AC INTERFERENCE ANALYSIS
&
MITIGATION SYSTEM DESIGN

Prepared for:

Vermont Gas System

12" Addison Natural Gas Project

Chittendon & Addison Counties, Vermont

Prepared By:

Report Issued: May 20, 2016

ARK Engineering & Technical Services, Inc.
639 Granite Street, Suite 200
Braintree, MA 02184
Phone: 781-849-3800
Fax: 781-849-3810

For information, please contact:
Mr. James Smith
Report Number: R-12144-AC
ISSUED FOR CONSTRUCTION

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.

TABLE OF CONTENTS

1. INTRODUCTION

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.

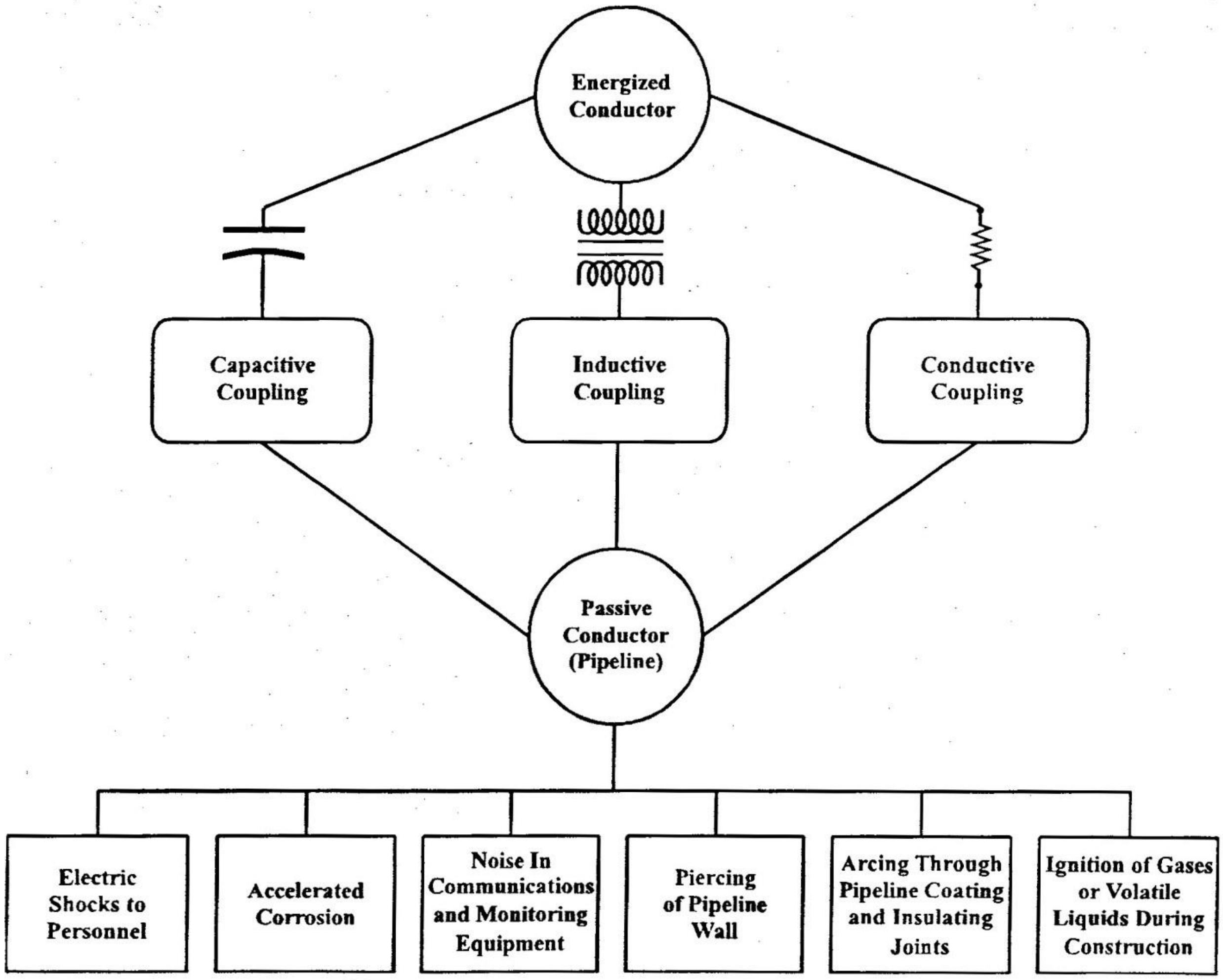


Figure 1-1: Interference Mechanisms and Effects on Pipeline

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^{o}) 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^2. In practice, the evaluation of AC corrosion likelihood is done on a broader basis:

- Current density lower than 30 A/m^2: no or low likelihood of AC Corrosion effects
- Current density between 30 and 100 A/m^2: medium likelihood of AC Corrosion
- Current density higher than 100 A/m^2: 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.

$$I = (8 * Vac) / (\rho * \pi * d) \qquad \text{(Equation 1)}$$

<u>Where</u>:

i = Current Density (A/m^2)
V_{ac} = 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^2 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[1] (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^2 Coating Holiday	100 A/m^2 (Current)	
Coating Stress Voltage	-----	5,000

[1] With respect to "Local Earth"

2. PHYSICAL LAYOUT

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^2

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:

ρ = Apparent soil resistivity, in ohm-meters (Ω-m)
a = Electrode separation, in meters (m)
R = Measured resistance, in ohms (Ω)

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 (Ω-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 (Ω-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 Ω
- 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
Touch Voltage (Volts AC)	347.46 V	58.98 V	187.30 V
Step Voltage (Volts AC)	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
Touch Voltage (Volts AC)	1,870.85 V	148.34 V	228.20 V
Step Voltage (Volts AC)	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
Touch Voltage (Volts AC)	1,855.42 V	186.70 V	227.60 V
Step Voltage (Volts AC)	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
Touch Voltage (Volts AC)	1,290.12 V	252.64 V	432.80 V
Step Voltage (Volts AC)	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
Touch Voltage (Volts AC)	1,466 V	273.62 V	287.80 V
Step Voltage (Volts AC)	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
Touch Voltage (Volts AC)	797.65 V	271.9 V	298.80 V
Step Voltage (Volts AC)	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^2 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^2 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^2.

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/m²)	Design Limit (A/m²)
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^2 to monitor these locations.

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

4. CONCLUSIONS

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^2 coating holiday will exceed the 100 A/m^2 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^2 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 Ω-ft^2 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^2 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
Total			**37,113 Feet**

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).

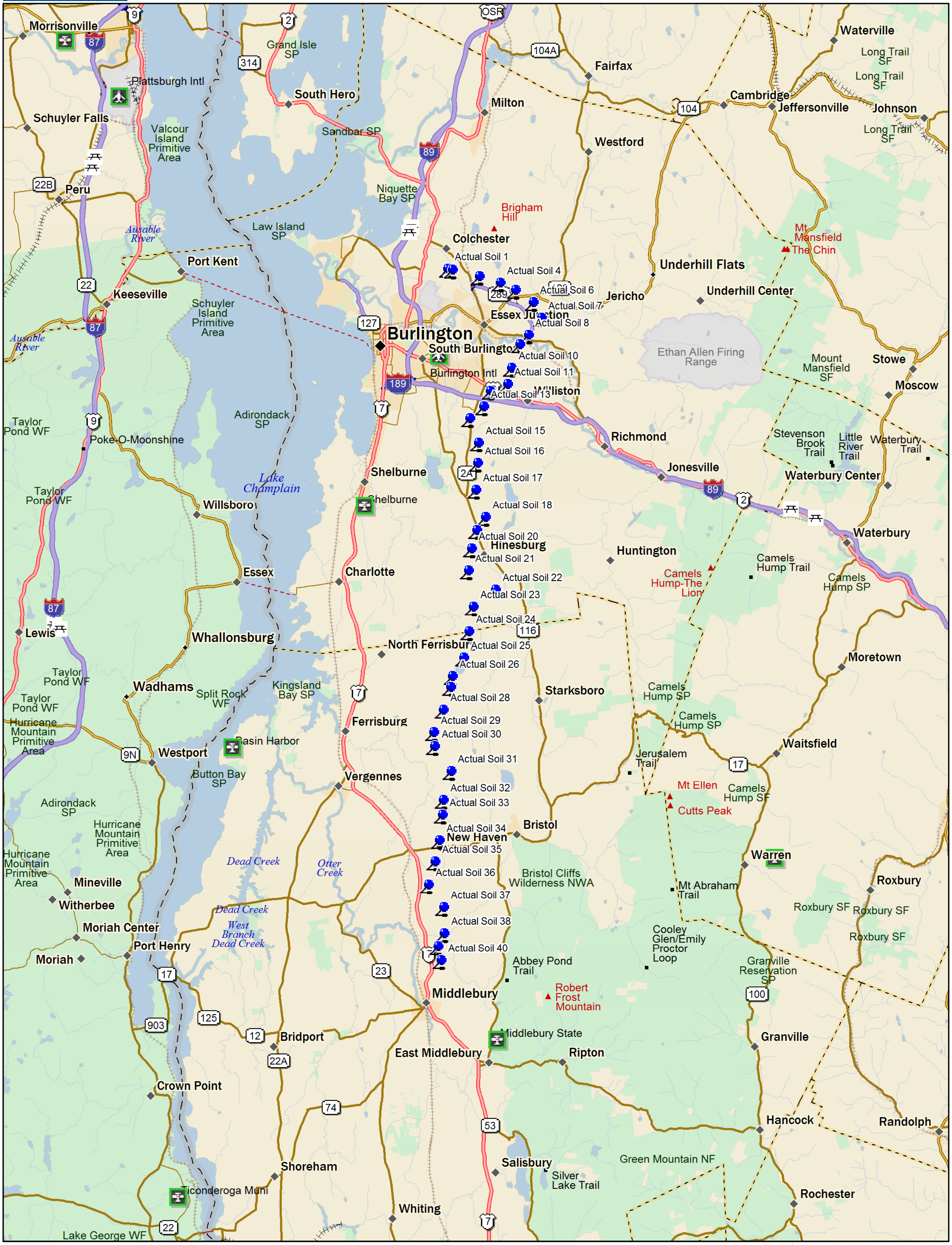
Reference - ARK Engineering design drawing package number: 12144-101, in Appendix D for copper ground loop installation details.

