPLICE KIT (ITEM #14), OR VERMONT GAS APPROVED ALTERNATIVE.
- FOR ALL ZINC RIBBON EXOTHERMIC WELD CONNECTIONS, USE A NON-METALLIC SPLINT TO REINFORCE WELD. WRAP DUCT TAPE AROUND SPLINT AND ZINC RIBBON FOR ADDED SUPPORT. (SEE DETAIL C)
- INSTALL ZINC RIBBON FROM STATION NO. START TO STATION NO. END, REFERENCE DRAWINGS 12144-201 FOR SSD WIRING AND TAPING DETAILS.
- ZINC RIBBON BASED ON 2,000 FOOT REEL. REFERENCE DETAIL B FOR ZINC RIBBON TO ZINC RIBBON EXOTHERMIC WELD WHERE ZINC RIBBON MUST BE SPLICED.

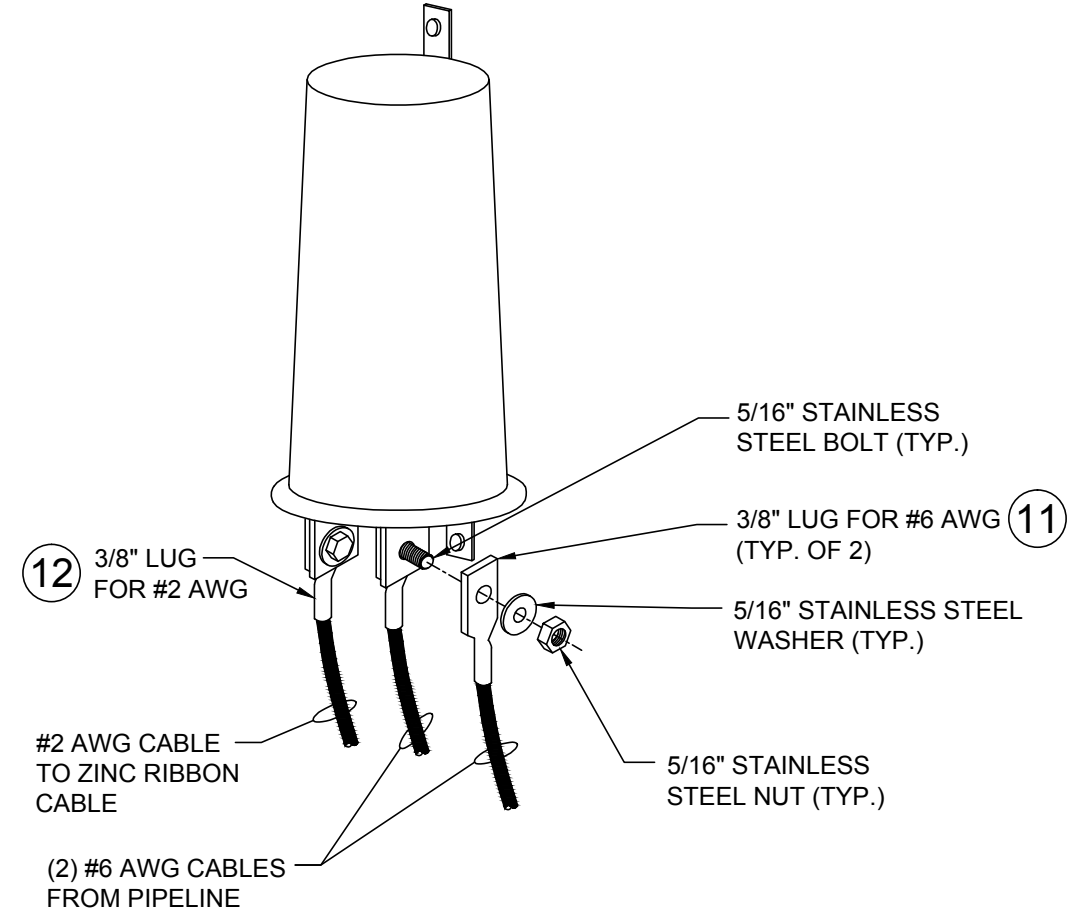
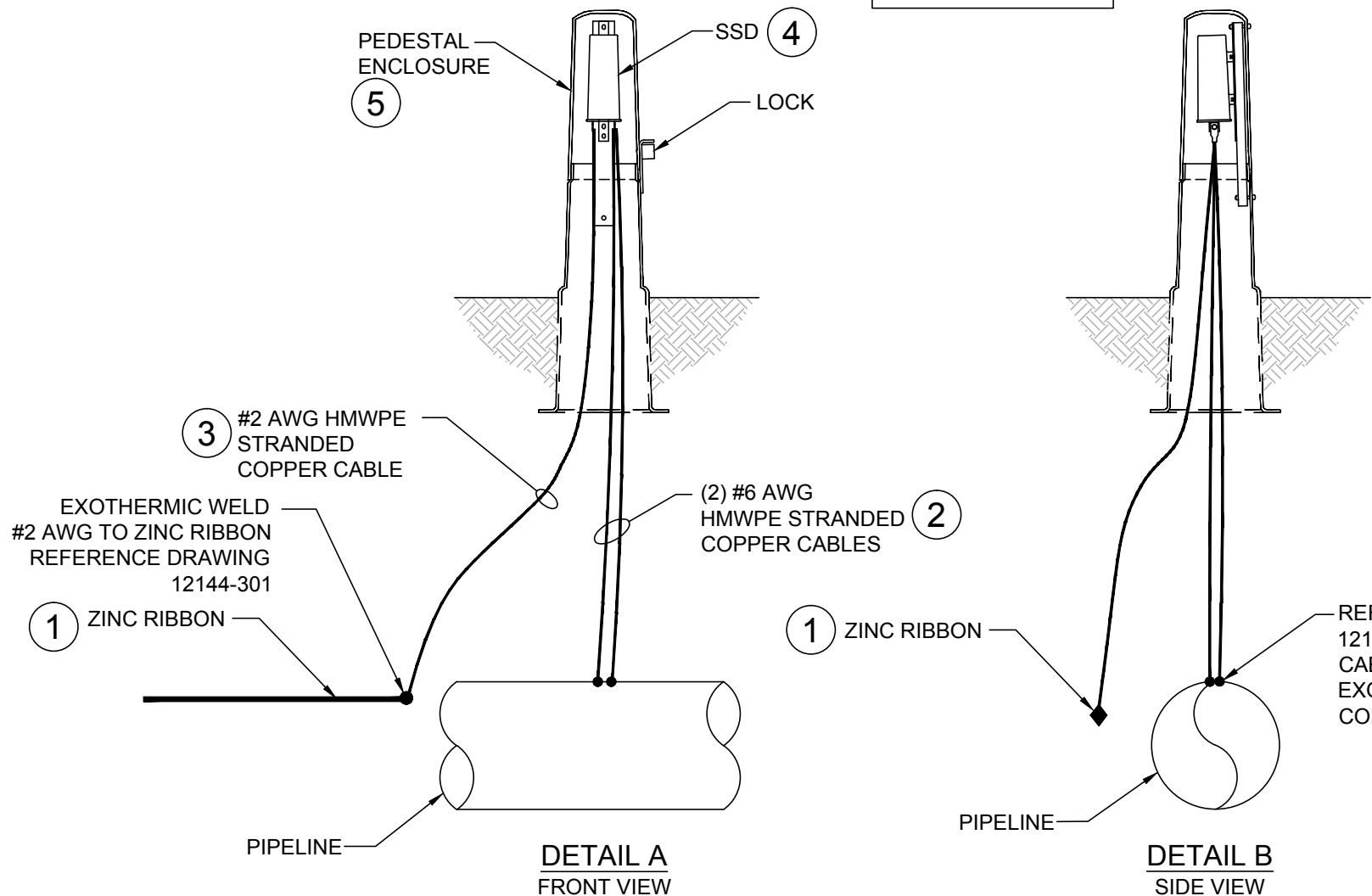
**ISSUED FOR CONSTRUCTION**

CLIENT  SITE VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT	 ARK ENGINEERING & TECH. SERVICES, INC. 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.	TITLE <b>CABLE SPLICE          INSTALLATION DETAILS</b>		
		DRAWN BY JRW	DATE 6/18/13	SIZE B
PROJECT NO. 12-E-144-AC	APPROVED BY RFA	DATE 5/16/16	SCALE NTS	CAD FILE NAME 12144-301-1-RC
			SHEET 1 OF 1	REV C



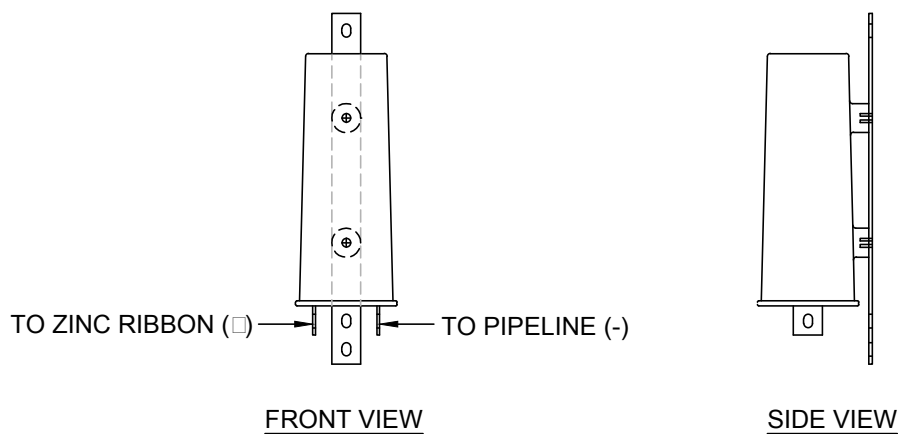
REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM
B	REVISED PER ECO 2015-017	4/1/15	RFA
C	CLIENT REVISIONS	5/16/16	RFA

SSD POLARITY:  
NEG: PIPELINE  
POS: ZINC RIBBON



SSD INSTALLATION DETAILS

CABLE TO SSD TERMINAL CONNECTION DETAIL



SOLID STATE DECOUPLING DEVICE (SSD)

NOTES:

1. SSD IS TO BE MOUNTED INSIDE THE FIBERGLASS PEDESTAL. ALL COPPER CABLES ARE TO PASS THROUGH BOTTOM OF PEDESTAL.
2. INSTALL PEDESTAL AS CLOSE AS POSSIBLE TO PIPING CONNECTIONS TO REDUCE LEAD LENGTHS.
3. WIRING ON THIS SHEET DEPICTS Zn-1C CONFIGURATION. REFERENCE DRAWING 12144-201 FOR SPECIFIC WIRING DETAILS.

**ISSUED FOR CONSTRUCTION**

CLIENT <b>CHA</b> SITE VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT		<b>ARK</b> ENGINEERING & TECHNICAL SERVICES, INC. ARK ENGINEERING & TECH. SERVICES, INC. 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.		TITLE <b>SOLID STATE DECOUPLER (SSD) INSTALLATION DETAILS</b>	
DRAWN BY JRW	DATE 6/18/13	SIZE B	DWG. NO. 12144-302		REV C
PROJECT NO. 12-E-144-AC	APPROVED BY RFA	DATE 5/16/16	SCALE NTS	CAD FILE NAME 12144-302-1-RC	SHEET 1 OF 1

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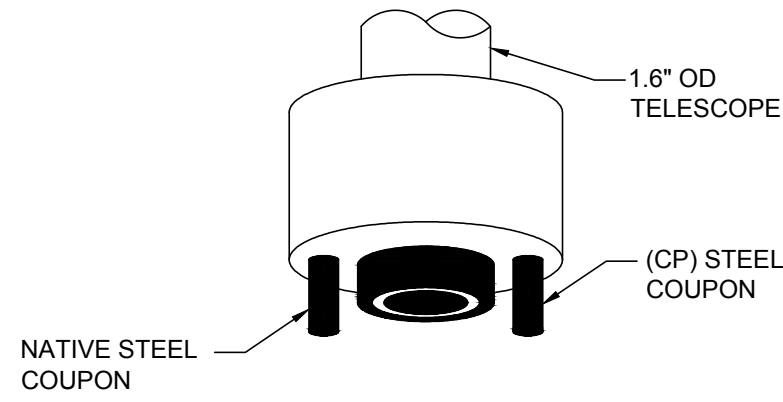
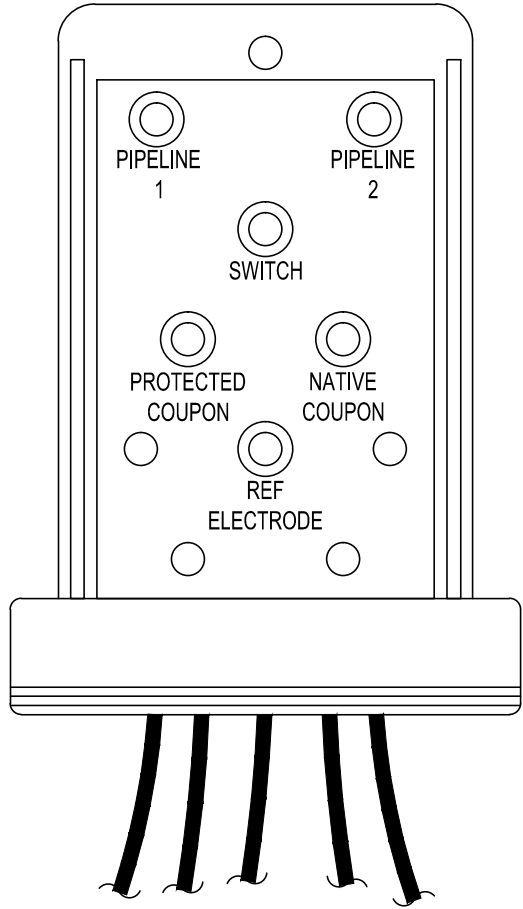
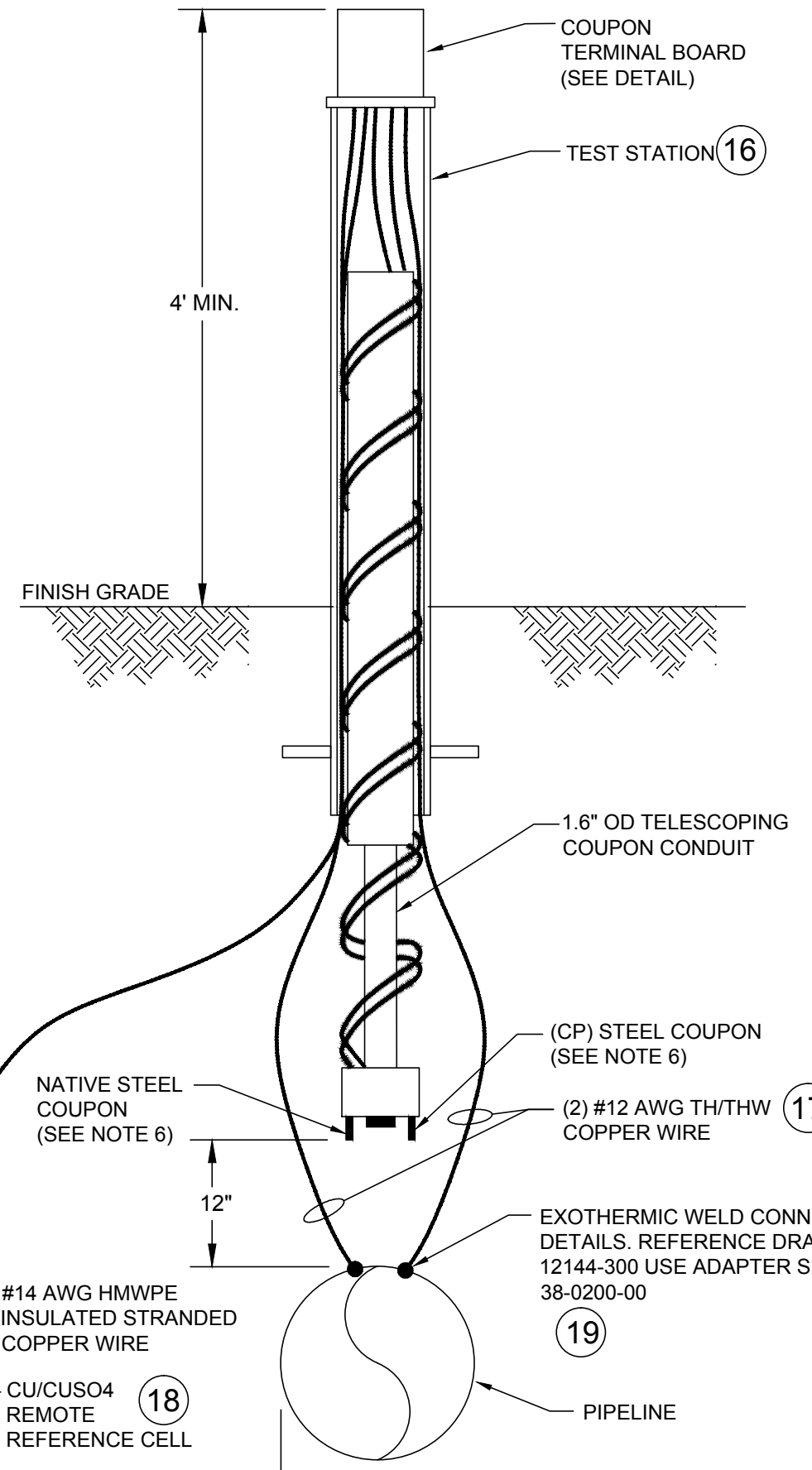
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REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM
B	REVISED PER ECO 2015-017	4/1/15	RFA
C	CLIENT REVISIONS	5/16/16	RFA