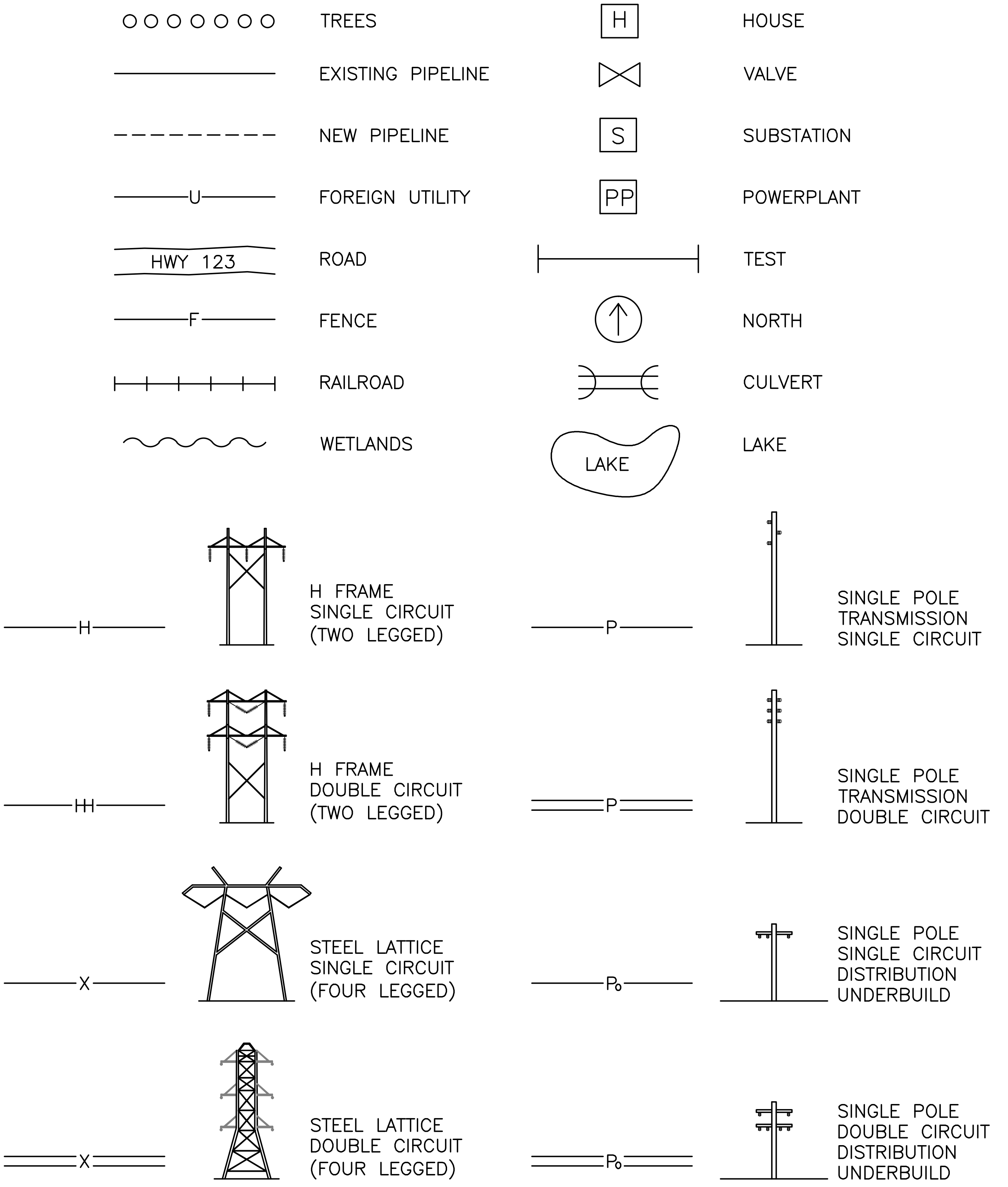
12144-101	Vermont Gas 12" Pipeline Project
Rev. B	Valves Sites:
	Williston M&R
	MLV-2
	MLV-3
	MLV-4
	MLV-5/Plank Rd. M&R,
	MLV-6
	Colchester Launcher
	Middlebury M&R

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


Burlington
South Burlington
Burlington Intl
Colchester
Essex Junction
Williston
Richmond
Jonesville
Shelburne
Charlotte
Hinesburg
North Ferrisburg
Ferrisburg
Vergennes
Starksboro
Bristol
New Haven
Middlebury
East Middlebury
Ripton
Salisbury
Whiting
Shoreham
Bridport
Crown Point
Port Henry
Moriah Center
Moriah
Mineville
Witherbee
Westport
Wadhams
Whallonsburg
Essex
Willsboro
Lewis
Keeseville
Port Kent
Peru
Schuyler Falls
Morrisonville
Plattsburgh Intl
South Hero
Grand Isle SP
Milton
Fairfax
Westford
Cambridge
Jeffersonville
Waterville
Johnson
Underhill Flats
Underhill Center
Jericho
Stowe
Moscow
Waterbury Center
Waterbury
Huntington
Moretown
Waitsfield
Warren
Roxbury
Granville
Hancock
Randolph
Rochester
Lake Champlain
Ethan Allen Firing Range
Green Mountain NF
Actual Soil 1
Actual Soil 4
Actual Soil 6
Actual Soil 7
Actual Soil 8
Actual Soil 10
Actual Soil 11
Actual Soil 13
Actual Soil 15
Actual Soil 16
Actual Soil 17
Actual Soil 18
Actual Soil 20
Actual Soil 21
Actual Soil 22
Actual Soil 23
Actual Soil 24
Actual Soil 25
Actual Soil 26
Actual Soil 28
Actual Soil 29
Actual Soil 30
Actual Soil 31
Actual Soil 32
Actual Soil 33
Actual Soil 34
Actual Soil 35
Actual Soil 36
Actual Soil 37
Actual Soil 38
Actual Soil 40
TN
MN (14.6°W)
Scale 1 : 400,000
1" = 6.31 mi
Data Zoom 9-0



ARK Engineering & Technical Services, Inc.

DRAWING KEY

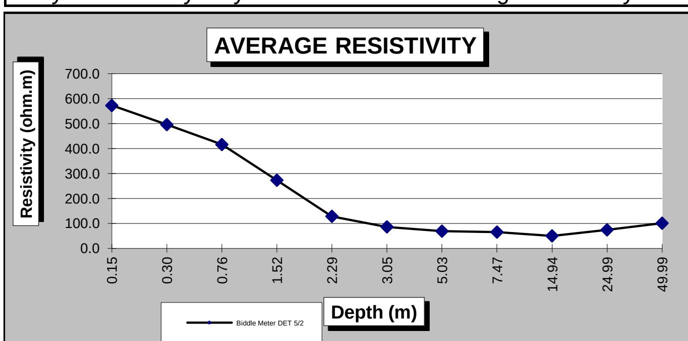
SOIL RESISTIVITY DATA

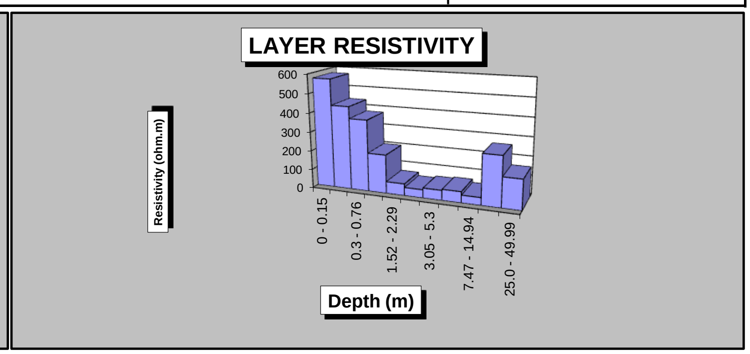
Project Name: Vermont Gas Project
12-144-01
Date: 5/3/2013
Location: Rd sd off Severance Rd
44 31.4488N, 73 9.3344W
Testers: KJ, LM
Methodology: ρ = 2πdR, per ASTM G 57 & Barnes Method
Instrumentation: Biddle Meter DET 5/2
Weather: 61F/Clear
Soil Description Hard packed clay/Sand

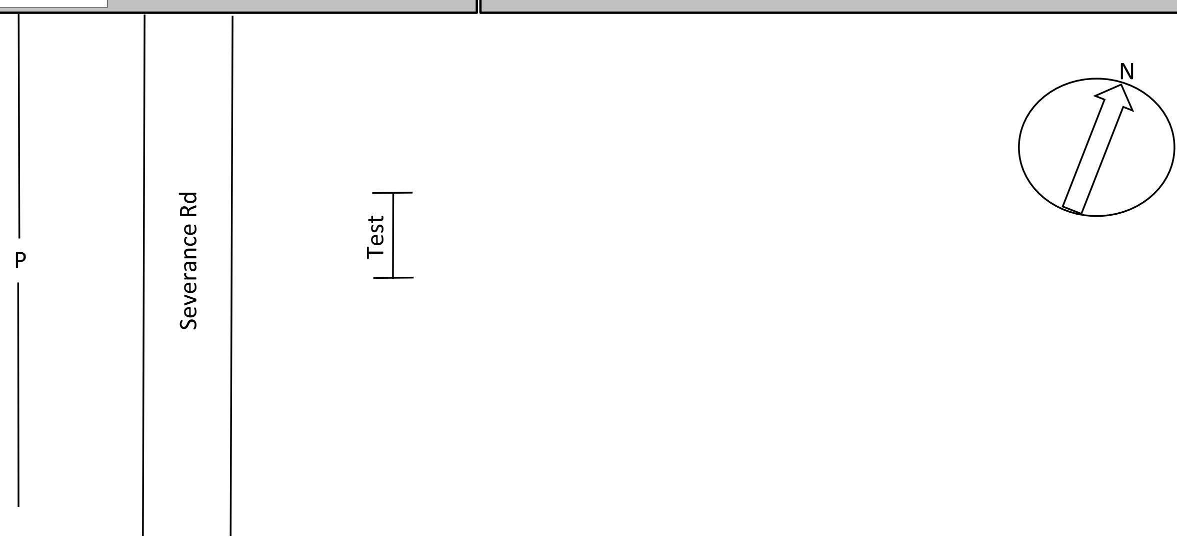
ARK ENGINEERING & TECHNICAL SERVICES, INC.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 1/R) ohms	Spacing Factor	Layer Resistivity* Layer (m)	Layer Resistivity* 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







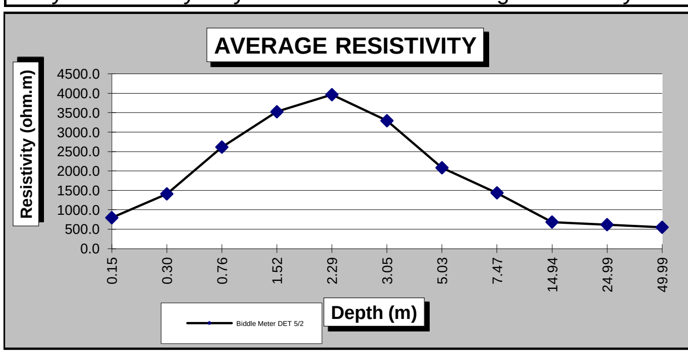
SOIL RESISTIVITY DATA

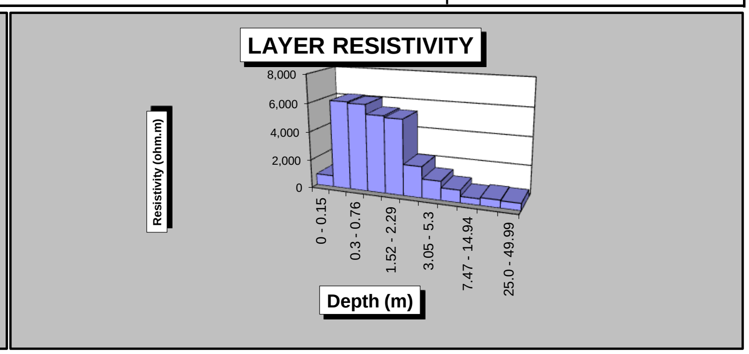
Project Name: Vermont Gas Project
12-144-02
Date: 5/3/2013
Location: Open Field off Access Rd East of Severance Rd
44 31.4187N, 73 9.0318N
Testers: KJ, LM
Methodology: ρ = 2πdR, per ASTM G 57 & Barnes Method
Instrumentation: Biddle Meter DET 5/2
Weather: 63F/Clear
Soil Description Hard packed clay/Sand