NOTES:

- TEST STATION TO BE INSTALLED DIRECTLY ABOVE BURIED PIPE. COUPON TO BE 12" FROM TOP OF PIPE.
- COUPON TEST STATION INCLUDES TERMINAL BOARD, COVER, TELESCOPING BODY, TWO COUPONS AND INTERNAL WIRING. (ITEM 15)
- INSTALL CU/CUS04 PERMANENT REMOTE REFERENCE ELECTRODE HORIZONTALLY A MINIMUM OF 1 FOOT AND A MAXIMUM OF 5 FEET FROM THE PIPE AT THE 9 O'CLOCK POSITION.
- COUPONS TO HAVE 1.44 SQUARE INCH SURFACE AREA.
- REFERENCE DRAWING 12144-204 FOR TEST STATION LOCATIONS.
- SOIL PLACED AROUND AND BENEATH COUPON SHOULD BE NATIVE AND FREE OF FOREIGN MATERIAL AND ROCKS.
- REFERENCE CP SYSTEM DESIGN DRAWINGS FOR COUPON TEST STATION LOCATIONS.

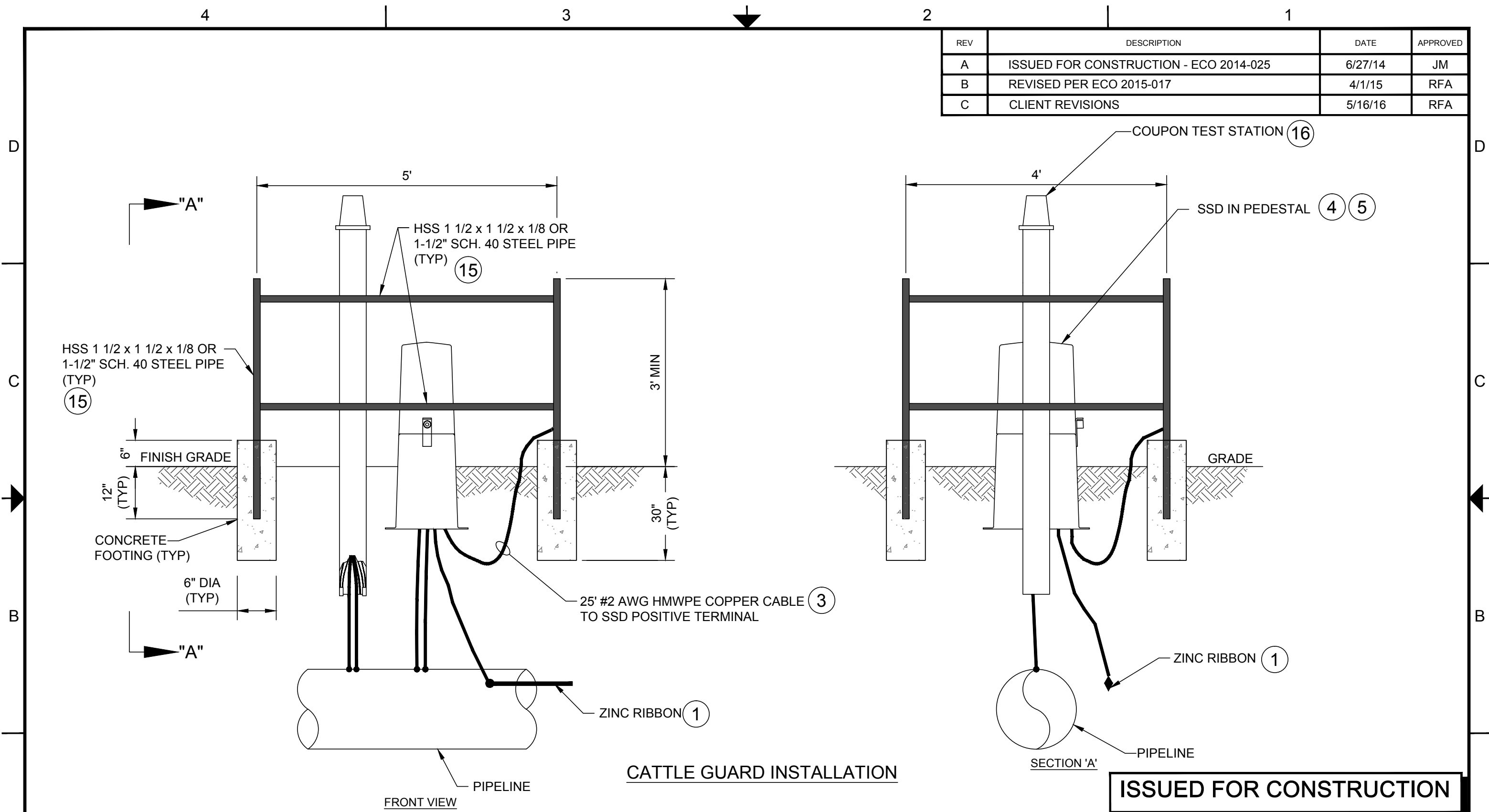
CONNECTIONS:		QUANTITY	CABLE/WIRE SIZE	COLOR
TEST STATION	PIPE/DEVICE			
PIPELINE 1	PIPELINE	1	#12	BLACK
PIPELINE 2	PIPELINE	1	#12	BLACK
NATIVE COUPON	NATIVE COUPON	1	#12	ORANGE
PROTECTED COUPON	CP COUPON	1	#12	BLUE
REFERENCE ELECTRODE	PERMANENT REFERENCE ELECTRODE	1	#14	YELLOW



**ISSUED FOR CONSTRUCTION**

<b>CLIENT</b> 		<b>ARK ENGINEERING &amp; TECH. SERVICES, INC.</b> 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.		<b>TITLE</b> COUPON TEST STATION WIRING DETAILS	
<b>SITE</b> VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT		<b>DRAWN BY</b> JRW	<b>DATE</b> 6/18/13	<b>SIZE</b> B	DWG. NO. 12144-303
<b>PROJECT NO.</b> 12-E-144-AC		<b>APPROVED BY</b> RFA	<b>DATE</b> 5/16/16	<b>SCALE</b> NTS	
The information contained on this drawing is confidential and is the sole property of ARK Engineering. Transferring this information to a third party or reproducing in part or in full without a written consent from ARK Engineering is prohibited.				<b>CAD FILE NAME</b> 12144-303-1-RC	
				<b>SHEET</b> 1 OF 1	<b>REV</b> C

REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM
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C	CLIENT REVISIONS	5/16/16	RFA



**CATTLE GUARD INSTALLATION**

**ISSUED FOR CONSTRUCTION**

- NOTES:**
- REFERENCE DRAWING 12144-201 & 303 FOR WIRING DETAILS.
  - VERMONT GAS TO DETERMINE SSD AND COUPON TEST STATION LOCATIONS REQUIRING CATTLE GUARD. CATTLE GUARD TO PROTECT SSD AND COUPON TEST STATION.

<b>CLIENT</b> 		<b>ARK ENGINEERING &amp; TECH. SERVICES, INC.</b> 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.		<b>TITLE</b> CATTLE GUARD INSTALLATION DETAIL	
<b>SITE</b> VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT		<b>DRAWN BY</b> JRW	<b>DATE</b> 6/18/13	<b>SIZE</b> B	<small>The information contained on this drawing is confidential and is the sole property of ARK Engineering. Transferring this information to a third party or reproducing in part or in full without a written consent from ARK Engineering is prohibited.</small>
<b>PROJECT NO.</b> 12-E-144-AC	<b>APPROVED BY</b> RFA	<b>DATE</b> 5/16/16	<b>SCALE</b> NTS	<b>DWG. NO.</b> 12144-304	
			<b>CAD FILE NAME</b> 12144-304-1-RC	<b>SHEET</b> 1 OF 1	

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REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM
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ITEM	QUANTITY	DESCRIPTION
1	37,200'	ZINC RIBBON ANODE, HIGH GRADE ELECTROLYTIC ZINC, 99.99% PURE. CONFORMS IN COMPOSITION TO ASTM B-418-73 TYPE II; 5/8" X 7/8" CROSS SECTION WITH 0.135" DIAMETER GALVANIZED STEEL CORE CABLE; NOMINAL WEIGHT OF 1.2 POUNDS PER FOOT. PLATT BROS. PP2, 1-1017P
2	5,000'	#6 A WG HMM/PE INSULATED STRANDED COPPER CABLE. SOFT-DRAWN, COMMERCIALY PURE COPPER, ASTM B8, CLASS B STRANDING.
3	1,600'	#2 A WG HMM/PE INSULATED STRANDED COPPER CABLE. SOFT-DRAWN, COMMERCIALY PURE COPPER, ASTM B8, CLASS B STRANDING.
4	58	SSD (SOLID STATE DECOUPLER), -3V/+1V BLOCKING VOLTAGE, 5KA FAULT CURRENT RATING (30 CYCLES) AT 50/60HZ, 100KA LIGHTNING SURGE CURRENT RATING (4 X 10 WAVEFORM). DAIRYLAND ELECTRICAL INDUSTRIES, P/N SSD-3/1-5.0-100.
5	58	SSD PEDESTAL, FIBERGLASS CASE: 6" X 6" X 42" HIGH, WITH STAINLESS STEEL BACK-PLATES FOR MOUNTING THE SOLID STATE DECOUPLING DEVICE. DAIRYLAND ELECTRICAL INDUSTRIES. P/N PEDESTAL - 42".
6	1	EXOTHERMIC WELD MOLD, THERMOWELD P/N M-7233. HANDLE CLAMP AND FLINT IGNITOR ARE INCLUDED. USED FOR ZINC RIBBON TO ZINC RIBBON IN-LINE SPLICE CONNECTIONS. USE #15CP WELD METAL.
7	3	EXOTHERMIC WELD MOLD, THERMOWELD P/N M102. HANDLE CLAMP AND FLINT IGNITOR ARE INCLUDED. USED FOR EXOTHERMIC WELD CONNECTION OF #6 & #12 A WG STRANDED CABLE TO PIPE. USES 15CP WELD METAL.
8	7 BOXES	EXOTHERMIC WELD METAL, THERMOWELD P/N #15CP. BONDS #6 AND #12 A WG CABLE TO PIPELINE. ALSO USED FOR ZINC RIBBON TO ZINC RIBBON. 20 SHOTS PER BOX.
9	2	EXOTHERMIC WELD MOLD, THERMOWELD P/N M-11638. HANDLE CLAMP AND FLINT IGNITOR ARE INCLUDED. USED FOR IN-LINE SPLICE OF ZINC RIBBON TO #2 A WG CABLE. USE #32CP WELD METAL.
10	7 BOXES	EXOTHERMIC WELD METAL, THERMOWELD P/N #32CP. USED FOR #2 A WG CABLE TO ZINC RIBBON CONNECTIONS. 10 SHOTS PER BOX.
11	116	BURNDY YA Z6C-TC38 COMPRESSION LUG. THESE LUGS WILL CONNECT THE #6 A WG COPPER CABLE TO THE SOLID STATE DECOUPLING DEVICES. TWO LUGS PER SSD.
12	64	BURNDY YA Z2C-TC38 COMPRESSION LUG. THESE LUGS WILL CONNECT THE #2 A WG COPPER CABLE TO THE SOLID STATE DECOUPLING DEVICES. ONE OR TWO LUGS PER SSD.
13	58 TUBES	TWO PART EPOXY: SPECIALTY POLYMER COATINGS, INC SP-2888 (OR APPROVED EQUAL). USED FOR REPAIRING PIPE COATING AT #6 A WG CONNECTIONS TO PIPE. APPLY 20 MILS THICK MIN. 50ML TUBE WILL REPAIR TWO #6 EXOTHERMIC WELDS TO PIPE.
14	85 KITS	ROYSTON SPLICE RIGHT KIT (OR APPROVED EQUAL). INSULATION KIT FOR EXOTHERMIC WELD SPLICE CONNECTIONS.
15	4 (MIN.)	CATTLE GUARD, 5' X 4' X 3' MIN. ABOVE GRADE. CONSTRUCTED OF HOLLOW STEEL SECTION (HSS) 1 1/2 x 1 1/2 x 1/8 THICK OR 1.5" DIAMETER SCH. 40 STEEL PIPE, ANCHORED AT ALL FOUR CORNERS 30" DEEP X 6" DIAMETER CONCRETE FOOTINGS. CATTLE GUARD TO BE COATED WITH 6 MIL OF YELLOW POWDER COAT PER MANUFACTURER SPECIFICATION.
16	8	TEST STATION, DUAL COUPON (STEEL PIN) ON TELESCOPING 7" YELLOW CONDUIT. BINGHAM AND TAYLOR P/N CTS 1.4. COUPON SURFACE AREA OF 1.44 SQUARE INCHES.
17	400'	COPPER CABLE #12 A WG STRANDED, BLACK PVC INSULATED, TYPE TW/THW, 600V RATED, SUITABLE FOR WET OR DRY LOCATIONS, TEMP RANGE -25°C TO 75°C. ASTM B-1, B-3 & B-8 COMPLIANT FOR COPPER CONDUCTORS. ROHS COMPLIANT. USED FOR CONNECTIONS FROM TEST STATIONS TO PIPE.
18	8	PERMANENT REFERENCE ELECTRODE (CU/CUS04) FOR REMOTE USE AT COUPON TEST STATIONS. ELECTROCHEMICAL DEVICES INC P/N: MODEL UL-CUG-SW. INCLUDES 50 FT OF #14 A WG YELLOW HMM/PE WIRE, PREPACKAGED REFERENCE ELECTRODE.
19	20	ADAPTER SLEEVE FOR USE WITH THERMOWELD TYPE CS-32, MOLD # M-102 (THERMOWELD OR EQUAL). P/N 38-0200-00 (THERMOWELD OR EQUAL). USED FOR EXOTHERMIC WELD CONNECTION OF #12 A WG STRANDED COPPER CABLE TO PIPE.

**ISSUED FOR CONSTRUCTION**

**NOTE:**  
 ARK ENGINEERING CAN PROVIDE ALL MATERIALS LISTED ABOVE AND INSTALLATION SERVICES. PLEASE CALL 1-800-469-3436 FOR A MATERIAL OR INSTALLATION QUOTATION.

CLIENT  SITE VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT		 ARK ENGINEERING & TECH. SERVICES, INC. 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.		TITLE MATERIALS LIST	
PROJECT NO. 12-E-144-AC		DRAWN BY JRW		DATE 6/18/13	
APPROVED BY RFA		DATE 5/16/16		SIZE B	
SCALE NTS		DWG. NO. 12144-400		REV C	
SHEET 1 OF 1		CAD FILE NAME 12144-400-1-RC		The information contained on this drawing is confidential and is the sole property of ARK Engineering. Transferring this information to a third party or reproducing in part or in full without a written consent from ARK Engineering is prohibited.	

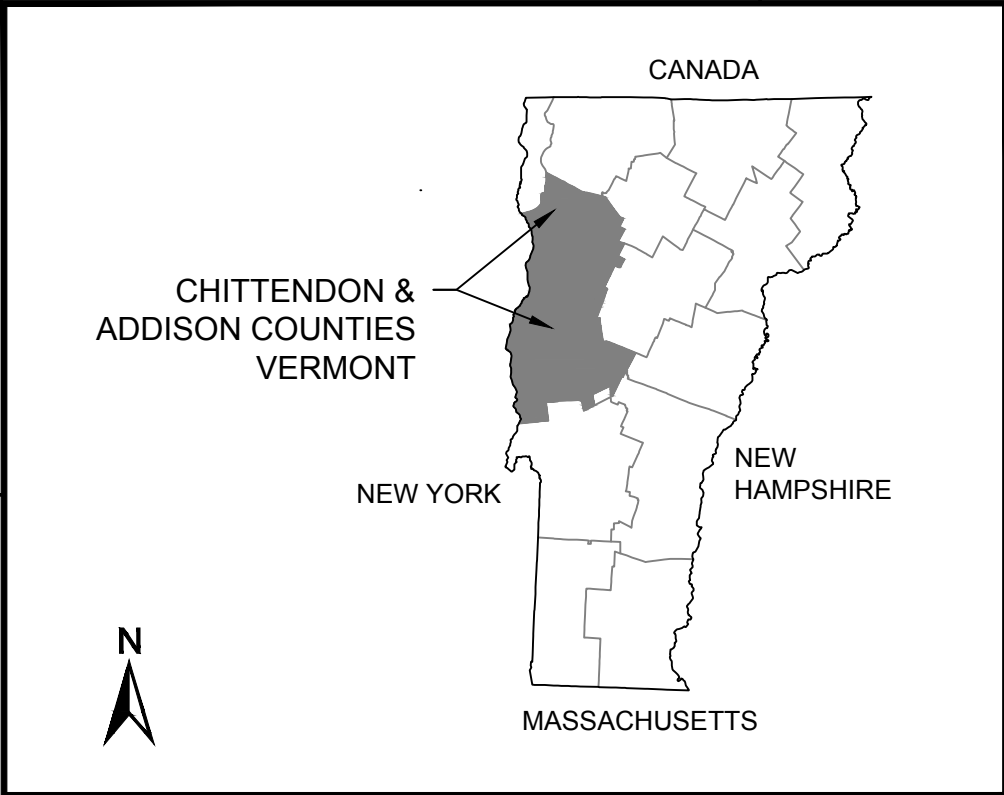
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REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM
B	REVISED PER ECO 2015-017	4/3/15	RFA



**VERMONT GAS SYSTEMS, INC.**  
**ADDISON NATURAL GAS PROJECT**  
**VALVES: WILLISTON M & R**  
**MLV-2, MLV-3, MLV-4,**  
**MLV-5/ PLANK ROAD M & R, MLV-6,**  
**COLCHESTER LAUNCHER,**  
**MIDDLEBURY M & R**  
**AC MITIGATION SYSTEM DESIGN**  
**VALVE SITE GROUNDING INSTALLATION DRAWINGS**  
**CHITTENDON & ADDISON COUNTIES, VERMONT**

**PROJECT DRAWING LISTING**

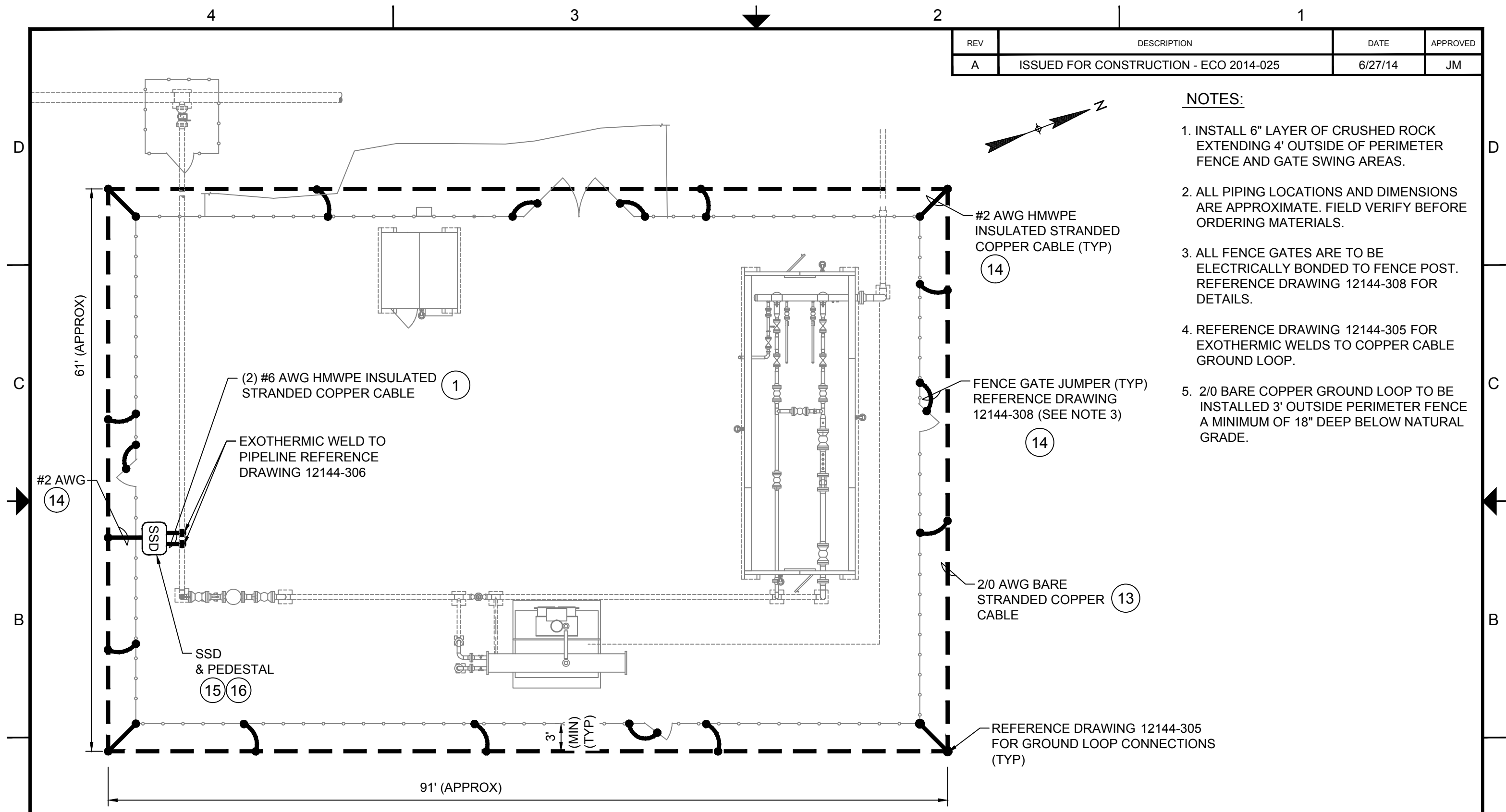
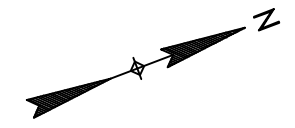
DRAWING NO.	SHEETS	REV	TITLE
12144-101	1	B	COVER SHEET
12144-205	1	A	GROUNDING PLAN - WILLISTON M & R
12144-206	1	A	GROUNDING PLAN - MLV-2
12144-207	1	B	GROUNDING PLAN - MLV-3
12144-208	1	A	GROUNDING PLAN - MLV-4
12144-209	1	A	GROUNDING PLAN - MLV-5/PLANK ROAD M & R
12144-210	1	A	GROUNDING PLAN - MLV-6
12144-211	1	A	GROUNDING PLAN - COLCHESTER LAUNCHER
12144-212	1	A	GROUNDING PLAN - MIDDLEBURY M & R
12144-305	1	A	GROUND LOOP SPLICE CONNECTION DETAILS
12144-306	1	A	CABLE TO PIPELINE CONNECTION DETAILS
12144-307	1	A	SOLID STATE DECOUPLER (SSD) INSTALLATION DETAILS
12144-308	1	A	FENCE & GATE CLAMP CONNECTION DETAILS
12144-309	1	A	GROUND ROD INSTALLATION DETAILS - DRILL PROCEDURE
12144-401	2	B	MATERIALS LIST

<b>CLIENT</b>  <b>SITE</b> VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT		 <b>ENGINEERING &amp; TECHNICAL SERVICES, INC.</b> ARK ENGINEERING & TECH. SERVICES, INC. 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.		<b>TITLE</b> <p style="text-align: center; font-size: 24pt;"><b>COVER SHEET</b></p>	
<b>DRAWN BY</b> JRW	<b>DATE</b> 6/18/13	<b>SIZE</b> B	<small>The information contained on this drawing is confidential and is the sole property of ARK Engineering. Transferring this information to a third party or reproducing in part or in full without a written consent from ARK Engineering is prohibited.</small>		<b>DWG. NO.</b> 12144-101
<b>APPROVED BY</b> JM	<b>DATE</b> 9/30/13	<b>SCALE</b> NTS	<b>CAD FILE NAME</b> 12144-101-1-RB	<b>SHEET</b> 1 OF 1	<b>REV</b> B

REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM

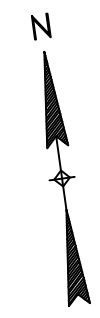
**NOTES:**

1. INSTALL 6" LAYER OF CRUSHED ROCK EXTENDING 4' OUTSIDE OF PERIMETER FENCE AND GATE SWING AREAS.
2. ALL PIPING LOCATIONS AND DIMENSIONS ARE APPROXIMATE. FIELD VERIFY BEFORE ORDERING MATERIALS.
3. ALL FENCE GATES ARE TO BE ELECTRICALLY BONDED TO FENCE POST. REFERENCE DRAWING 12144-308 FOR DETAILS.
4. REFERENCE DRAWING 12144-305 FOR EXOTHERMIC WELDS TO COPPER CABLE GROUND LOOP.
5. 2/0 BARE COPPER GROUND LOOP TO BE INSTALLED 3' OUTSIDE PERIMETER FENCE A MINIMUM OF 18" DEEP BELOW NATURAL GRADE.



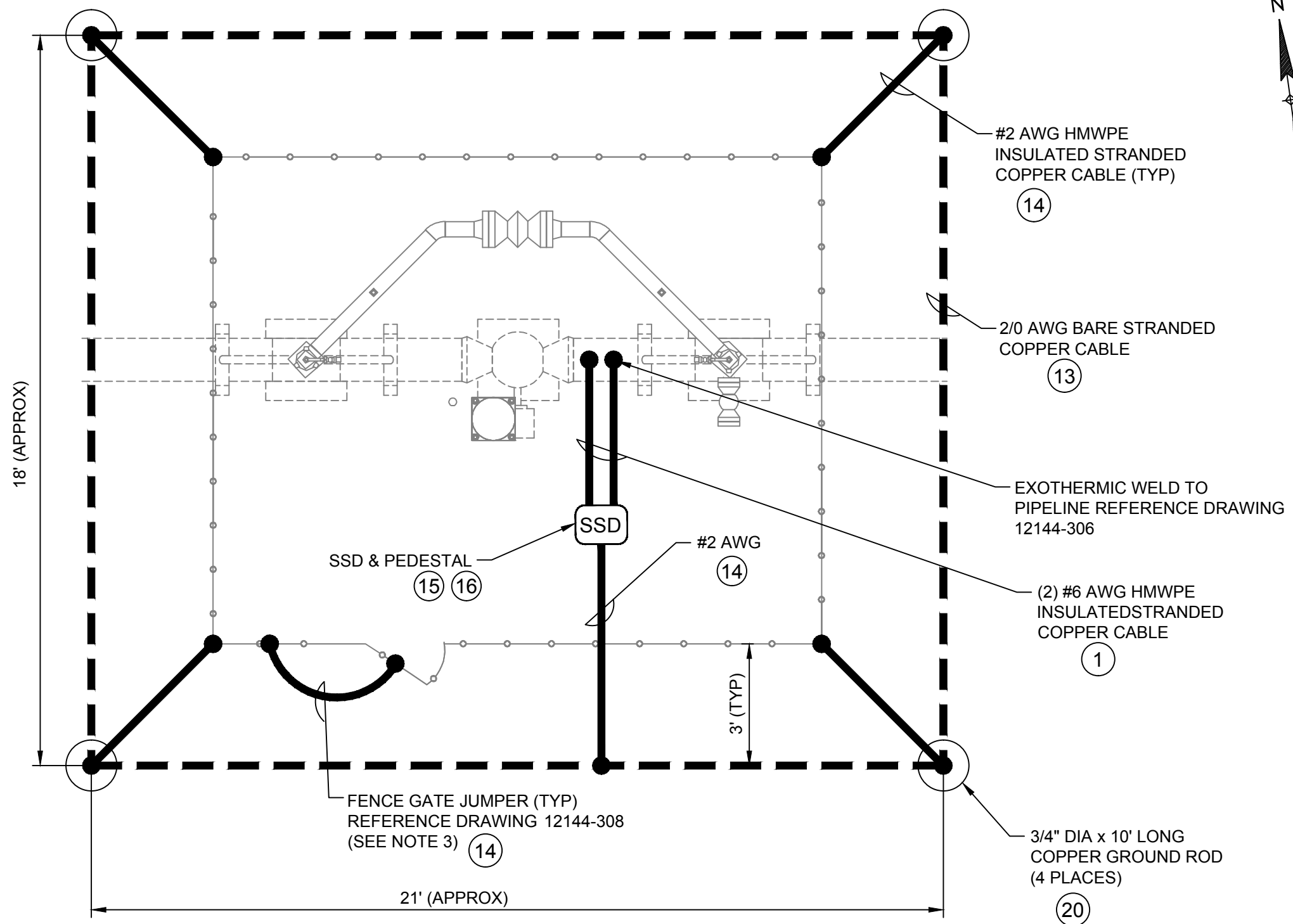
CLIENT 		ARK ENGINEERING & TECH. SERVICES, INC. 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.		TITLE GROUNDING PLAN - WILLISTON M & R	
SITE VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT		DRAWN BY JRW	DATE 6/18/13	SIZE B	DWG. NO. 12144-205
PROJECT NO. 12-E-144-AC		APPROVED BY JM	DATE 9/30/13	SCALE NTS	
			The information contained on this drawing is confidential and is the sole property of ARK Engineering. Transferring this information to a third party or reproducing in part or in full without a written consent from ARK Engineering is prohibited.		REV A
			CAD FILE NAME 12144-205-1-RA		SHEET 1 OF 1

REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM



**NOTES:**

1. INSTALL 6" LAYER OF CRUSHED ROCK EXTENDING 4' OUTSIDE OF PERIMETER FENCE AND GATE SWING AREAS.
2. ALL PIPING LOCATIONS AND DIMENSIONS ARE APPROXIMATE. FIELD VERIFY BEFORE ORDERING MATERIALS.
3. ALL FENCE GATES ARE TO BE ELECTRICALLY BONDED TO FENCE POST. REFERENCE DRAWING 12144-308 FOR DETAILS.
4. REFERENCE DRAWING 12144-305 FOR EXOTHERMIC WELDS TO COPPER CABLE GROUND LOOP.
5. 2/0 BARE COPPER GROUND LOOP TO BE INSTALLED 3' OUTSIDE PERIMETER FENCE A MINIMUM OF 18" BELOW NATURAL GRADE.
6. IF GROUND RODS REQUIRE DRILLING, REFERENCE DWG. 12144-309 FOR DRILLING PROCEDURE.
7. GROUND RODS TO BE INSTALLED AT EACH CORNER OF GROUND LOOP.