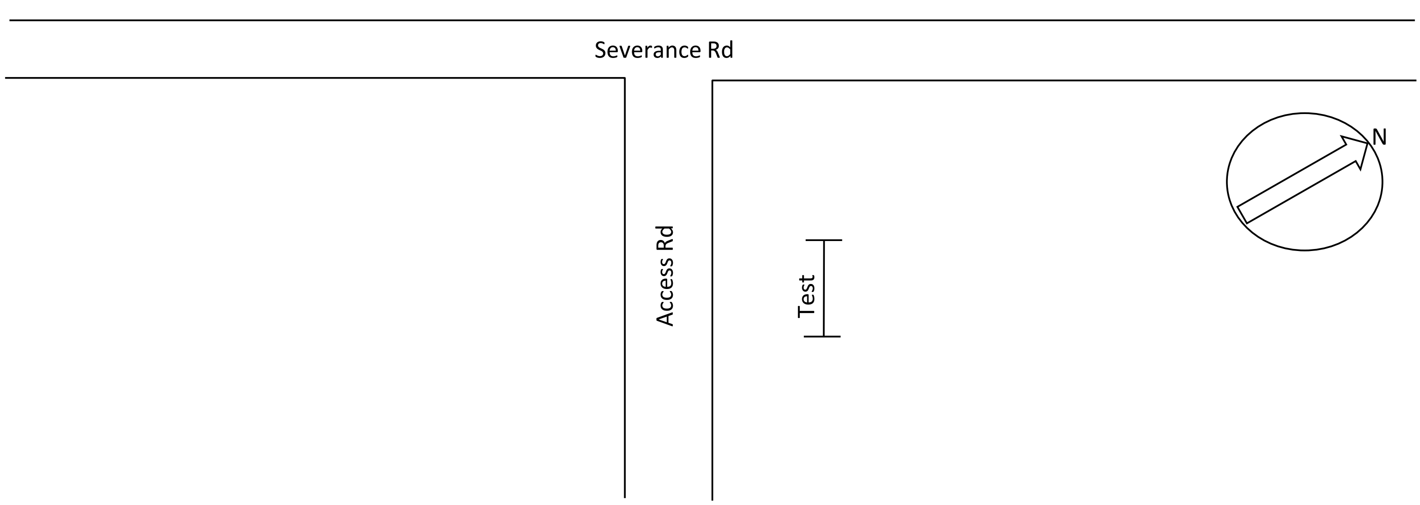
ARK ENGINEERING & TECHNICAL SERVICES, INC.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 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







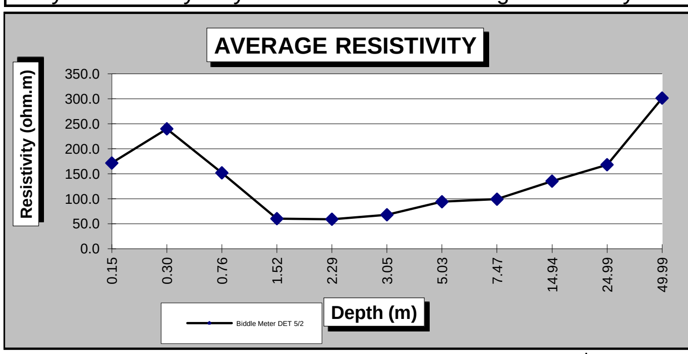
SOIL RESISTIVITY DATA

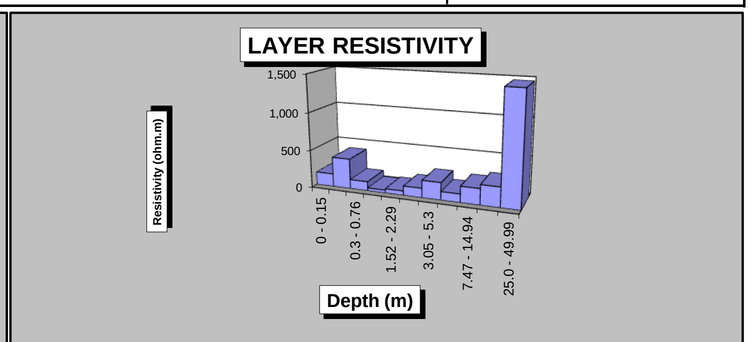
Project Name:	Vermont Gas Project
	12-144-03
Date:	5/3/2013
Location:	Rd Sd off Landfill Ln
	44 31.1464N, 73 7.4733W
Testers:	KJ, LM
Methodology:	$\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation:	Biddle Meter DET 5/2
Weather:	58F/Clear
Soil Description	Loose dry rocky soil

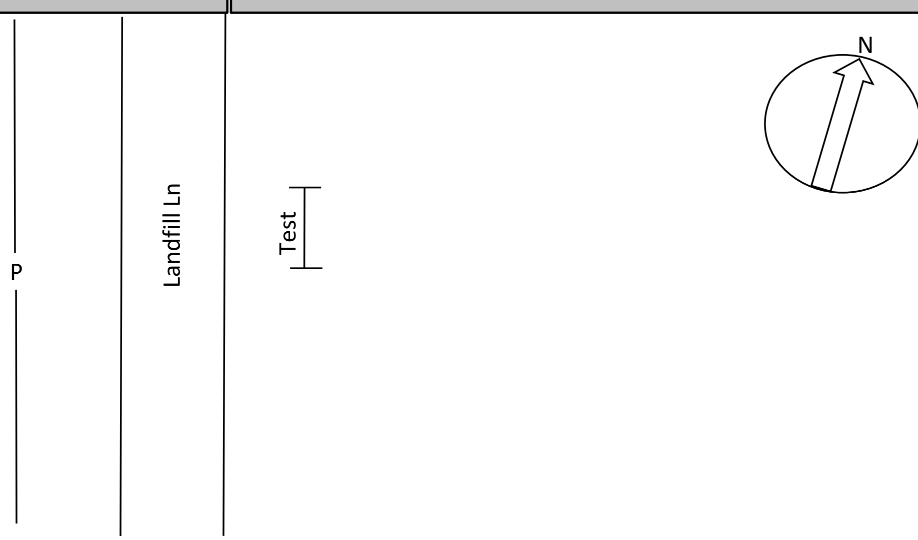
ARK Engineering & Technical Services, Inc.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 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







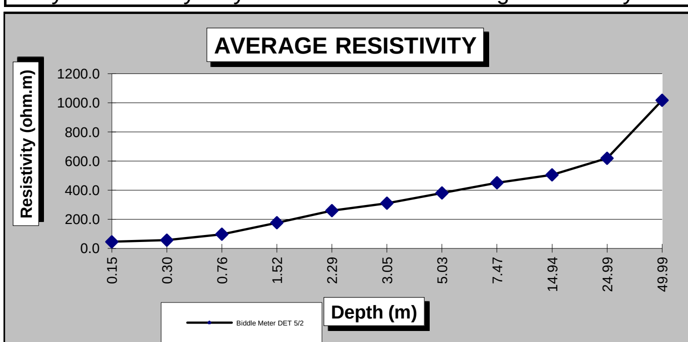
SOIL RESISTIVITY DATA

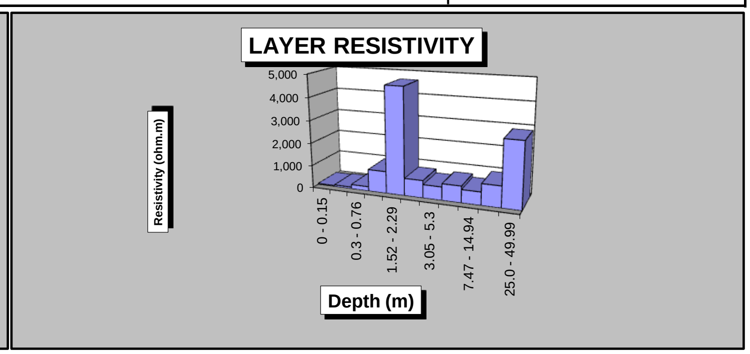
Project Name: Vermont Gas Project
12-144-04
Date: 5/3/2013
Location: Rd Sd off SR 289
44 30.866N, 73 6.228W
Testers: KJ, LM
Methodology: ρ = 2πdR, per ASTM G 57 & Barnes Method
Instrumentation: Biddle Meter DET 5/2
Weather: 55F/Clear
Soil Description Dry rocky soil and vegetation

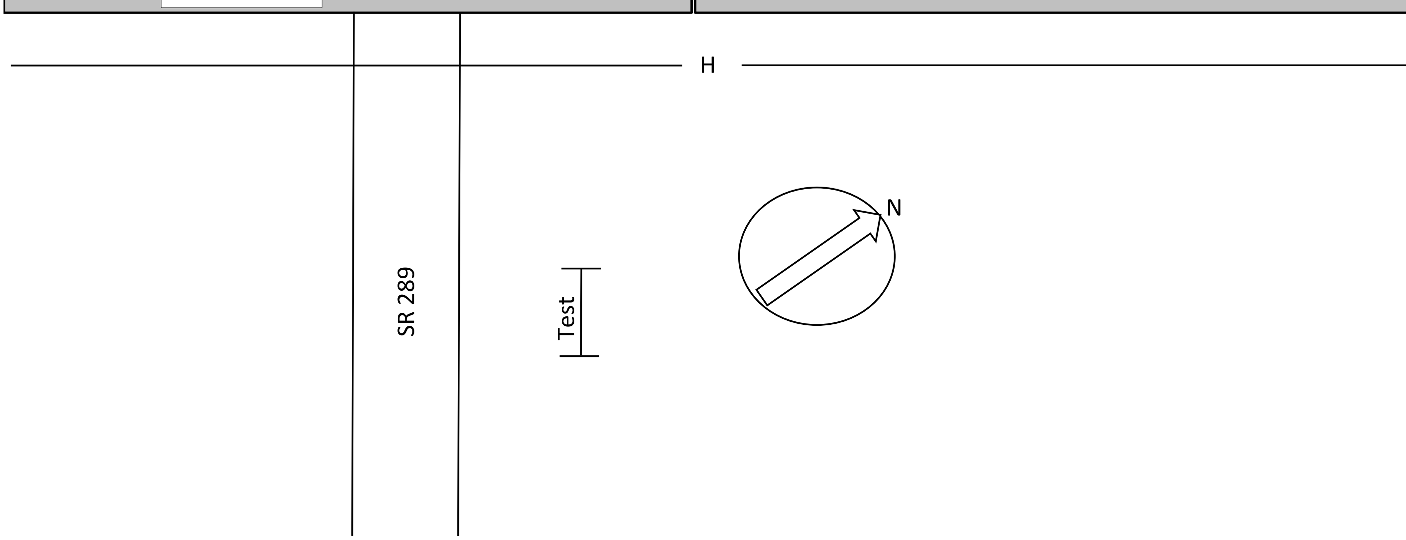
ARK Engineering & Technical Services, Inc.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 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







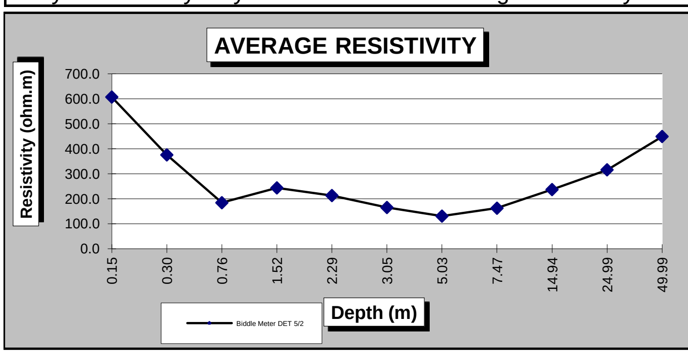
SOIL RESISTIVITY DATA

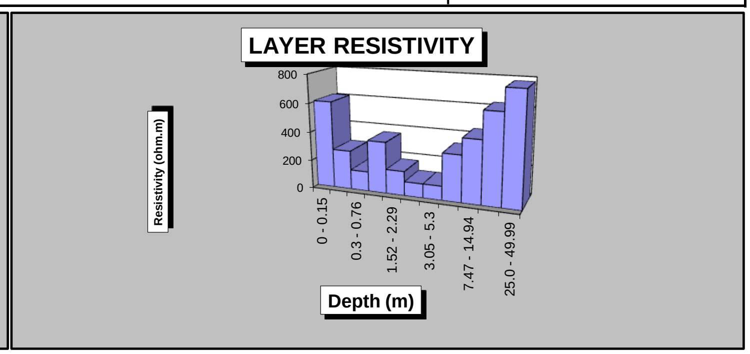
Project Name:	Vermont Gas Project
	12-144-05
Date:	5/3/2013
Location:	Open Lot off SR 289
	44 30.5592N, 73 5.3331W
Testers:	KJ, LM
Methodology:	$\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation:	Biddle Meter DET 5/2
Weather:	52F/Clear
Soil Description	Hard rocky soil

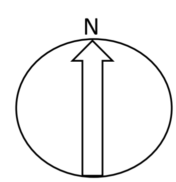
ARK ENGINEERING & TECHNICAL SERVICES, INC.

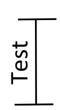
4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 1/R) ohms	Spacing Factor	Layer Resistivity* Layer (m)	Layer Resistivity* ohm.m
0.50	0.15	634.000	1	607.1	0.00158	n/a	n/a	n/a	0 - 0.15	607
1.00	0.30	196.000	2	375.4	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









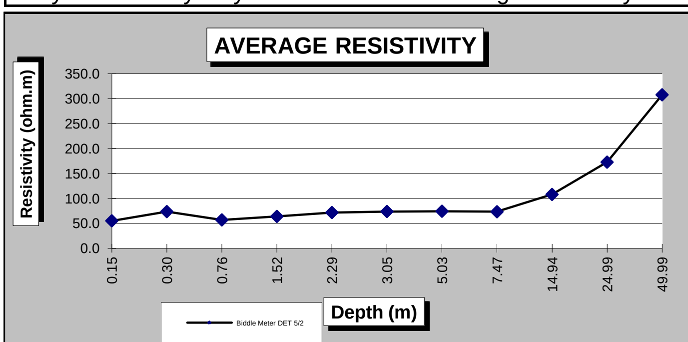
SOIL RESISTIVITY DATA

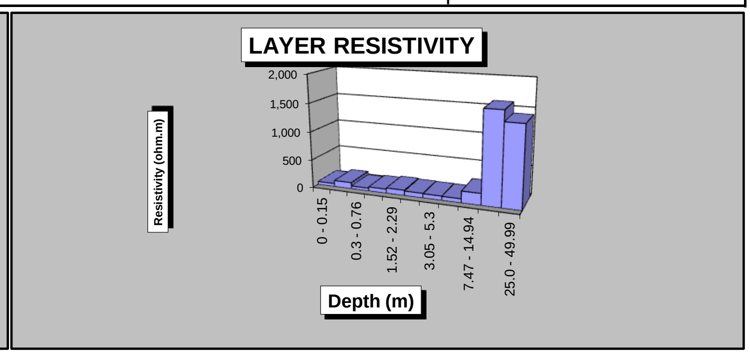
Project Name: Vermont Gas Project
12-144-06
Date: 5/2/2013
Location: Rd Sd off SR 289
44 30.0397N, 73 4.2916W
Testers: KJ, LM
Methodology: $\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation: Biddle Meter DET 5/2
Weather: 81F/Clear
Soil Description Dark moist soil

ENGINEERING & TECHNICAL SERVICES, INC.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 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





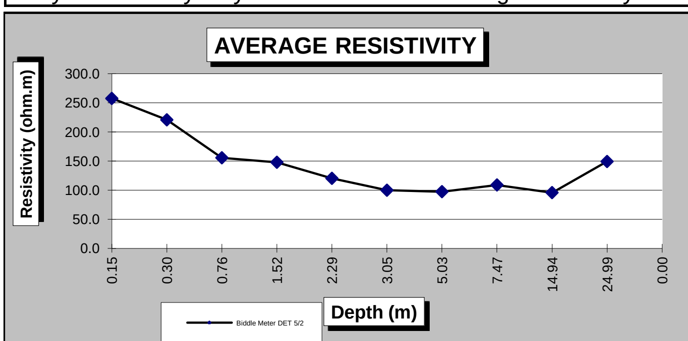
SOIL RESISTIVITY DATA

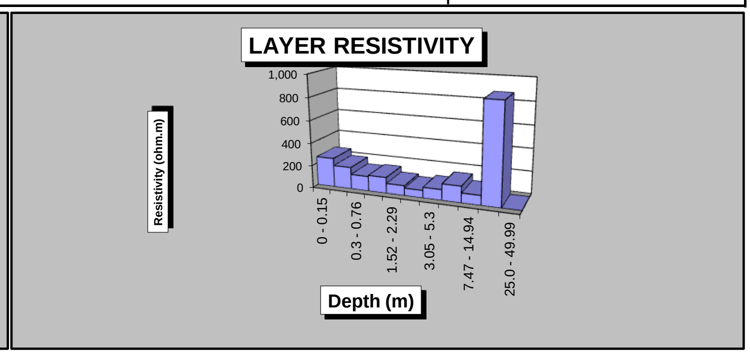
Project Name:	Vermont Gas Project
	12-144-07
Date:	5/2/2013
Location:	Rd Sd off SR 289
	44 29.3821N, 73 3.8092W
Testers:	KJ, LM
Methodology:	$\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation:	Biddle Meter DET 5/2
Weather:	81F/Clear
Soil Description	Moist dark soil and vegetation

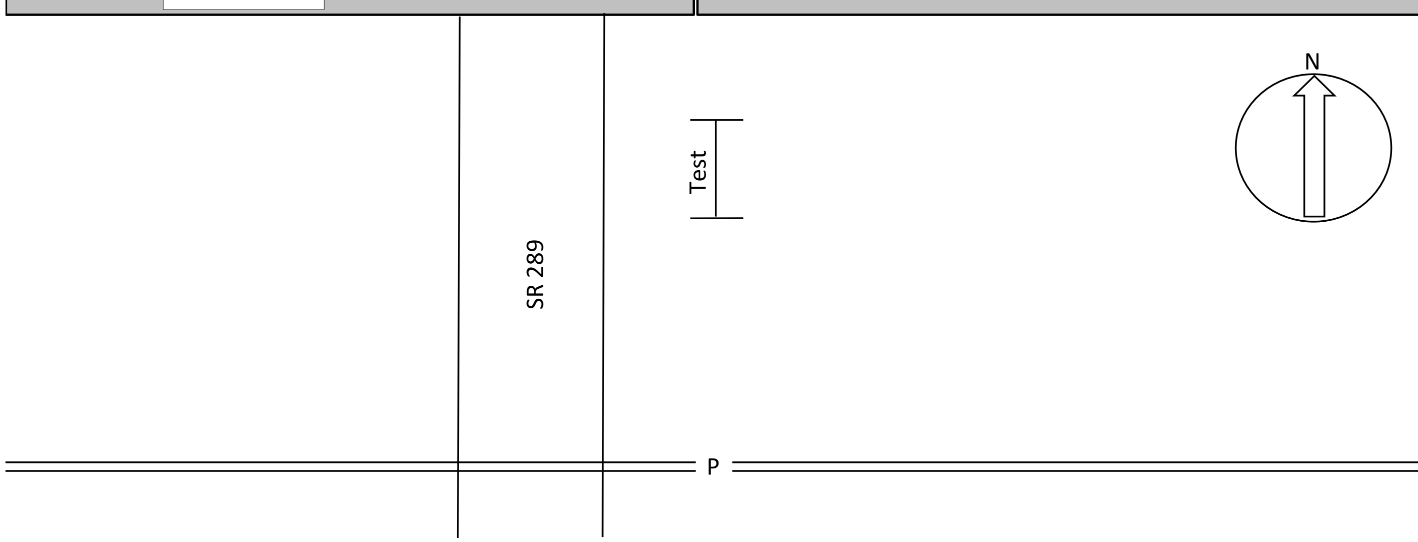
ARK Engineering & Technical Services, Inc.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	**Depth (d) m**	**R ohms**	**Spacing Factor**	**Resistivity ohm.m**	**1/R mhos**	**Δ 1/R mhos**	**1/(Δ 1/R) ohms**	**Spacing Factor**	**Layer Resistivity* Layer (m)**	**Layer Resistivity* 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







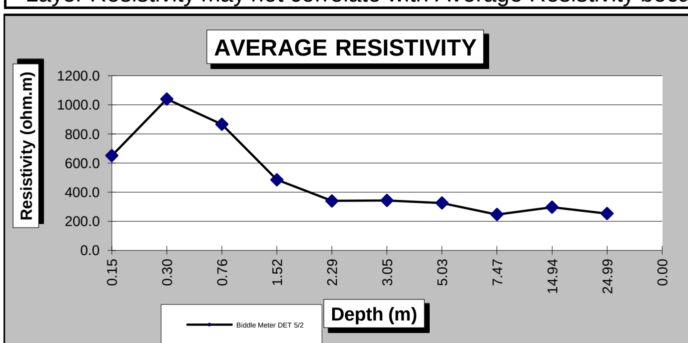
SOIL RESISTIVITY DATA

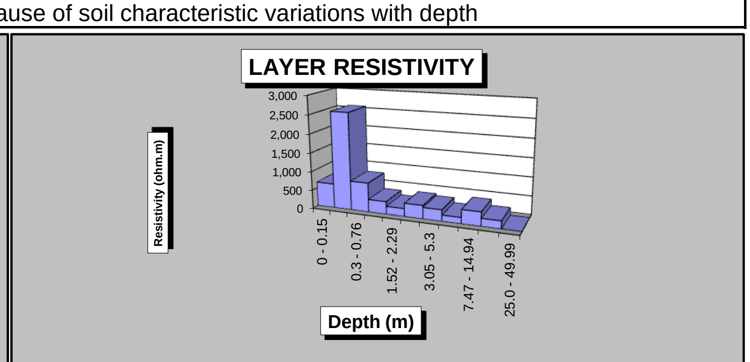
ARK Engineering & Technical Services, Inc.

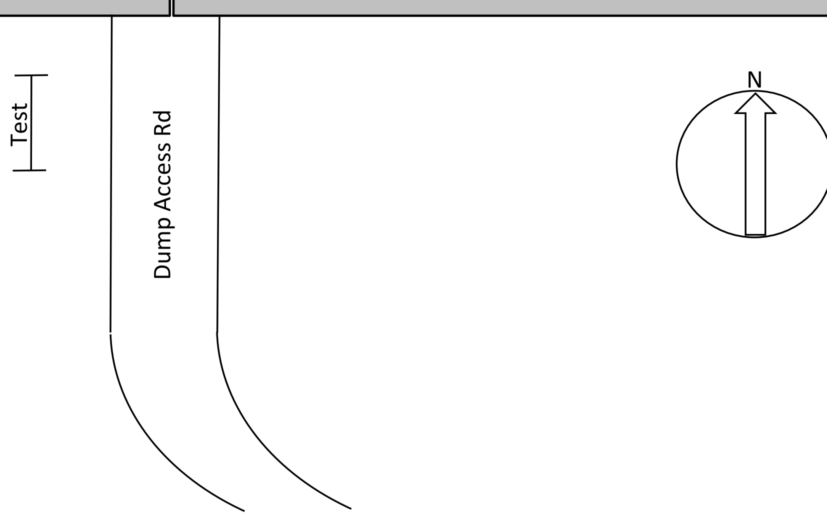
Project Name:	Vermont Gas Project
	12-144-08
Date:	5/2/2013
Location:	Rd Sd off Dump Access Rd
	44 28.6848N, 73 4.5661W
Testers:	KJ, LM
Methodology:	$\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation:	Biddle Meter DET2/2
Weather:	80F/Clear
Soil Description	Dry sand and rock

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 1/R) ohms	Spacing Factor	Layer Resistivity* Layer (m)	Layer Resistivity* 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