18' (APPROX)

21' (APPROX)

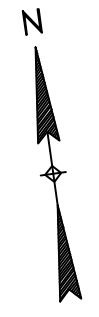
3' (TYP)

**LEGEND**

● GROUND ROD

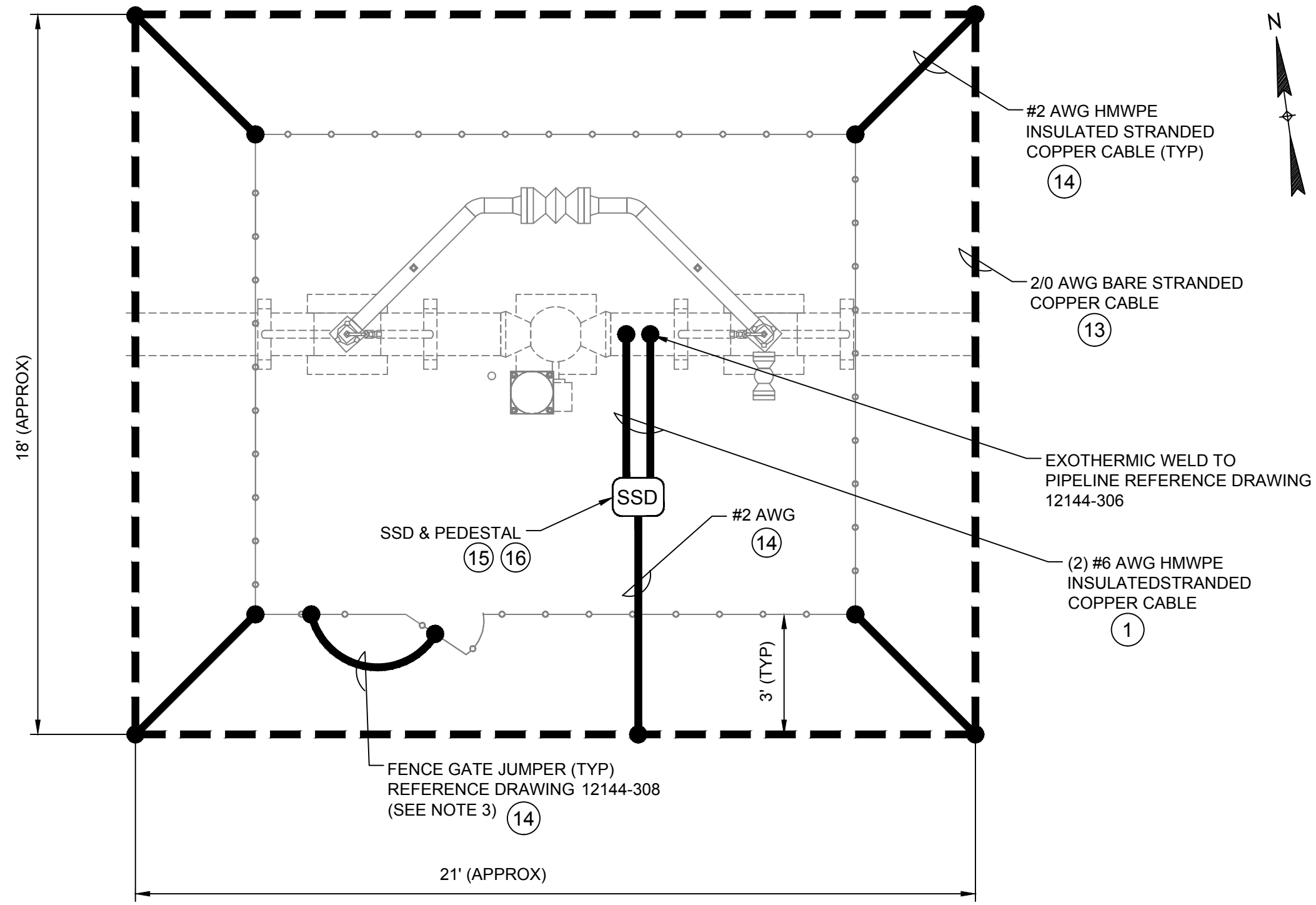
CLIENT 		ARK ENGINEERING & TECH. SERVICES, INC. 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.		TITLE <b>GROUNDING PLAN - MLV-2</b>	
SITE VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT	DRAWN BY JRW	DATE 6/18/13	SIZE B	DWG. NO. 12144-206	REV A
PROJECT NO. 12-E-144-AC	APPROVED BY JM	DATE 9/30/13	SCALE NTS	CAD FILE NAME 12144-206-1-RA	SHEET 1 OF 1

REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM
B	REVISED PER ECO 2015-017	4/3/15	RFA



**NOTES:**

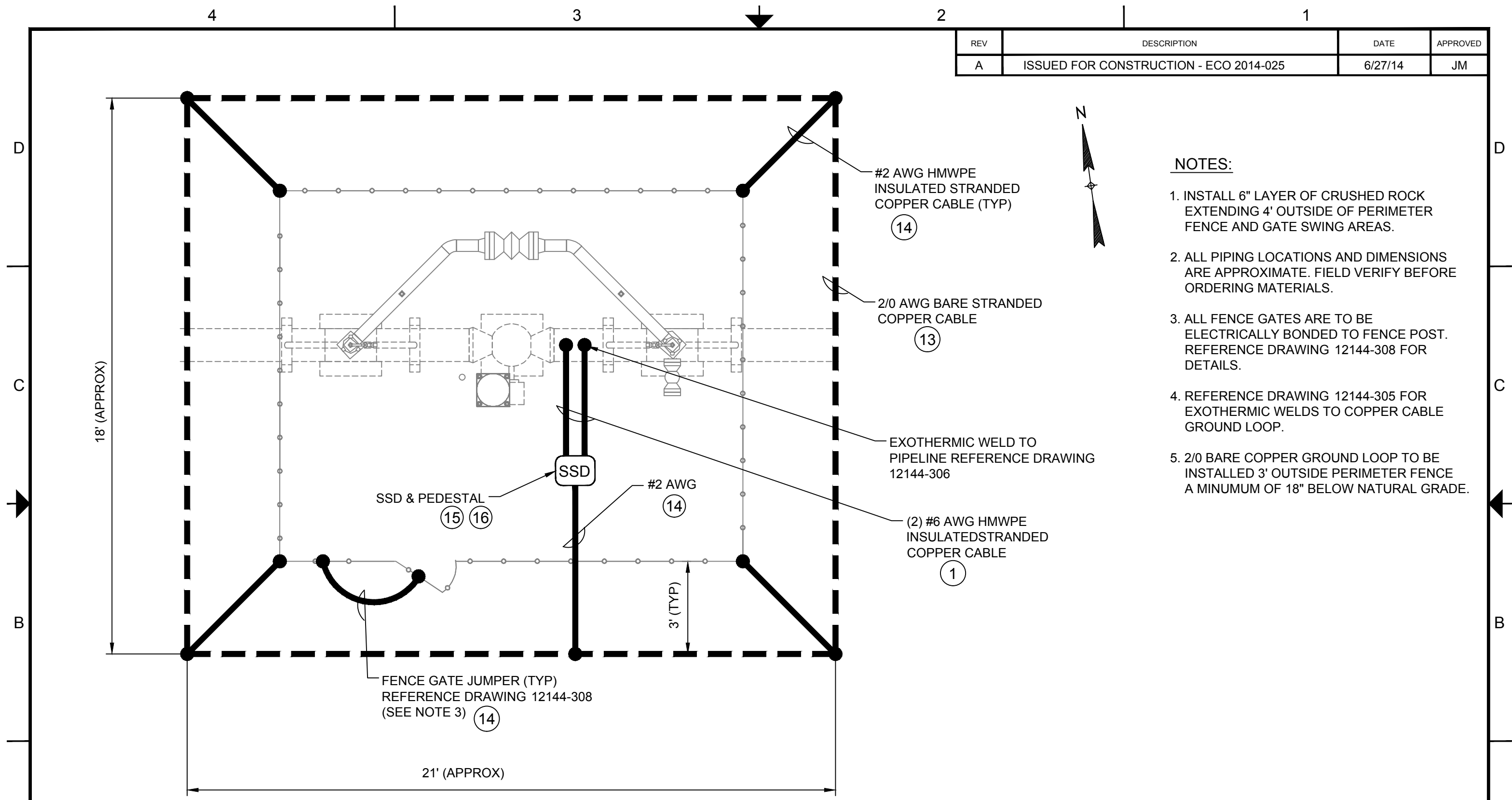
1. INSTALL 6" LAYER OF CRUSHED ROCK EXTENDING 4' OUTSIDE OF PERIMETER FENCE AND GATE SWING AREAS.
2. ALL PIPING LOCATIONS AND DIMENSIONS ARE APPROXIMATE. FIELD VERIFY BEFORE ORDERING MATERIALS.
3. ALL FENCE GATES ARE TO BE ELECTRICALLY BONDED TO FENCE POST. REFERENCE DRAWING 12144-308 FOR DETAILS.
4. REFERENCE DRAWING 12144-305 FOR EXOTHERMIC WELDS TO COPPER CABLE GROUND LOOP.
5. 2/0 BARE COPPER GROUND LOOP TO BE INSTALLED 3' OUTSIDE PERIMETER FENCE A MINIMUM OF 18" BELOW NATURAL GRADE.



CLIENT 		ARK ENGINEERING & TECH. SERVICES, INC. 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.		TITLE GROUNDING PLAN - MLV-3	
SITE VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT		DRAWN BY JRW	DATE 6/18/13	SIZE B	DWG. NO. 12144-207
PROJECT NO. 12-E-144-AC		APPROVED BY JM	DATE 9/30/13	SCALE NTS	CAD FILE NAME 12144-207-1-RB
				SHEET 1 OF 1	REV B



REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM



- NOTES:**
1. INSTALL 6" LAYER OF CRUSHED ROCK EXTENDING 4' OUTSIDE OF PERIMETER FENCE AND GATE SWING AREAS.
  2. ALL PIPING LOCATIONS AND DIMENSIONS ARE APPROXIMATE. FIELD VERIFY BEFORE ORDERING MATERIALS.
  3. ALL FENCE GATES ARE TO BE ELECTRICALLY BONDED TO FENCE POST. REFERENCE DRAWING 12144-308 FOR DETAILS.
  4. REFERENCE DRAWING 12144-305 FOR EXOTHERMIC WELDS TO COPPER CABLE GROUND LOOP.
  5. 2/0 BARE COPPER GROUND LOOP TO BE INSTALLED 3' OUTSIDE PERIMETER FENCE A MINIMUM OF 18" BELOW NATURAL GRADE.

<b>CLIENT</b>  SITE VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT		 ARK ENGINEERING & TECH. SERVICES, INC. 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.		<b>TITLE</b> GROUNDING PLAN - MLV-4	
DRAWN BY JRW	DATE 6/18/13	SIZE B	DWG. NO. 12144-208		REV A
PROJECT NO. 12-E-144-AC	APPROVED BY JM	DATE 9/30/13	SCALE NTS	CAD FILE NAME 12144-208-1-RA	SHEET 1 OF 1

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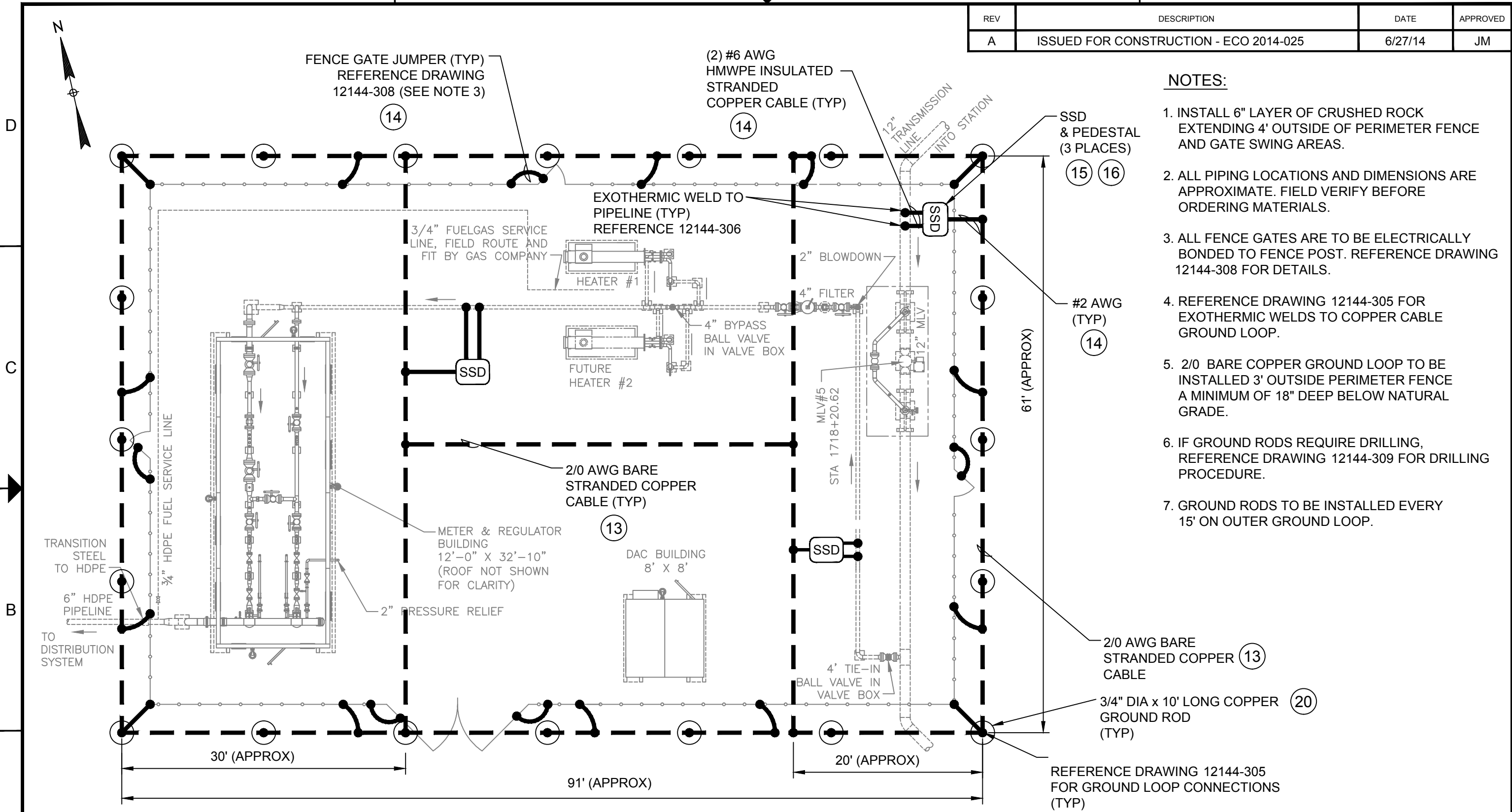
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REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM

**NOTES:**

1. INSTALL 6" LAYER OF CRUSHED ROCK EXTENDING 4' OUTSIDE OF PERIMETER FENCE AND GATE SWING AREAS.
2. ALL PIPING LOCATIONS AND DIMENSIONS ARE APPROXIMATE. FIELD VERIFY BEFORE ORDERING MATERIALS.
3. ALL FENCE GATES ARE TO BE ELECTRICALLY BONDED TO FENCE POST. REFERENCE DRAWING 12144-308 FOR DETAILS.
4. REFERENCE DRAWING 12144-305 FOR EXOTHERMIC WELDS TO COPPER CABLE GROUND LOOP.
5. 2/0 BARE COPPER GROUND LOOP TO BE INSTALLED 3' OUTSIDE PERIMETER FENCE A MINIMUM OF 18" DEEP BELOW NATURAL GRADE.
6. IF GROUND RODS REQUIRE DRILLING, REFERENCE DRAWING 12144-309 FOR DRILLING PROCEDURE.
7. GROUND RODS TO BE INSTALLED EVERY 15' ON OUTER GROUND LOOP.