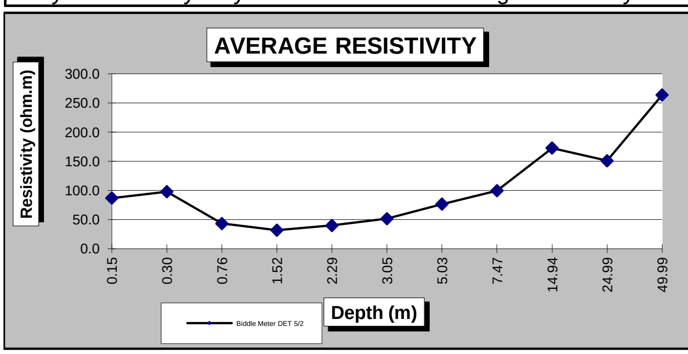
SOIL RESISTIVITY DATA

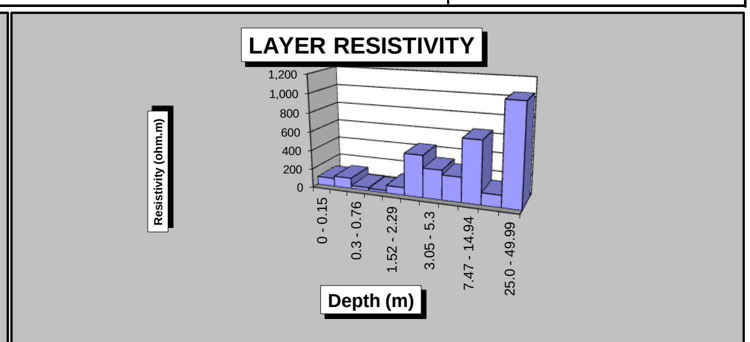
Project Name:	Vermont Gas Project
	12-144-09
Date:	5/2/2013
Location:	Rd Sd off Redmond Rd
	44 28.277N, 73 5.082W
Testers:	KJ, LM
Methodology:	$\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation:	Biddle Meter DET 5/2
Weather:	80F/Clear
Soil Description	Moist dark sodded

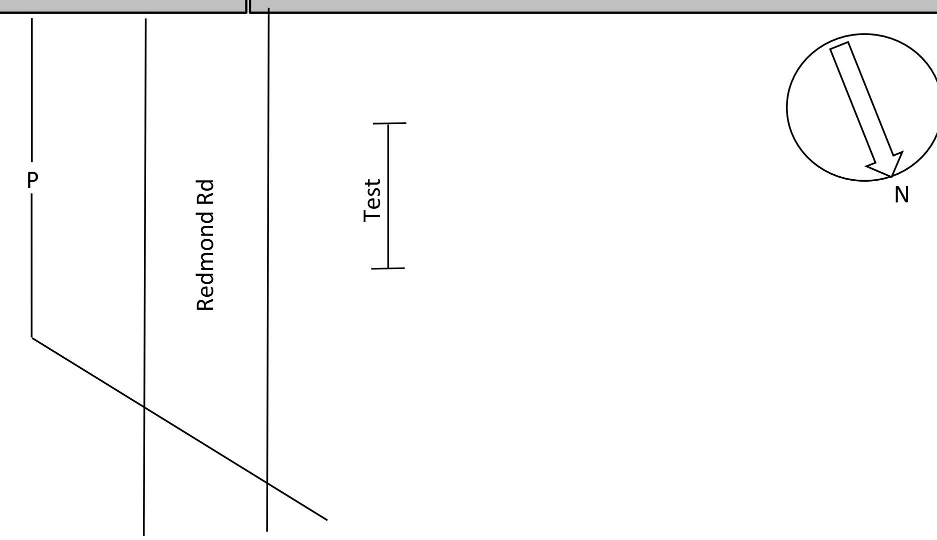
ARK Engineering & Technical Services, Inc.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 1/R) ohms	Spacing Factor	Layer Resistivity* Layer (m)	Layer Resistivity* 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







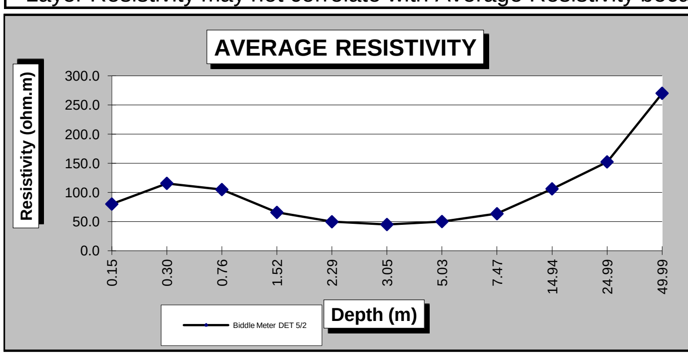
SOIL RESISTIVITY DATA

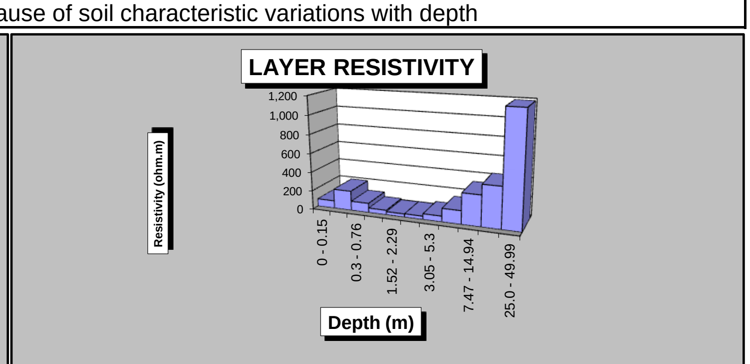
Project Name:	Vermont Gas Project
	12-144-10
Date:	5/2/2013
Location:	Overgrown lot off Brennan Woods Dr
	44 27.286N, 73 5.568W
Testers:	KJ, LM
Methodology:	$\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation:	Biddle Meter DET 5/2
Weather:	75F/Clear
Soil Description	Wet dark soil

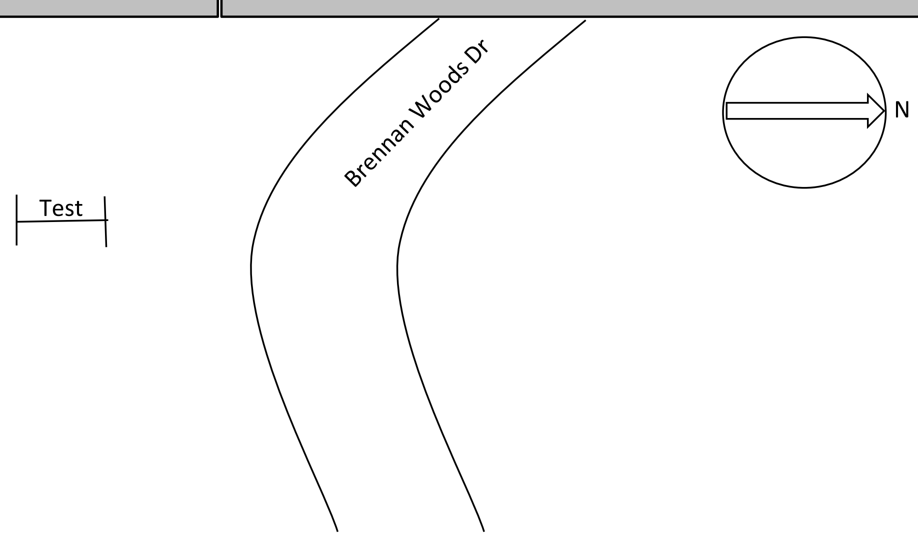
ARK Engineering & Technical Services, Inc.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d)	Depth (d)	R	Spacing	Resistivity	1/R	Δ 1/R	1/(Δ 1/R)	Spacing	Layer Resistivity*	
ft	m	ohms	Factor	ohm.m	mhos	mhos	ohms	Factor	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







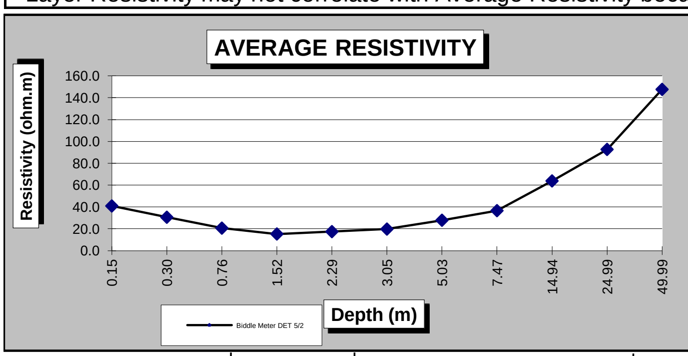
SOIL RESISTIVITY DATA

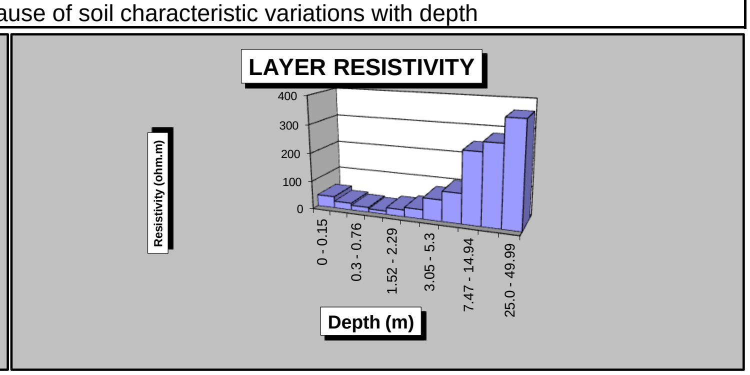
Project Name:	Vermont Gas Project
	12-144-11
Date:	5/2/2013
Location:	Rd Sd off Williston Rd
	44 26.6096N, 73 5.7963W
Testers:	KJ, LM
Methodology:	$\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation:	Biddle Meter DET 5/2
Weather:	74F/Clear
Soil Description	Sandy, Rocky soil

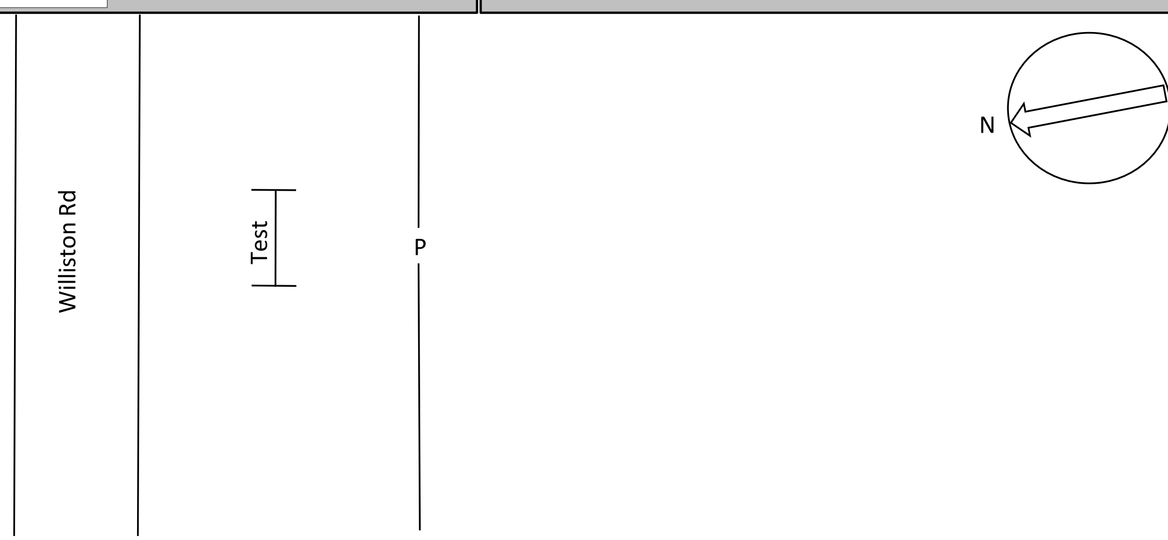
ARK ENGINEERING & TECHNICAL SERVICES, INC.

4 Pin Wenner Data					**Barnes Layer Analysis**					
Depth (d) ft	**Depth (d) m**	**R ohms**	**Spacing Factor**	**Resistivity ohm.m**	**1/R mhos**	**Δ 1/R mhos**	**1/(Δ 1/R) ohms**	**Spacing Factor**	**Layer Resistivity*: Layer (m)**	**Layer Resistivity*: 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







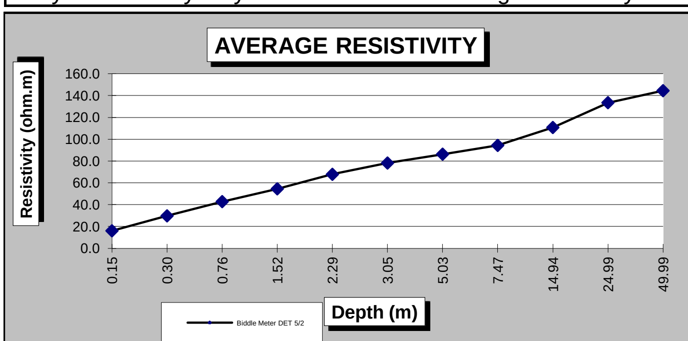
SOIL RESISTIVITY DATA

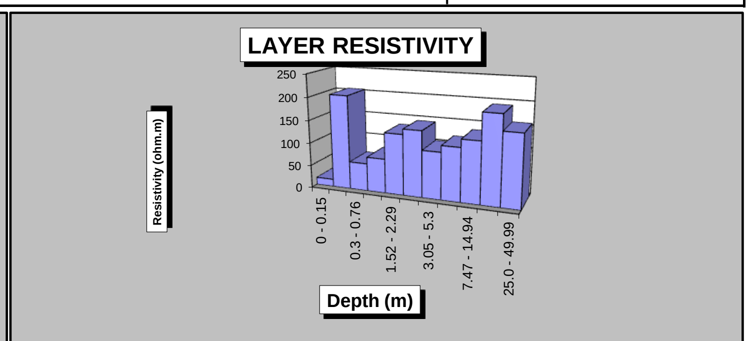
Project Name:	Vermont Gas Project
	12-144-12
Date:	5/2/2013
Location:	Rd Sd off entry ramp to I-89
	44 26.3197N, 73 6.8117W
Testers:	KJ, LM
Methodology:	ρ = 2πdR, per ASTM G 57 & Barnes Method
Instrumentation:	Biddle Meter DET 5/2
Weather:	73F/Clear
Soil Description	Wet, dark, and rocky soil

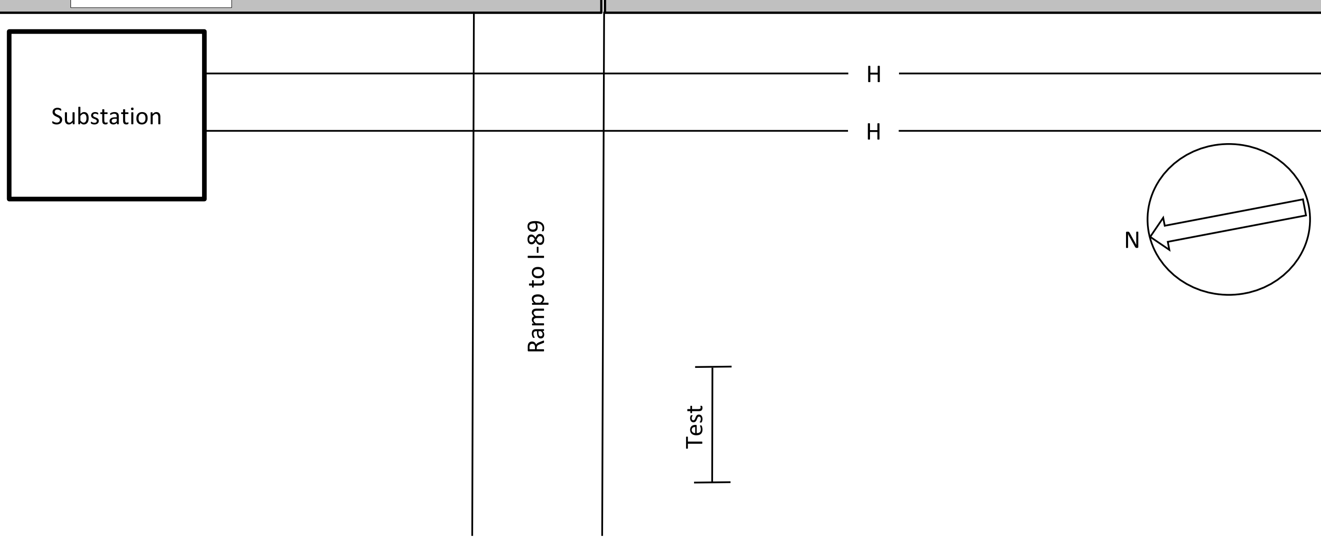
ARK
ENGINEERING & TECHNICAL SERVICES, INC.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 1/R) ohms	Spacing Factor	Layer Resistivity* Layer (m)	Layer Resistivity* 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







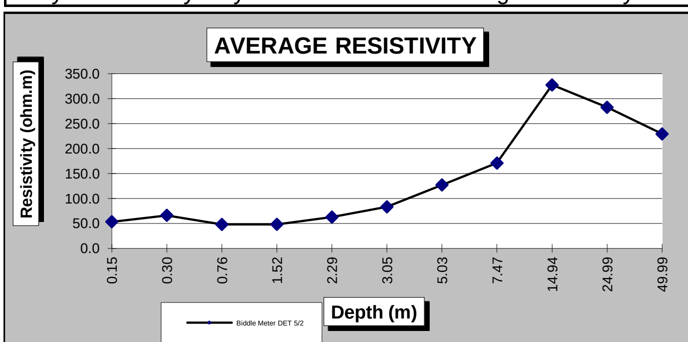
SOIL RESISTIVITY DATA

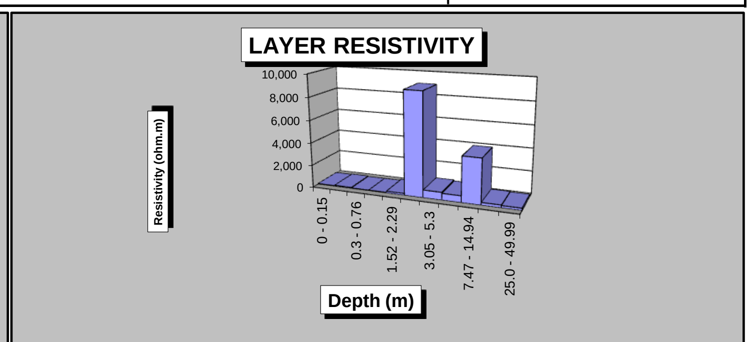
Project Name:	Vermont Gas Project
	12-144-13
Date:	5/2/2013
Location:	Rd Sd off Old Creamery Rd
	44 25.6578N, 73 7.205W
Testers:	KJ, LM
Methodology:	$\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation:	Biddle Meter DET 5/2
Weather:	64F/Clear
Soil Description	Wet, dark, and rocky soil

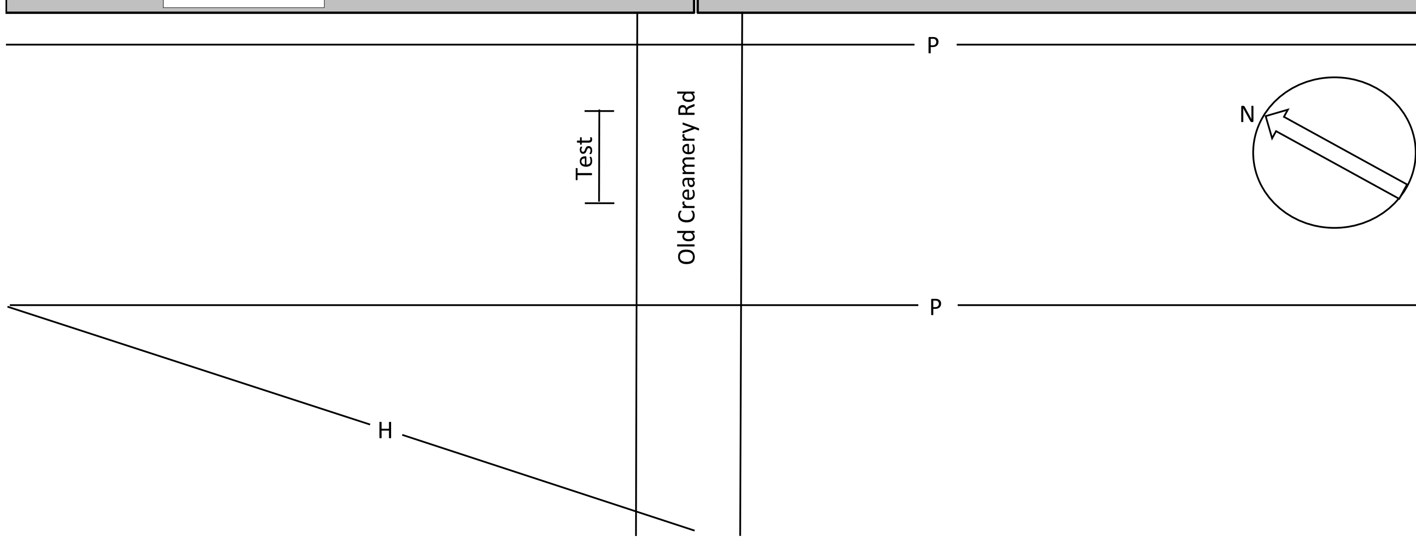
ARK ENGINEERING & TECHNICAL SERVICES, INC.