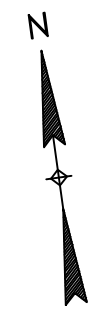


**LEGEND**

	GROUND ROD
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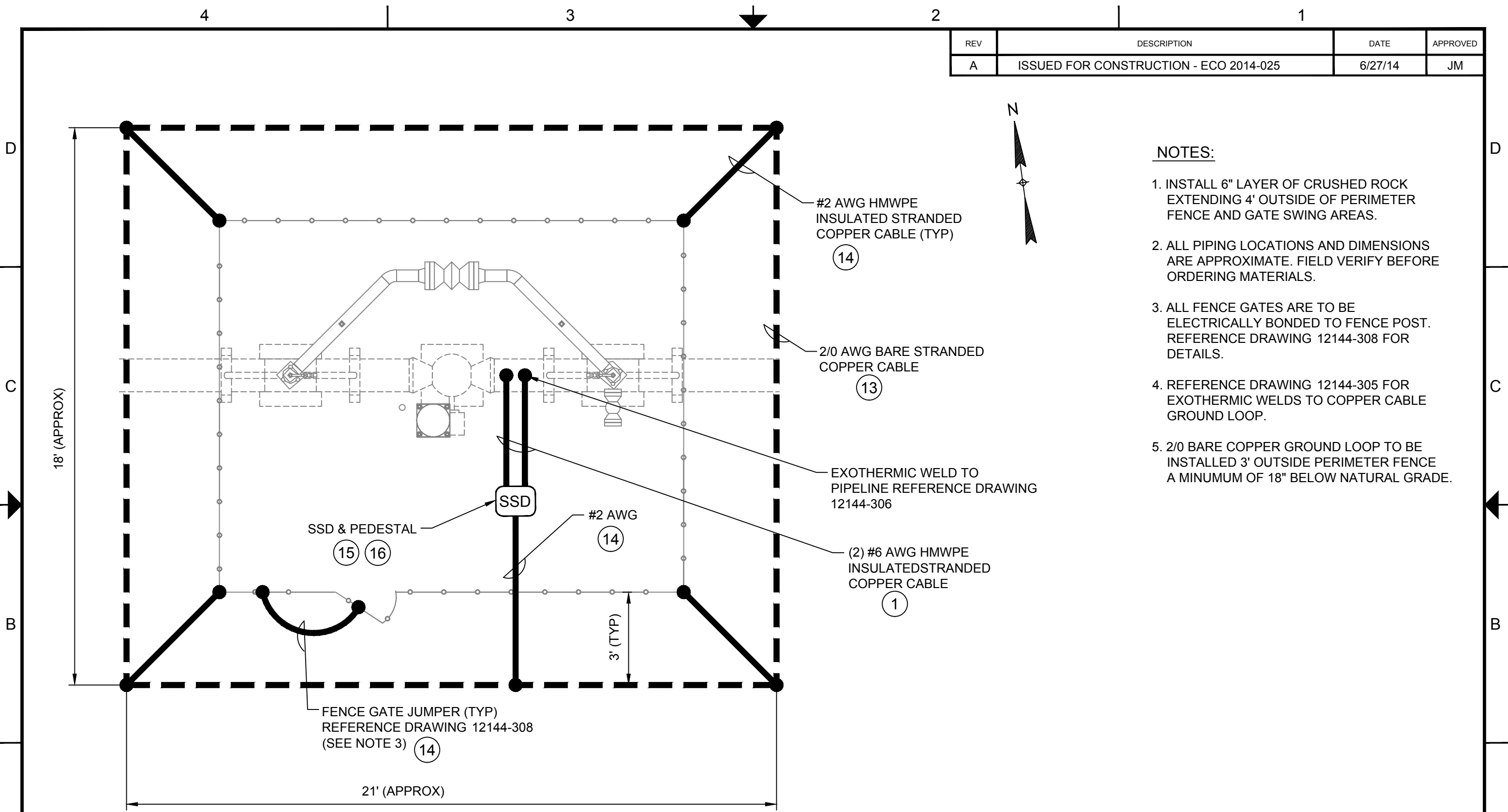
<b>CLIENT</b>  SITE VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT		<b>ARK</b> ENGINEERING & TECHNICAL SERVICES, INC. 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.		<b>TITLE</b> GROUNDING PLAN - MLV-5/PLANK ROAD M & R	
DRAWN BY JRW	DATE 6/18/13	SIZE B	The information contained on this drawing is confidential and is the sole property of ARK Engineering. Transferring this information to a third party or reproducing in part or in full without a written consent from ARK Engineering is prohibited.		DWG. NO. 12144-209
PROJECT NO. 12-E-144-AC	APPROVED BY JM	DATE 9/30/13	SCALE NTS	CAD FILE NAME 12144-209-1-RA	REV A
			SHEET 1 OF 1		

REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM



**NOTES:**

1. INSTALL 6" LAYER OF CRUSHED ROCK EXTENDING 4' OUTSIDE OF PERIMETER FENCE AND GATE SWING AREAS.
2. ALL PIPING LOCATIONS AND DIMENSIONS ARE APPROXIMATE. FIELD VERIFY BEFORE ORDERING MATERIALS.
3. ALL FENCE GATES ARE TO BE ELECTRICALLY BONDED TO FENCE POST. REFERENCE DRAWING 12144-308 FOR DETAILS.
4. REFERENCE DRAWING 12144-305 FOR EXOTHERMIC WELDS TO COPPER CABLE GROUND LOOP.
5. 2/0 BARE COPPER GROUND LOOP TO BE INSTALLED 3' OUTSIDE PERIMETER FENCE A MINIMUM OF 18" BELOW NATURAL GRADE.



CLIENT 		ARK ENGINEERING & TECH. SERVICES, INC. 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.		TITLE GROUNDING PLAN - MLV-6	
SITE VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT		DRAWN BY JRW	DATE 6/18/13	SIZE B	DWG. NO. 12144-210
PROJECT NO. 12-E-144-AC		APPROVED BY JM	DATE 9/30/13	SCALE NTS	REV A
CAD FILE NAME 12144-210-1-RA			SHEET 1 OF 1		

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REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM

**NOTES:**

1. INSTALL 6" LAYER OF CRUSHED ROCK EXTENDING 4' OUTSIDE OF PERIMETER FENCE AND GATE SWING AREAS.
2. ALL PIPING LOCATIONS AND DIMENSIONS ARE APPROXIMATE. FIELD VERIFY BEFORE ORDERING MATERIALS.
3. ALL FENCE GATES ARE TO BE ELECTRICALLY BONDED TO FENCE POST. REFERENCE DRAWING 12144-308 FOR DETAILS.
4. REFERENCE DRAWING 12144-305 FOR EXOTHERMIC WELDS TO COPPER CABLE GROUND LOOP.
5. 2/0 BARE COPPER GROUND LOOP TO BE INSTALLED 3' OUTSIDE PERIMETER FENCE A MINIMUM OF 18" DEEP BELOW NATURAL GRADE.

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D

C

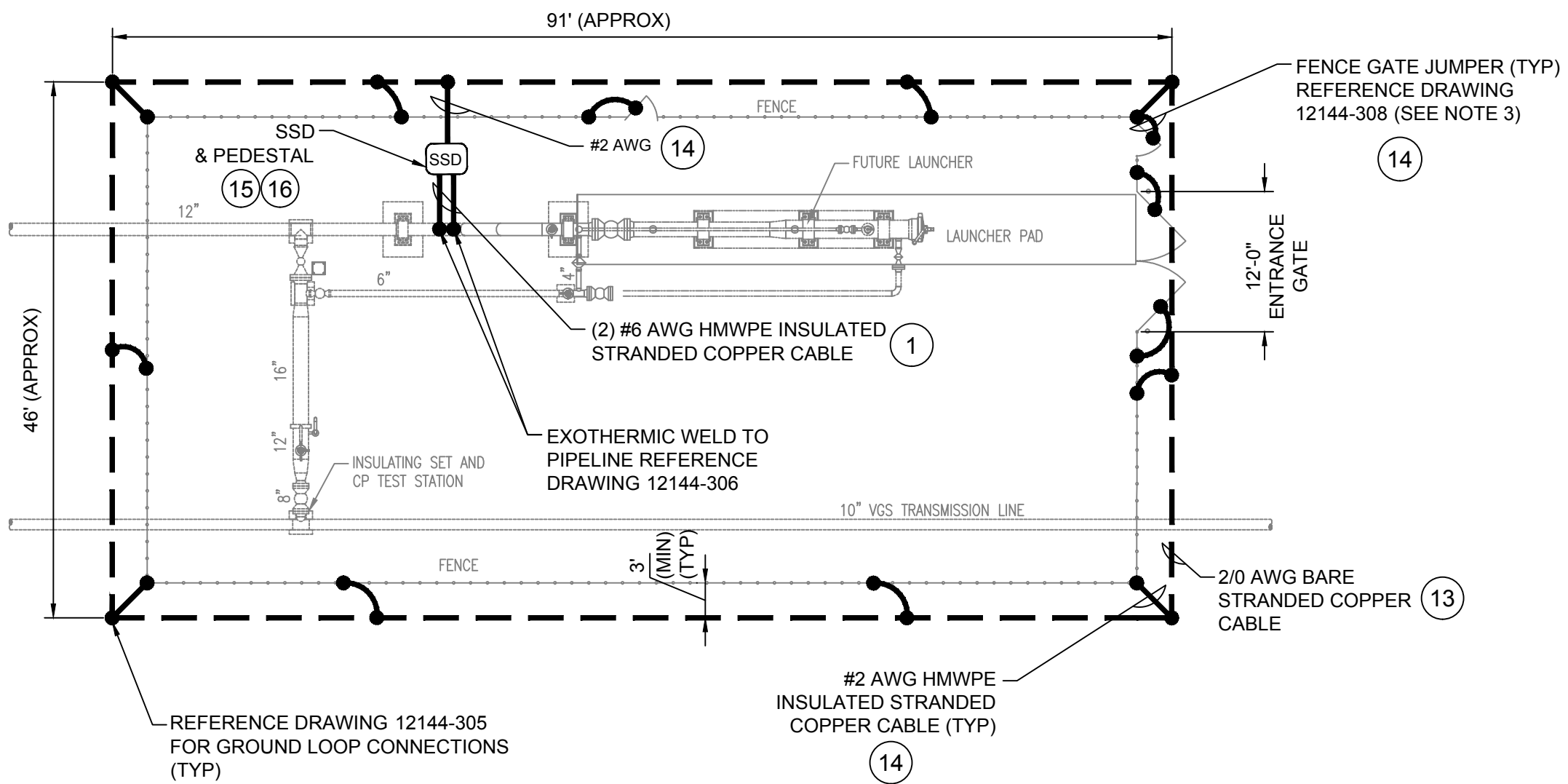
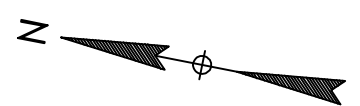
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A

A



CLIENT  SITE VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT	 ARK ENGINEERING & TECH. SERVICES, INC. 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.	TITLE <b>GROUNDING PLAN - COLCHESTER LAUNCHER</b>		
		DRAWN BY JRW	DATE 6/18/13	SIZE B
PROJECT NO. 12-E-144-AC	APPROVED BY JM	DATE 9/30/13	SCALE NTS	CAD FILE NAME 12144-211-1-RA
			SHEET 1 OF 1	REV A

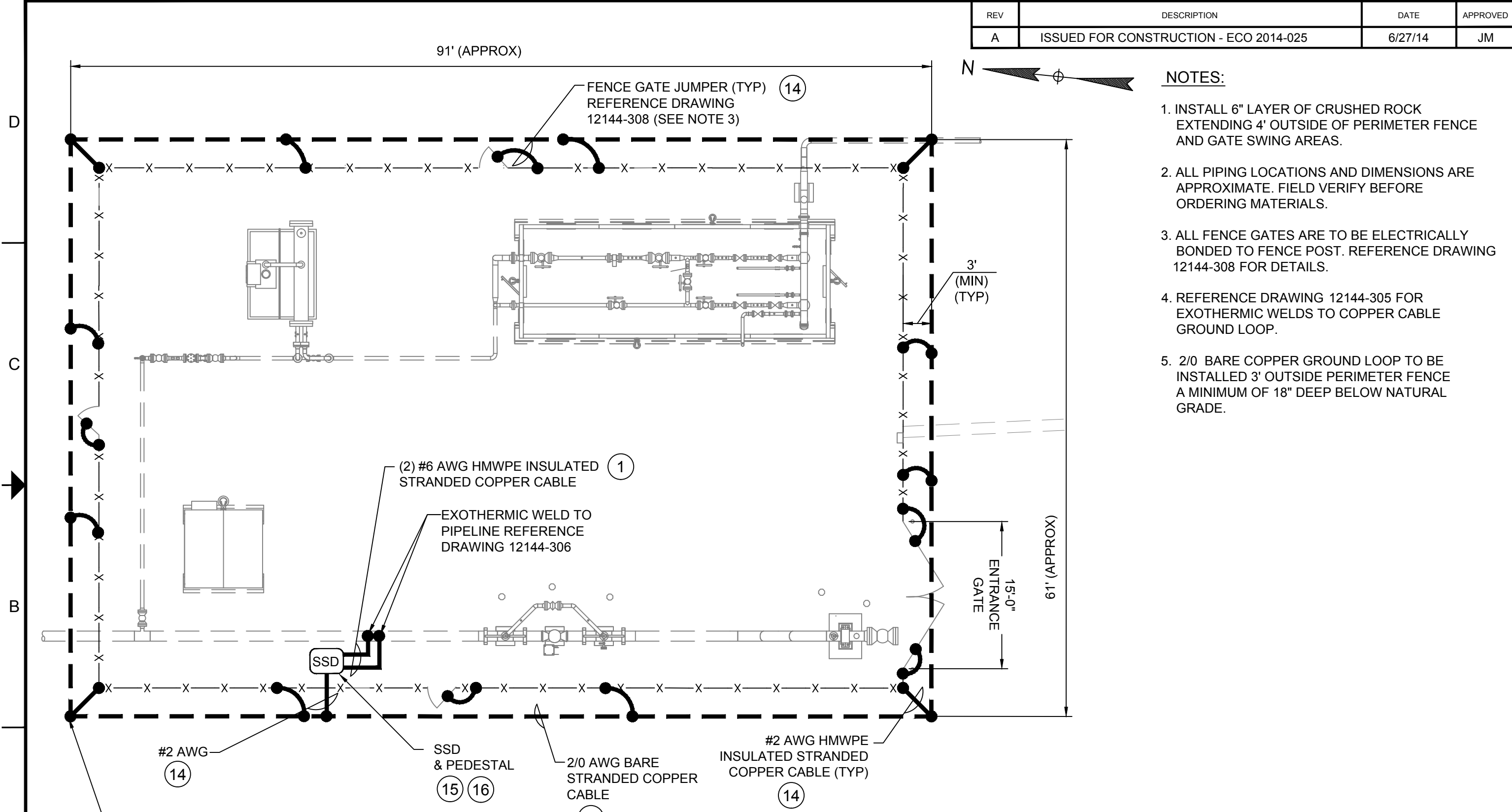
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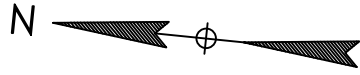
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REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM

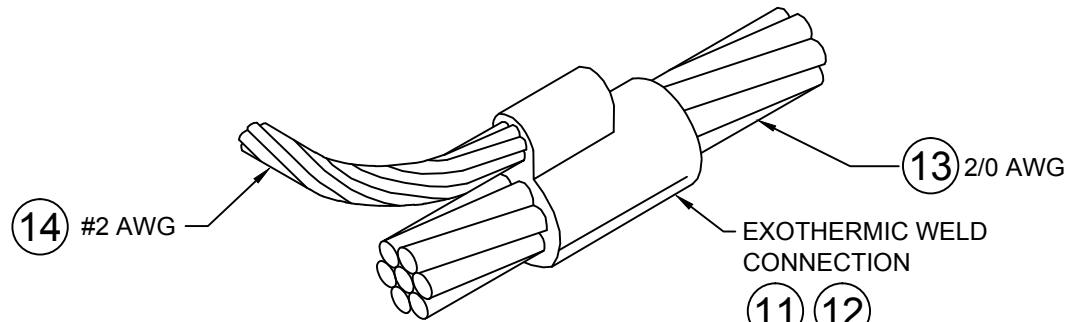


- NOTES:**
1. INSTALL 6" LAYER OF CRUSHED ROCK EXTENDING 4' OUTSIDE OF PERIMETER FENCE AND GATE SWING AREAS.
  2. ALL PIPING LOCATIONS AND DIMENSIONS ARE APPROXIMATE. FIELD VERIFY BEFORE ORDERING MATERIALS.
  3. ALL FENCE GATES ARE TO BE ELECTRICALLY BONDED TO FENCE POST. REFERENCE DRAWING 12144-308 FOR DETAILS.
  4. REFERENCE DRAWING 12144-305 FOR EXOTHERMIC WELDS TO COPPER CABLE GROUND LOOP.
  5. 2/0 BARE COPPER GROUND LOOP TO BE INSTALLED 3' OUTSIDE PERIMETER FENCE A MINIMUM OF 18" DEEP BELOW NATURAL GRADE.