4 Pin Wenner Data					**Barnes Layer Analysis**					
Depth (d) ft	**Depth (d) m**	**R ohms**	**Spacing Factor**	**Resistivity ohm.m**	**1/R mhos**	**Δ 1/R mhos**	**1/(Δ 1/R) ohms**	**Spacing Factor**	**Layer Resistivity* Layer (m)**	**Layer Resistivity* 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







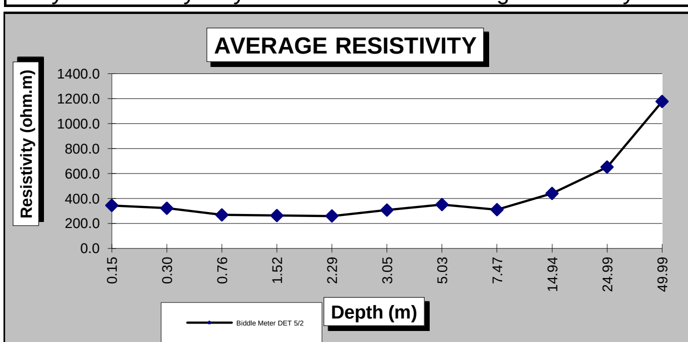
SOIL RESISTIVITY DATA

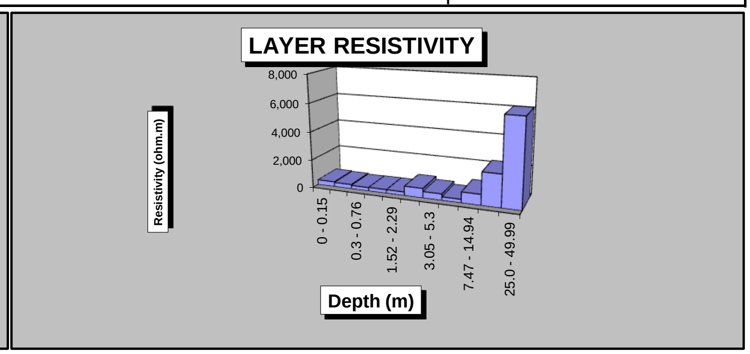
Project Name:	Vermont Gas Project
	12-144-14
Date:	5/2/2013
Location:	Rd Sd off Charles Rd
	44 25.1789N, 73 8.0221W
Testers:	KJ, LM
Methodology:	$\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation:	Biddle Meter DET 5/2
Weather:	64F/Clear
Soil Description	Dark, moist, and rocky soil

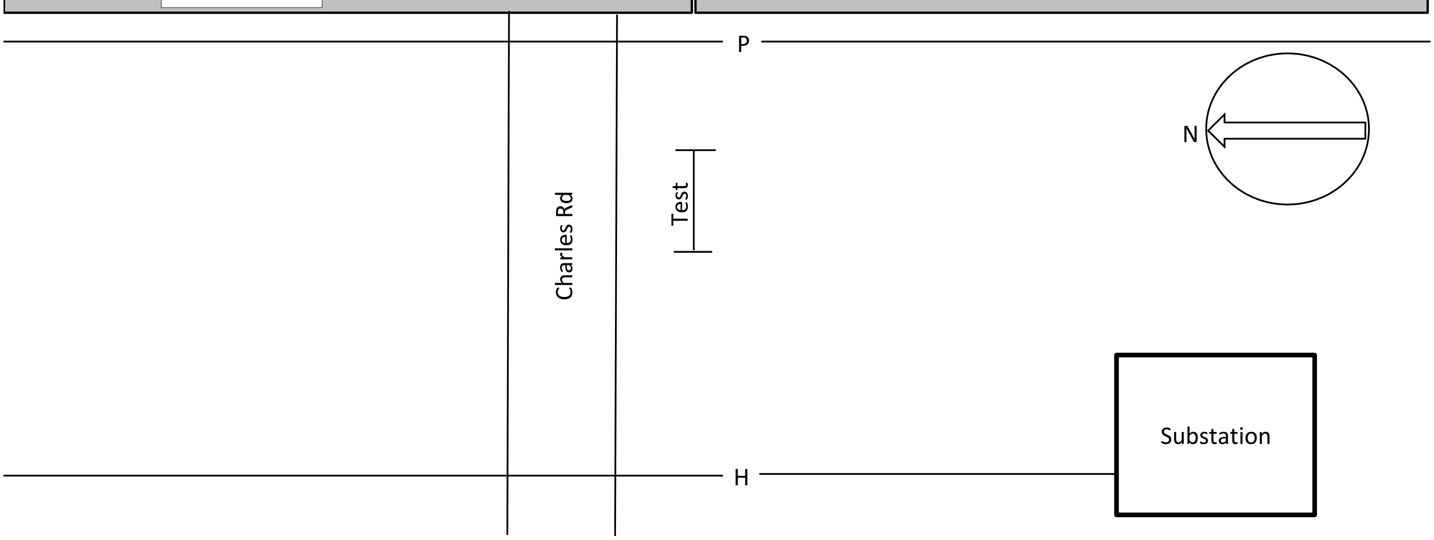
ARK Engineering & Technical Services, Inc.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 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







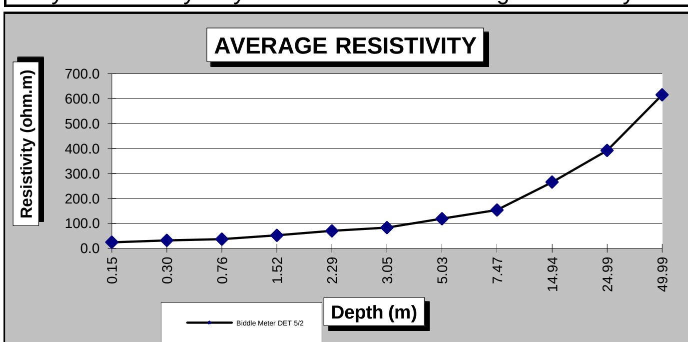
SOIL RESISTIVITY DATA

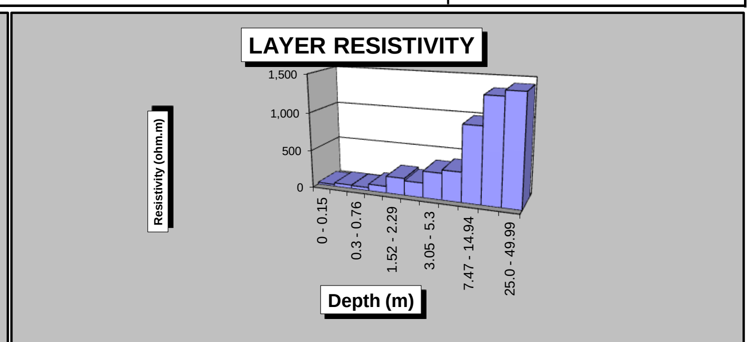
Project Name: Vermont Gas Project
12-144-15
Date: 5/2/2013
Location: Rd Sd off Butternut Rd
44 24.1525N, 73 7.5014W
Testers: KJ, LM
Methodology: ρ = 2πdR, per ASTM G 57 & Barnes Method
Instrumentation: Biddle Meter DET 5/2
Weather: 61F/Clear
Soil Description Moist, dark, and rocky soil

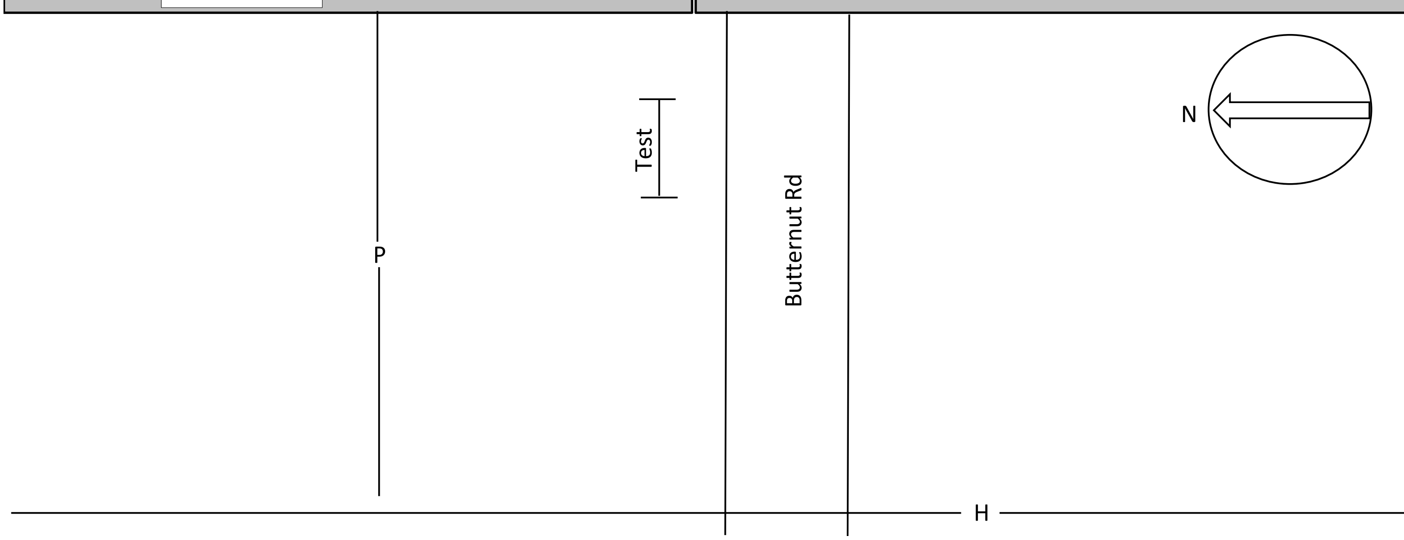
ARK® Engineering & Technical Services, Inc.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 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







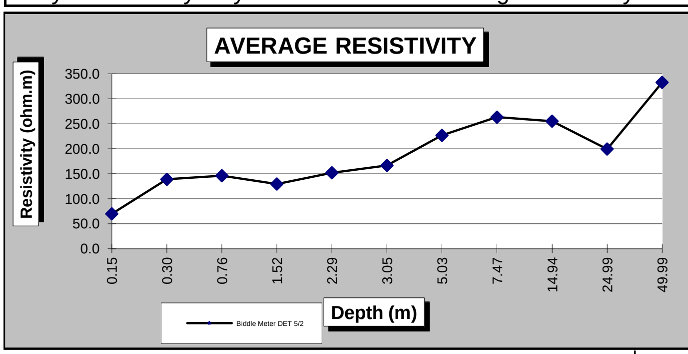
SOIL RESISTIVITY DATA

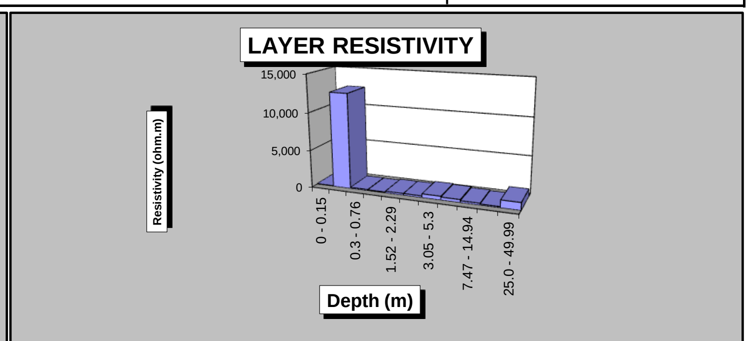
Project Name:	Vermont Gas Project
	12-144-16
Date:	5/2/2013
Location:	Rd Sd off Beliveau Rd
	44 23.2839N, 73 7.5540W
Testers:	KJ, LM
Methodology:	ρ = 2πdR, per ASTM G 57 & Barnes Method
Instrumentation:	Biddle Meter DET 5/2
Weather:	62F/Clear
Soil Description	Dry, rocky soil

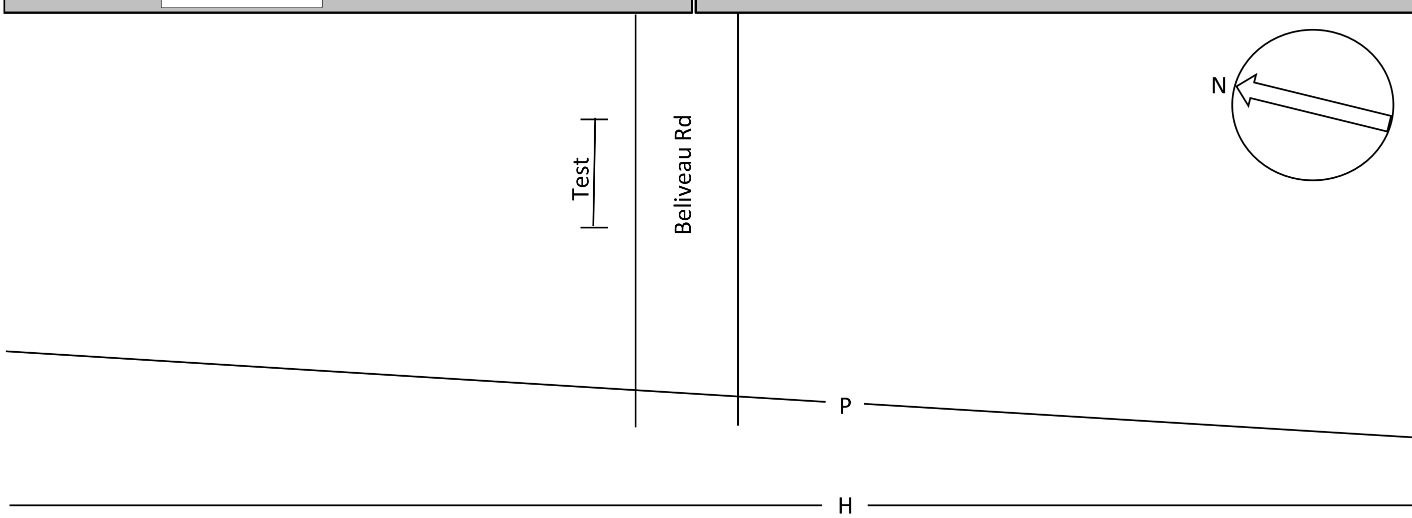
ARK ENGINEERING & TECHNICAL SERVICES, INC.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 1/R) ohms	Spacing Factor	Layer Resistivity* Layer (m)	Layer Resistivity* 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