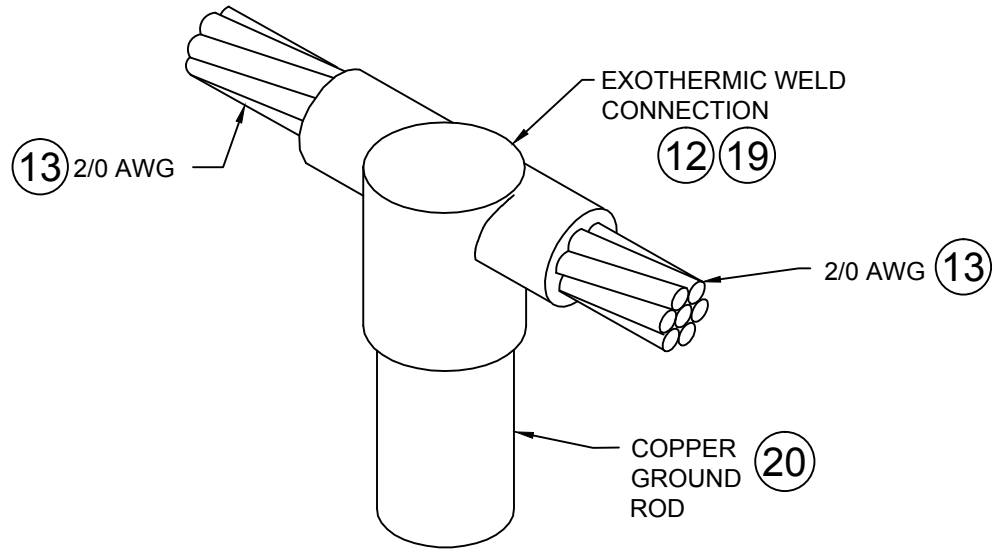


CLIENT <b>CHA</b> SITE VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT	 ARK ENGINEERING & TECH. SERVICES, INC. 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.	TITLE <b>GROUNDING PLAN - MIDDLEBURY M &amp; R</b>		
		DRAWN BY JRW	DATE 6/18/13	SIZE B
PROJECT NO. 12-E-144-AC	APPROVED BY JM	DATE 9/30/13	SCALE NTS	CAD FILE NAME 12144-212-1-RA
<small>The information contained on this drawing is confidential and is the sole property of ARK Engineering. Transferring this information to a third party or reproducing in part or in full without a written consent from ARK Engineering is prohibited.</small>			SHEET 1 OF 1	REV A

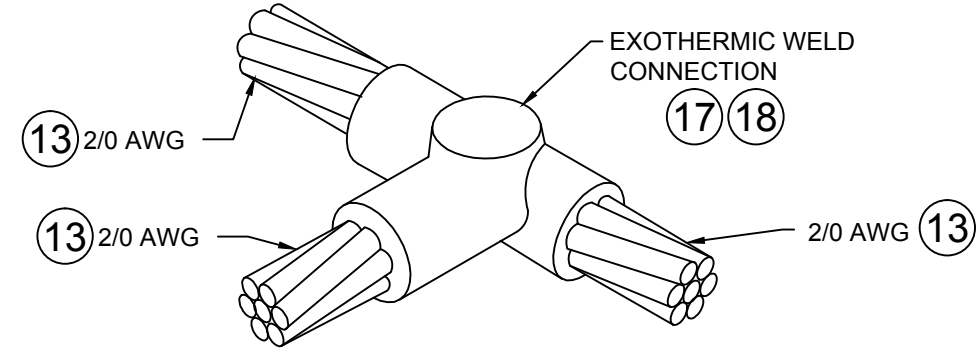
REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM



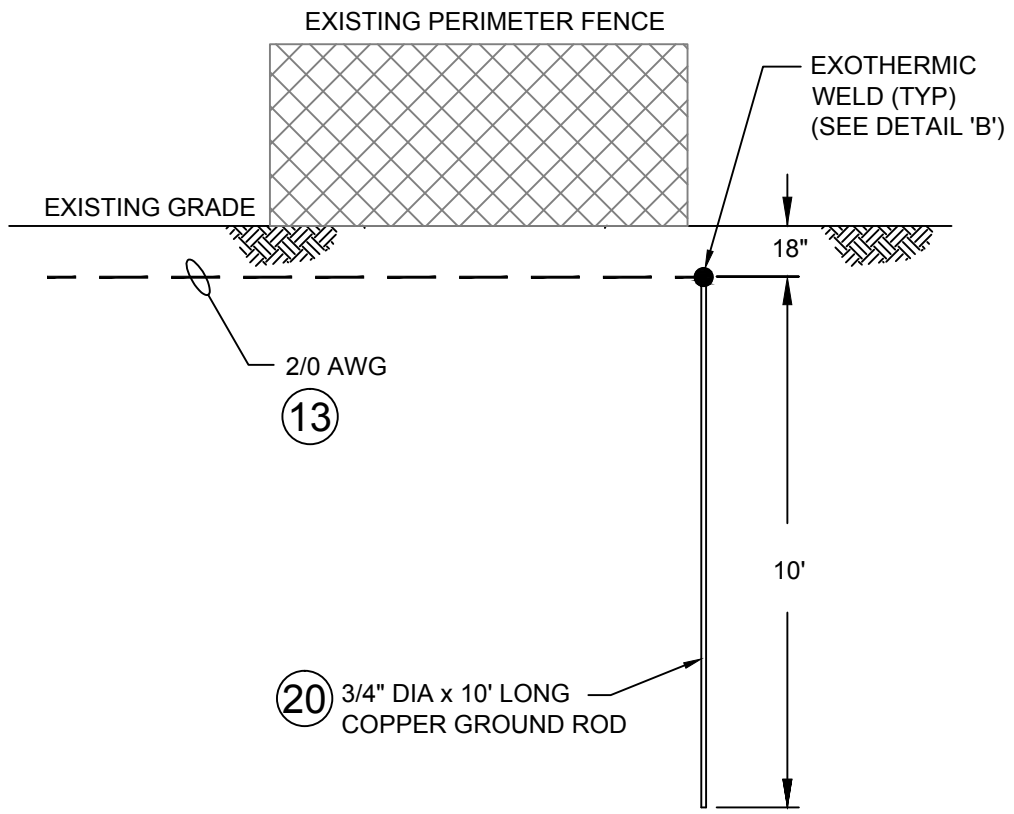
**DETAIL 'A'**  
BARE 2/0 AWG STRANDED COPPER CABLE TO #2 AWG STRANDED COPPER CABLE EXOTHERMIC WELD INSTALLATION



**DETAIL 'B'**  
BARE 2/0 AWG STRANDED COPPER CABLE TO COPPER GROUND ROD EXOTHERMIC WELD INSTALLATION



**DETAIL 'C'**  
BARE 2/0 AWG STRANDED COPPER CABLE RUN WITH BARE 2/0 AWG STRANDED COPPER CABLE TAP EXOTHERMIC WELD INSTALLATION



**GROUND ROD CONNECTIONS DETAIL**  
SIDE VIEW

**NOTES:**

1. ALL EXOTHERMIC WELD CONNECTIONS ARE TO BE SEALED WITH ROYSTON "SPlice RIGHT" SPlice KIT, OR VERMONT GAS APPROVED ALTERNATIVE.
2. REFERENCE DRAWING 12144-206, -207 & -209 FOR LOCATIONS AND QUANTITIES OF GROUND RODS.
3. IF GROUND RODS REQUIRE DRILLING, REFERENCE DRAWING 12144-309 FOR DRILLING PROCEDURE.

**NOTES - 2/0 AWG COPPER CABLE TO COPPER GROUND ROD EXOTHERMIC WELD:**

1. SEAL BOTTOM OF EXOTHERMIC WELD MOLD WITH WELD PUTTY PRIOR TO EXOTHERMIC WELD PROCESS TO PREVENT LEAKAGE.
2. IF GROUND ROD END IS MUSHROOMED DURING INSTALLATION AND CANNOT ACCEPT THE EXOTHERMIC MOLD, THE END MAY REQUIRE REMOVAL PRIOR TO EXOTHERMIC WELD PROCESS.
3. GROUND RODS MUST BE CLEAN, SHINY AND DRY TO HELP ENSURE A GOOD WELD.
4. INSTALL ROYSTON SPlice RIGHT KIT ON 2/0 AWG COPPER CABLE TO GROUND ROD EXOTHERMIC CONNECTION.

DETAIL	MOLD	WELD METAL
'A'	TYPE CC-6 M-8306	(2) #45
'B'	TYPE CR-2 M2005	(2) #45
'C'	TYPE CC-2 M-232	#90

<b>CLIENT</b>  <b>SITE</b> VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT	 <b>ENGINEERING &amp; TECHNICAL SERVICES, INC.</b> ARK ENGINEERING & TECH. SERVICES, INC. 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.	<b>TITLE</b> GROUND LOOP SPlice CONNECTION DETAILS		
		<b>DRAWN BY</b> JRW	<b>DATE</b> 6/18/13	<b>SIZE</b> B
<b>PROJECT NO.</b> 12-E-144-AC	<b>APPROVED BY</b> JM	<b>DATE</b> 9/30/13	<b>SCALE</b> NTS	<b>CAD FILE NAME</b> 12144-305-1-RA
			<b>REVISION</b> A	<b>SHEET</b> 1 OF 1

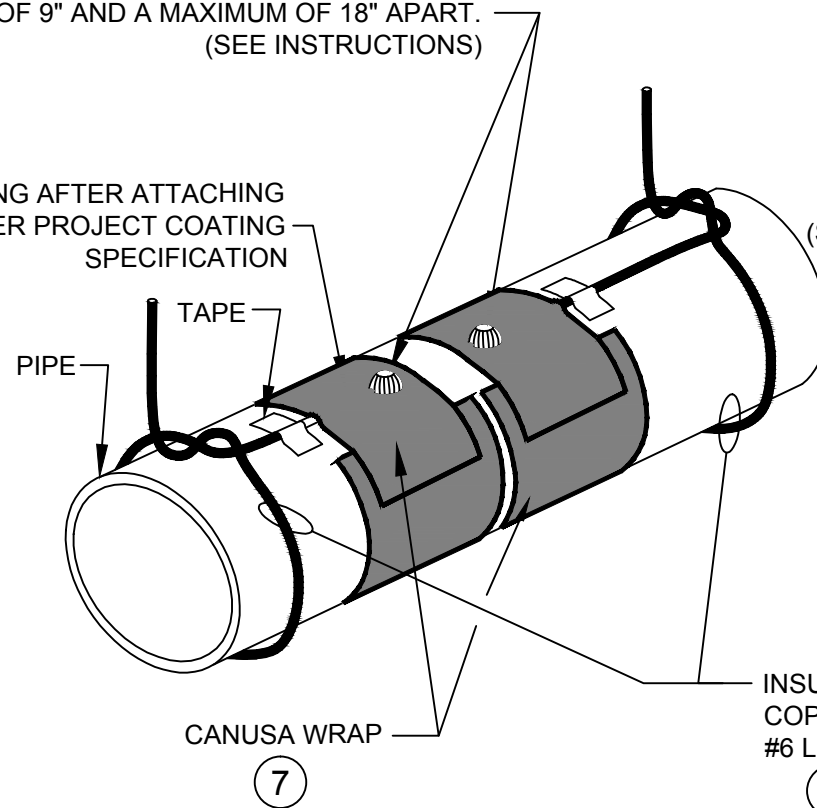
REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM

**EXOTHERMIC WELD INSTRUCTIONS:**

1. FIRST DETERMINE IF THE PIPELINE IS SUITABLE FOR EXOTHERMIC WELDING BY CONDUCTING THE FOLLOWING TESTS:
  - A) DETERMINE THAT THE PIPELINE SYMS (SPECIFIED MINIMUM YIELD STRENGTH) IS  $\geq 80,000$  PSI.
  - B) DETERMINE THAT PIPELINE WALL THICKNESS IS  $\frac{1}{8}$ " (0.125") OR GREATER.
  - C) PERFORM ULTRASONIC TESTING TO PIPELINE TO DETERMINE THAT NO SURFACE OR INTERNAL DEFECTS EXIST.
2. FOR EACH CABLE TO PIPELINE CONNECTION (EXOTHERMIC WELD), REMOVE A 3"X3" MAX AREA OF PIPELINE COATING AT THE 12:00 O'CLOCK POSITION ON THE PIPELINE AND BRUSH UNTIL SHINY. ANY ADJACENT CABLE CONNECTIONS SHALL BE NO CLOSER THAN 9" AND NO FURTHER THAN 18".
3. USING A FILE, PREPARE A CROSSHATCH PATTERN IN THE AREA WHERE THE WELD CONNECTION WILL SIT.
4. PROVIDE CABLE STRAIN RELIEF BY WRAPPING CABLE ONCE AROUND THE PIPE AS SHOWN IN CABLE CONNECTION DETAIL. (SEE ABOVE)
5. STRIP BACK ANY CABLE INSULATION 1"-2" AND TAPE CABLE TO PIPE.
6. ENSURE THAT THE PIPELINE WELD AREA AND CABLE ARE CLEAN AND DRY PRIOR TO WELDING.
7. USE SPECIFIC WELD MOLD AND WELD METAL AS INDICATED IN DRAWING MATERIAL LIST.
8. IF INDICATED, USE COPPER HEAT SLEEVE ON CABLE END TO BE WELDED.
9. USE ONLY A 15 GRAM MELDING CHARGE. DO NOT EXCEED.
10. PLACE THE METAL RETAINER DISK IN THE SPECIFIED WELD MOLD AND DUMP (DO NOT POUR) WELD METAL POWDER ONTO THE DISK. MAKE SURE THAT ALL OF THE FINE STARTING POWDER IS IN THE MOLD. IF ANY POWDER REMAINS IN THE CARTRIDGE BOTTOM, SQUEEZE OUT INTO MOLD AND BREAK UP.
11. CLOSE MOLD LID.
12. REPLACE CAP ON EMPTY WELD METAL CARTRIDGE AND PLACE BACK INTO CARTRIDGE PACK BOX UPSIDE DOWN TO KEEP THE REMAINING CARTRIDGES UPRIGHT.
13. LAY THE CABLE END ON THE CROSSHATCHED PIPE SURFACE USING A SPRING LOADED CHAIN CLAMP TO HOLD CRUCIBLE TIGHT TO PIPELINE.
14. USING EYE AND HAND PROTECTION, STAND ON THE OPPOSITE SIDE OF THE CRUCIBLE FROM THE TOUCH HOLE AND IGNITE POWDER WITH SPARK FROM FLINT GUN. CAUTION: POWDER WILL FLASH WHEN IGNITED

EXOTHERMIC WELD CONNECTIONS. PLACE ON TOP OF PIPE A MINIMUM OF 9" AND A MAXIMUM OF 18" APART. (SEE INSTRUCTIONS)

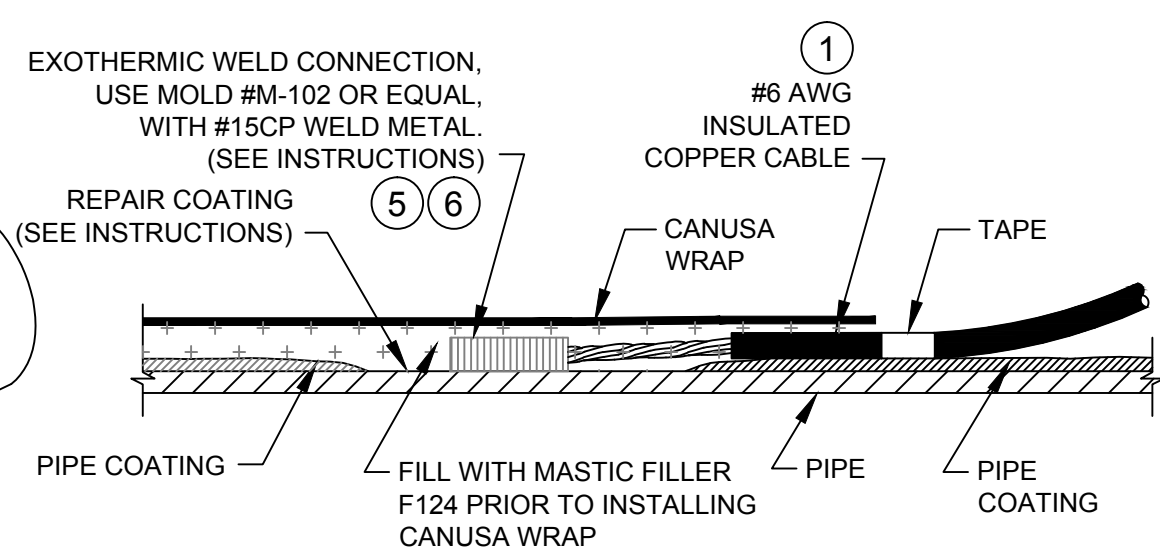
REPAIR COATING AFTER ATTACHING CABLES PER PROJECT COATING SPECIFICATION



**CABLE TO PIPELINE ATTACHMENT DETAIL**

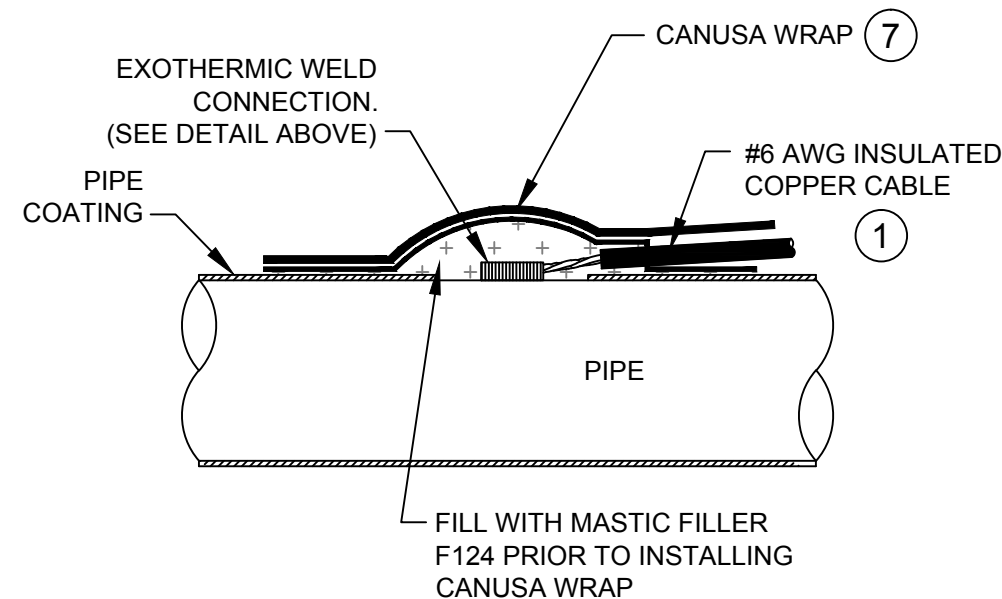
EXOTHERMIC WELD CONNECTION, USE MOLD #M-102 OR EQUAL, WITH #15CP WELD METAL. (SEE INSTRUCTIONS)

REPAIR COATING (SEE INSTRUCTIONS)



**EXOTHERMIC WELD CONNECTION**

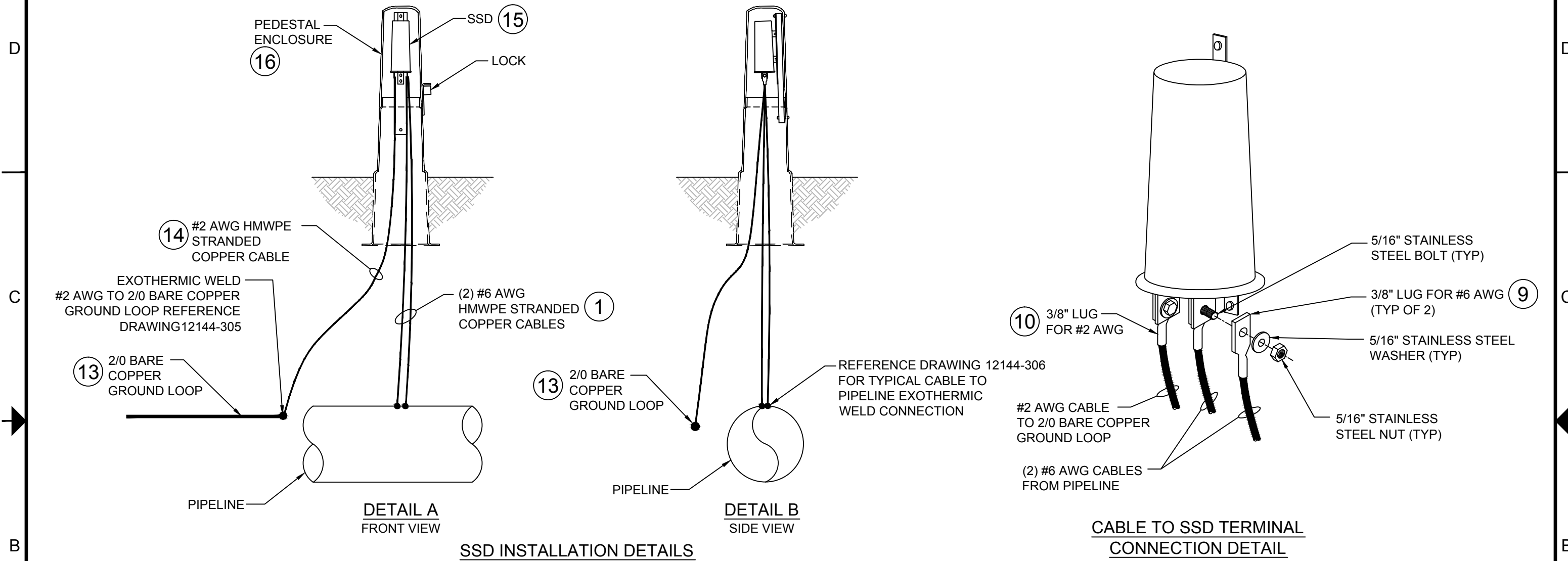
15. WHEN WELD HAS SET, REMOVE WELD MOLD AND TEST CONNECTION BY RAPPING SHARPLY WITH A SLAG HAMMER. IF THERE IS ANY INDICATION THAT A COMPLETE WELD HAS NOT BEEN ACHIEVED, REMOVE THE WELD AND RE-APPLY.
16. IF WELD IS GOOD, REMOVE ANY SLAG WITH HAMMER AND CLEAN USING A WIRE BRUSH.
17. ONCE THE WELD CONNECTION AND AREA HAVE BEEN CLEANED, REPAIR WITH FULL CIRCUMFERENCE CUNUSA WRAP REFER TO VERMONT GAS SPECIFICATIONS TO DETERMINE IF REPAIR IS ACCEPTABLE.



**CORROSION PROTECTION SEAL**

CLIENT <b>CHA</b>	ENGINEERING & TECHNICAL SERVICES, INC. <b>ARK</b>	TITLE <b>CABLE TO PIPELINE CONNECTION DETAILS</b>
SITE VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT	639 GRANITE STREET SUITE 200 BRAintree, MA 02184 U.S.A.	
PROJECT NO. 12-E-144-AC	DRAWN BY JRW	DATE 6/18/13
	APPROVED BY JM	DATE 9/30/13
	SIZE B	SCALE NTS
	DWG. NO. 12144-306	REV A
	CAD FILE NAME 12144-306-1-RA	SHEET 1 OF 1

REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM

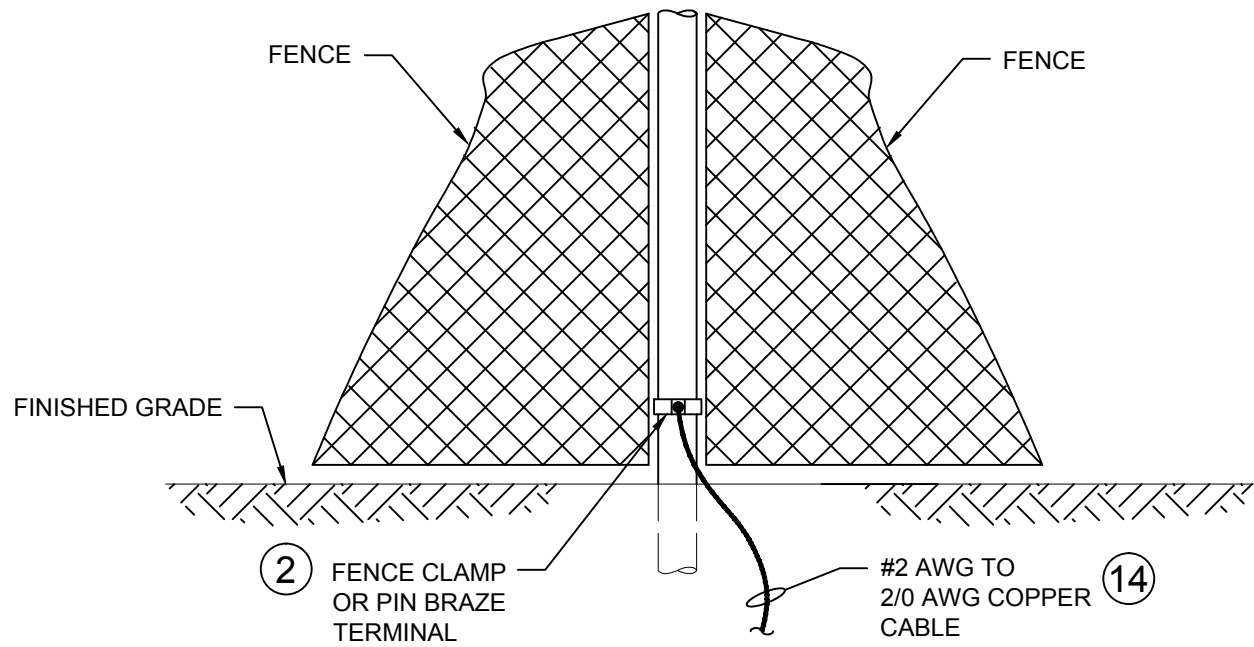


- NOTES:**
- SSD IS TO BE MOUNTED INSIDE THE FIBERGLASS PEDESTAL. ALL COPPER CABLES ARE TO PASS THROUGH BOTTOM OF PEDESTAL.
  - INSTALL PEDESTAL AS CLOSE AS POSSIBLE TO PIPING CONNECTIONS TO REDUCE LEAD LENGTHS.
  - LOCATE SSD & PEDESTAL IN A SERVICEABLE LOCATION. COORDINATE WITH VERMONT GAS PERSONNEL.

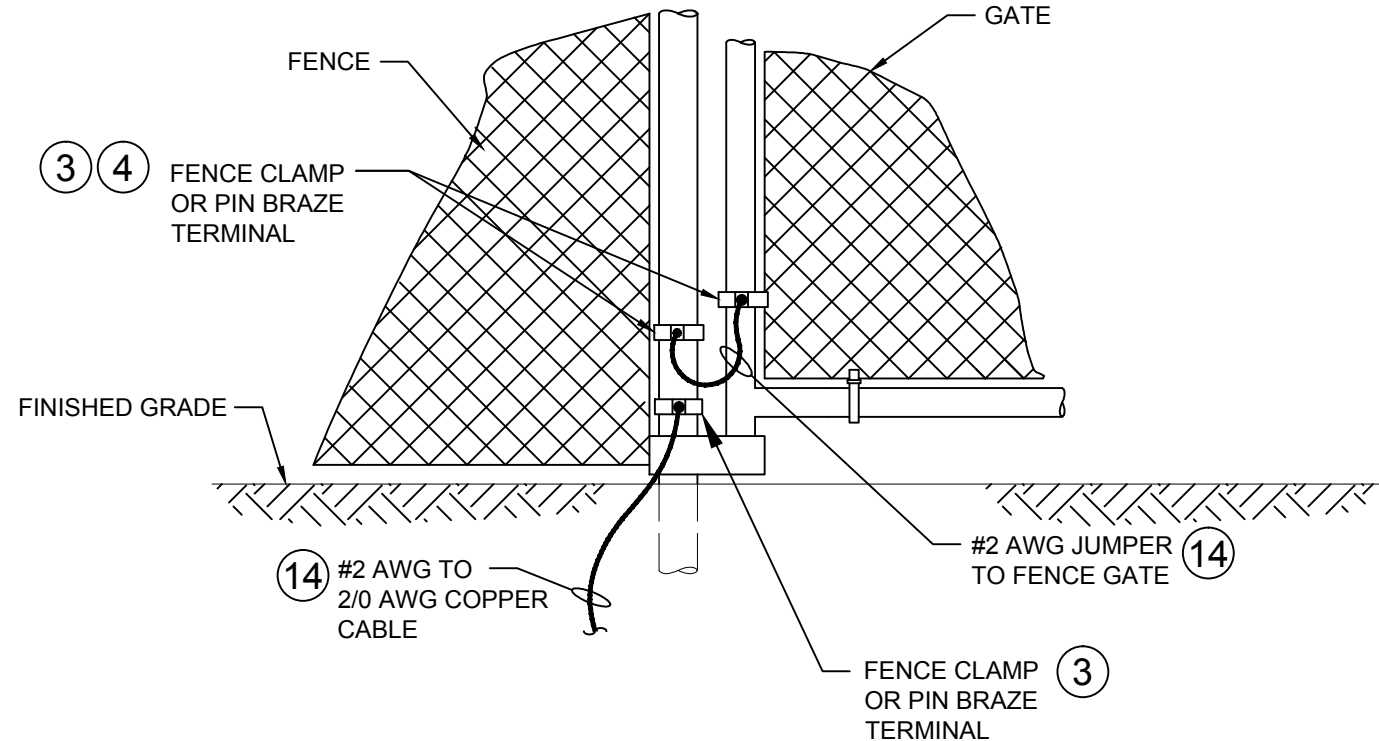
<b>CLIENT</b> 		<b>ARK ENGINEERING &amp; TECH. SERVICES, INC.</b> 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.		<b>TITLE</b> SOLID STATE DECOUPLER (SSD) INSTALLATION DETAILS	
<b>SITE</b> VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT		<b>DRAWN BY</b> JRW	<b>DATE</b> 6/18/13	<b>SIZE</b> B	The information contained on this drawing is confidential and is the sole property of ARK Engineering. Transferring this information to a third party or reproducing in part or in full without a written consent from ARK Engineering is prohibited.
<b>PROJECT NO.</b> 12-E-144-AC		<b>APPROVED BY</b> JM	<b>DATE</b> 9/30/13	<b>SCALE</b> NTS	
<b>DWG. NO.</b> 12144-307				<b>REV</b> A	
<b>CAD FILE NAME</b> 12144-307-1-RA			<b>SHEET</b> 1 OF 1		



REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM



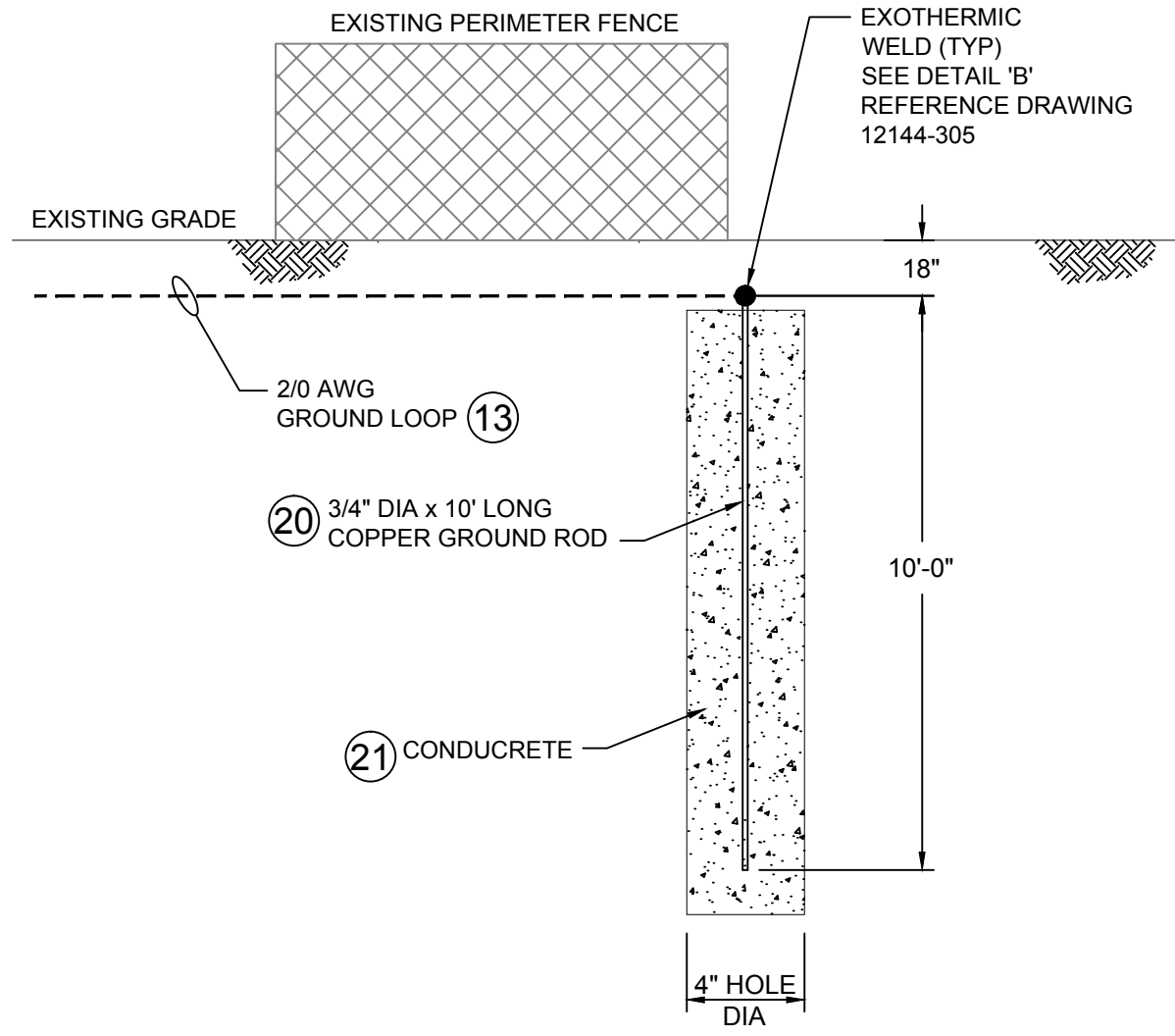
**DETAIL 'A'**  
FENCE TO GROUND LOOP



**DETAIL 'B'**  
FENCE AND GATE TO GROUND LOOP

<b>CLIENT</b> 		<b>ARK ENGINEERING &amp; TECH. SERVICES, INC.</b> 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.		<b>TITLE</b> <b>FENCE AND GATE CLAMP CONNECTION DETAILS</b>				
<b>SITE</b> VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT		<b>DRAWN BY</b> JRW	<b>DATE</b> 6/18/13	<b>SIZE</b> B	<small>The information contained on this drawing is confidential and is the sole property of ARK Engineering. Transferring this information to a third party or reproducing in part or in full without a written consent from ARK Engineering is prohibited.</small>			
<b>PROJECT NO.</b> 12-E-144-AC		<b>APPROVED BY</b> JM	<b>DATE</b> 9/30/13	<b>SCALE</b> NTS		<b>DWG. NO.</b> 12144-308		
<b>PROJECT NO.</b> 12-E-144-AC				<b>APPROVED BY</b> JM	<b>DATE</b> 9/30/13	<b>SCALE</b> NTS	<b>CAD FILE NAME</b> 12144-308-1-RA	<b>SHEET</b> 1 OF 1

REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM



**NOTES - GROUND ROD:**

1. IF GROUND RODS ARE POINTED AT ONE END AND MISSHAPEN, CUT OFF 1/2" OF GROUND ROD, FILE SMOOTH TO PREVENT CRACKING.
2. DRILL HOLE NOT BE MORE THAN 11.5' DEEP TO PREVENT GROUND ROD FROM SINKING AND STRAINING CONNECTION TO GROUND LOOP.
3. IF HOLE IS DRY, BACK FILL WITH DRY CONDUCRETE. TWO (2) 55 LB. BAGS OF DM-100 REQUIRED PER HOLE.
4. IF HOLE IS WET, CONDUCRETE MUST BE PUMPED INTO HOLE WITH TREMIE PIPE. CONDUCRETE IS TO BE MIXED AT A RATIO 4.2 GALLONS PER 55 LB. BAG OF CONDUCRETE. TWO (2) 55 LB. BAGS OF DM-100 REQUIRED PER HOLE.
5. CONDUCRETE QUANTITY TO BE DETERMINED BASED ON NUMBER OF HOLES REQUIRING DRILLING.

**ALTERNATE GROUND ROD INSTALLATION -  
DRILL PROCEDURE  
SIDE VIEW**  
BARE 2/0 AWG STRANDED COPPER GROUND LOOP &  
10' COPPER GROUND ROD CONNECTIONS

<b>CLIENT</b> 		<b>ARK ENGINEERING &amp; TECH. SERVICES, INC.</b> 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.		<b>TITLE</b> GROUND ROD INSTALLATION DETAILS DRILL PROCEDURE	
<b>SITE</b> VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT		<b>DRAWN BY</b> JRW	<b>DATE</b> 6/18/13	<b>SIZE</b> B	<small>The information contained on this drawing is confidential and is the sole property of ARK Engineering. Transferring this information to a third party or reproducing in part or in full without a written consent from ARK Engineering is prohibited.</small>
<b>PROJECT NO.</b> 12-E-144-AC		<b>APPROVED BY</b> JM	<b>DATE</b> 9/30/13	<b>SCALE</b> NTS	
<b>DWG. NO.</b> 12144-309			<b>REV</b> A		<b>SHEET</b> 1 OF 1
<b>CAD FILE NAME</b> 12144-309-1-RA				<b>SHEET</b> 1 OF 1	

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REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM
B	REVISED PER ECO 2015-017	4/3/15	RFA

ITEM	WILLISTON M&R	MLV-2	MLV-3	MLV-4	MLV-5/ PLANK RD. M&R	MLV-6	COLCHESTER LAUNCHER	MIDDLEBURY M&R	TOTAL	DESCRIPTION
1	50'	50'	50'	50'	150'	50'	50'	50'	500'	#6 AWG HMWPE INSULATED STRANDED COPPER CABLE. SOFT-DRAWN, COMMERCIALY PURE COPPER, ASTM B8, CLASS B STD.
2	13	4	4	4	14	4	10	12	65	FENCE CLAMP, LINE POST TO #2 AWG STRANDED CABLE. CONTRACTOR TO COORDINATE WITH FENCE CONTRACTOR ON POST SIZE. (TYPICALLY 2 1/2" DIAMETER.)
3	6	1	1	1	5	1	4	5	24	FENCE CLAMP, DRIVE GATE POST TO #2 AWG STRANDED CABLE. CONTRACTOR TO COORDINATE WITH FENCE CONTRACTOR ON POST SIZE. (TYPICALLY 4" DIAMETER.)
4	6	1	1	1	5	1	4	5	24	FENCE CLAMP, GATE SUPPORT POST TO #2 AWG CABLE JUMPER. CONTRACTOR TO COORDINATE WITH FENCE CONTRACTOR ON POST SIZE. (TYPICALLY 2" DIAMETER.)
5	1	1	1	1	1	1	1	1	8	EXOTHERMIC WELD MOLD, THERMOWELD P/N TYPE CS-32, M-102 (OR EQUAL). HANDLE CLAMP AND FLINT IGNITOR ARE INCLUDED. USED FOR EXOTHERMIC WELD CONNECTION OF #6 AWG STRANDED COPPER CABLE TO PIPELINE. USE 15CP WELD METAL.
6	1 BOX	1 BOX	1 BOX	1 BOX	1 BOX	1 BOX	1 BOX	1 BOX	8 BOXES	EXOTHERMIC WELD METAL, THERMOWELD P/N 15CP (OR EQUAL). BONDS #6 AWG STRANDED COPPER CABLE TO PIPELINE. 20 SHOTS PER BOX.
7	A/R	A/R	A/R	A/R	A/R	A/R	A/R	A/R	1 ROLL	PIPELINE COATING REPAIR: COVER EXOTHERMIC WELD WITH F124 MASTIC FILLER PRIOR TO WRAPPING PIPE WITH CANUSA WRAP P/N CPS K60 OR APPROVED EQUAL. USED FOR REPAIRING PIPE COATING AT #6 AWG CONNECTIONS TO PIPE.
8	15	6	6	6	40	6	12	13	108	ROYSTON SPLICERIGHT KIT (OR APPROVED EQUAL). INSULATION KIT FOR EXOTHERMIC WELD SPLICE CONNECTIONS.
9	2	2	2	2	6	2	2	2	20	BURNDY YAZ6C-TC38 COMPRESSION LUG. THESE LUGS WILL CONNECT THE #6 AWG COPPER CABLE TO THE SOLID STATE DECOUPLING DEVICES. TWO LUGS PER SSD.
10	1	1	1	1	3	1	1	1	10	BURNDY YAZ2C-TC38 COMPRESSION LUG. THESE LUGS WILL CONNECT THE #2 AWG COPPER CABLE TO THE SOLID STATE DECOUPLING DEVICES. ONE OR TWO LUGS PER SSD.
11	1	1	1	1	1	1	1	1	8	EXOTHERMIC WELD MOLD, THERMOWELD TYPE CC-6, MOLD# M-8306 (OR EQUAL). HANDLE CLAMP AND FLINT IGNITOR ARE INCLUDED. USED FOR EXOTHERMIC WELD CONNECTION OF 2/0 AWG COPPER GROUND LOOP TO #2 AWG STRANDED COPPER CABLE. USE TWO (2) #45 SHOTS
12	2 BOXES	1 BOX	1 BOX	1 BOX	4 BOXES	1 BOX	2 BOXES	2 BOXES	15 BOXES	EXOTHERMIC WELD METAL, THERMOWELD P/N 45 (OR EQUAL). BONDS 2/0 AWG COPPER GROUND LOOP TO #2 AWG STRANDED COPPER CABLE OR TO GROUND RODS. 20 SHOTS PER BOX.
13	315'	90'	90'	90'	475'	90'	300'	325'	1,795'	2/0 AWG BARE STRANDED COPPER CABLE. THE CABLE WILL BE BURIED IN A LOOP AROUND THE BOUNDARY FENCE.

**NOTE:**  
 ARK ENGINEERING CAN PROVIDE ALL MATERIALS LISTED ABOVE AND INSTALLATION SERVICES. PLEASE CALL 1-800-469-3436 FOR A MATERIAL OR INSTALLATION QUOTATION.

CLIENT  SITE VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT		 ARK ENGINEERING & TECH. SERVICES, INC. 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.		TITLE MATERIALS LIST	
PROJECT NO. 12-E-144-AC		DRAWN BY JRW	DATE 6/18/13	SIZE B	DWG. NO. 12144-401
APPROVED BY JM		DATE 9/30/13	SCALE NTS	CAD FILE NAME 12144-401-1-RB	REV B
				SHEET 1 OF 2	

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REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM
B	REVISED PER ECO 2015-017	4/3/15	RFA

ITEM	WILLISTON M&R	MLV-2	MLV-3	MLV-4	MLV-5/ PLANK RD. M&R	MLV-6	COLCHESTER LAUNCHER	MIDDLEBURY M&R	TOTAL	DESCRIPTION
14	155'	45'	45'	45'	175'	45'	100'	125'	735'	COPPER CABLE, #2 AWG HMWPE INSULATED, STRANDED, SOFT-DRAWN, COMMERCIAL PURE COPPER, ASTM B8, CLASS B STD. USED FOR CONNECTIONS TO GROUND LOOP AND FENCE GATE JUMPERS.
15	1	1	1	1	3	1	1	1	10	SSD (SOLID STATE DECOUPLER), SYMETRICAL BLOCKING VOLTAGE, 2KA FAULT CURRENT RATING (30 CYCLES) AT 50/60HZ, 100KA LIGHTNING SURGE CURRENT RATING (4 X 10 WAVEFORM). DAIRYLAND ELECTRICAL INDUSTRIES, P/N SSD-2/2-2.0-100.
16	1	1	1	1	3	1	1	1	10	SSD PEDESTAL, FIBERGLASS CASE: 6" X 6" X 42" HIGH, WITH STAINLESS STEEL BACK-PLATES FOR MOUNTING THE SOLID STATE DECOUPLING DEVICE. DAIRYLAND ELECTRICAL INDUSTRIES. P/N PEDESTAL - 42".
17	-	-	-	-	1	-	-	-	2	EXOTHERMIC WELD MOLD, THERMOWELD TYPE CC-2, MOLD# M-232 (OR EQUAL). USED FOR 2/0 AWG STRANDED COPPER CABLE TO 2/0 AWG STRANDED COPPER CABLE 'T' SPLICE.
18	-	-	-	-	1 BOX	-	-	-	2 BOXES	EXOTHERMIC WELD METAL, THERMOWELD P/N 90 (OR EQUAL). BONDS 2/0 AWG 2/0 AWG STRANDED COPPER CABLE TO 2/0 AWG STRANDED COPPER CABLE. 10 SHOTS PER BOX.
19	-	1	-	-	1	-	-	-	3	EXOTHERMIC WELD MOLD, THERMOWELD TYPE CR-2, MOLD# M-2005 (OR EQUAL). USED FOR 2/0 AWG STRANDED COPPER CABLE TO 3/4" DIAMETER COPPER GROUND ROD. USE TWO (2) #45 SHOTS.
20	-	4	-	-	20	-	-	-	28	COPPER GROUND RODS - 3/4" DIAMETER x 10' LONG P/N 7510 (GALVIN INDUSTRIES). ONE ROD WILL BE ATTACHED AND DRIVEN AT THE LOCATION SPECIFIED. THEY WILL EACH BE ATTACHED TO THE GROUND LOOP CABLE.
21	-	TBD	-	-	TBD	-	-	-	TBD	DM100 CONDUCRETE - 55 POUND BAGS. FOUR (4) BAGS PER DRILLED HOLE. TOTAL QUANTITY TO BE DETERMINED BASED ON NUMBER OF GROUND RODS REQUIRING DRILLING

SIZE  
B

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