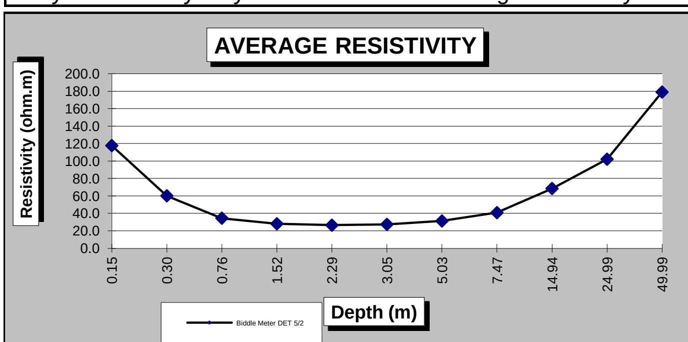
SOIL RESISTIVITY DATA

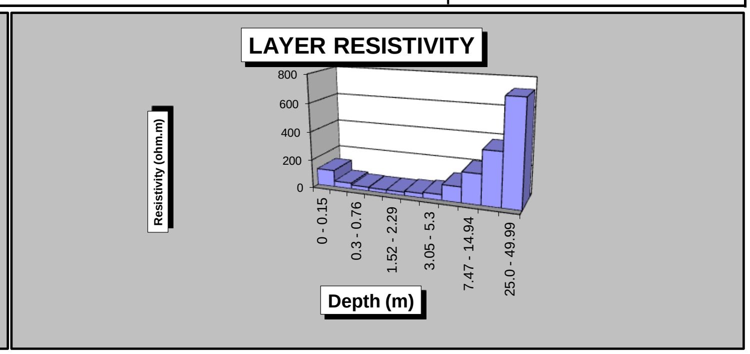
Project Name:	Vermont Gas Project
	12-144-17
Date:	5/1/2013
Location:	Rd Sd North of CR116
	44 22.1536N, 73 7.6751W
Testers:	KJ, LM
Methodology:	$\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation:	Biddle Meter DET 5/2
Weather:	76F/Clear
Soil Description	Dark, moist, sodded

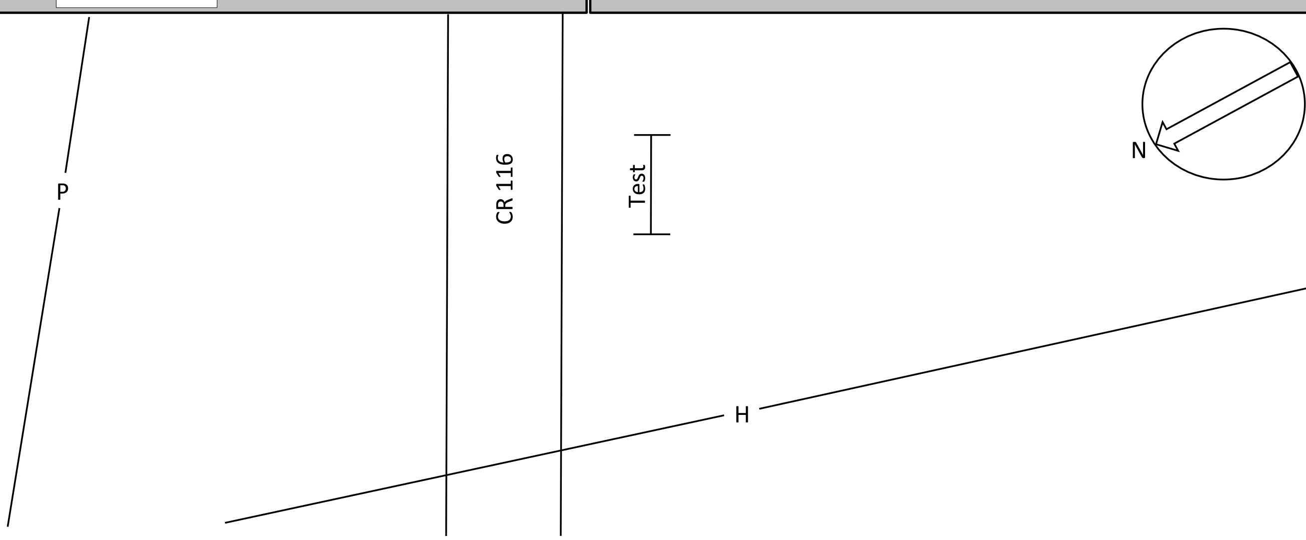
ARK ENGINEERING & TECHNICAL SERVICES, INC.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 1/R) ohms	Spacing Factor	Layer Resistivity* Layer (m)	Layer Resistivity* 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







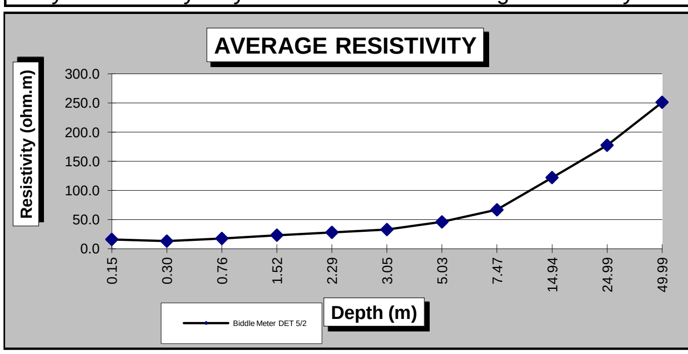
SOIL RESISTIVITY DATA

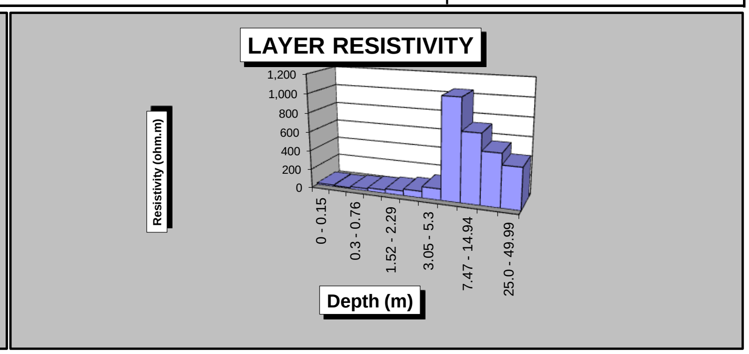
Project Name: Vermont Gas Project
12-144-18
Date: 5/1/2013
Location: Mowed pasture West of CR116
44 21.010N, 73 7.096W
Testers: KJ, LM
Methodology: ρ = 2πdR, per ASTM G 57 & Barnes Method
Instrumentation: Biddle Meter DET 5/2
Weather: 75F/Clear
Soil Description Wet, dark soil

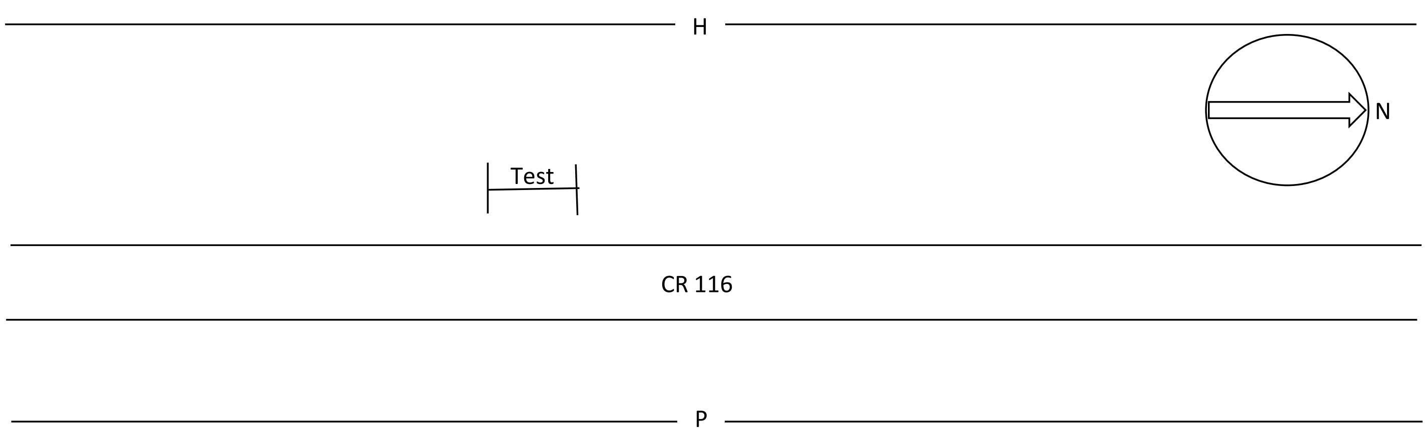
ARK Engineering & Technical Services, Inc.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 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







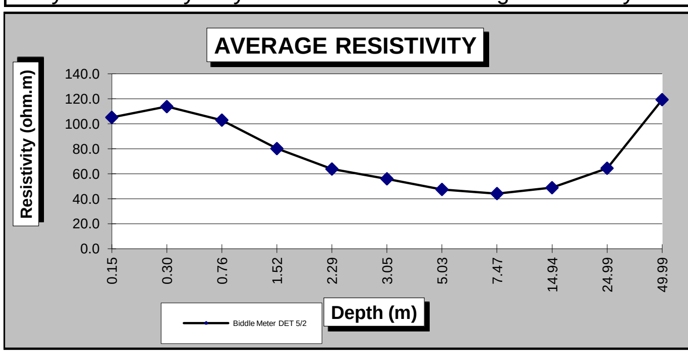
SOIL RESISTIVITY DATA

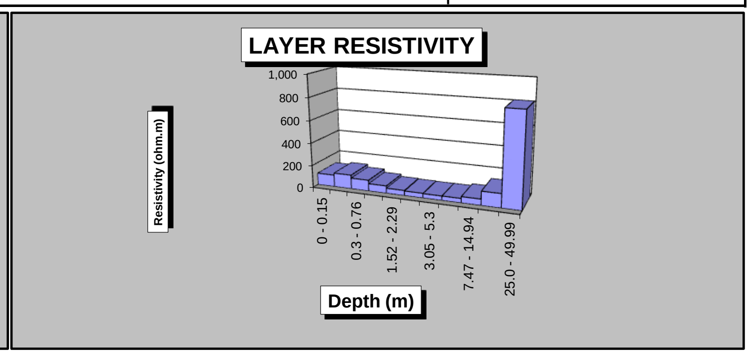
Project Name: Vermont Gas Project
12-144-19
Date: 5/1/2013
Location: Mowed field off Shelburne Falls Rd
44 20.454N, 73 7.615W
Testers: KJ, LM
Methodology: $\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation: Biddle Meter DET 5/2
Weather: 75F/Clear
Soil Description Dark and moist

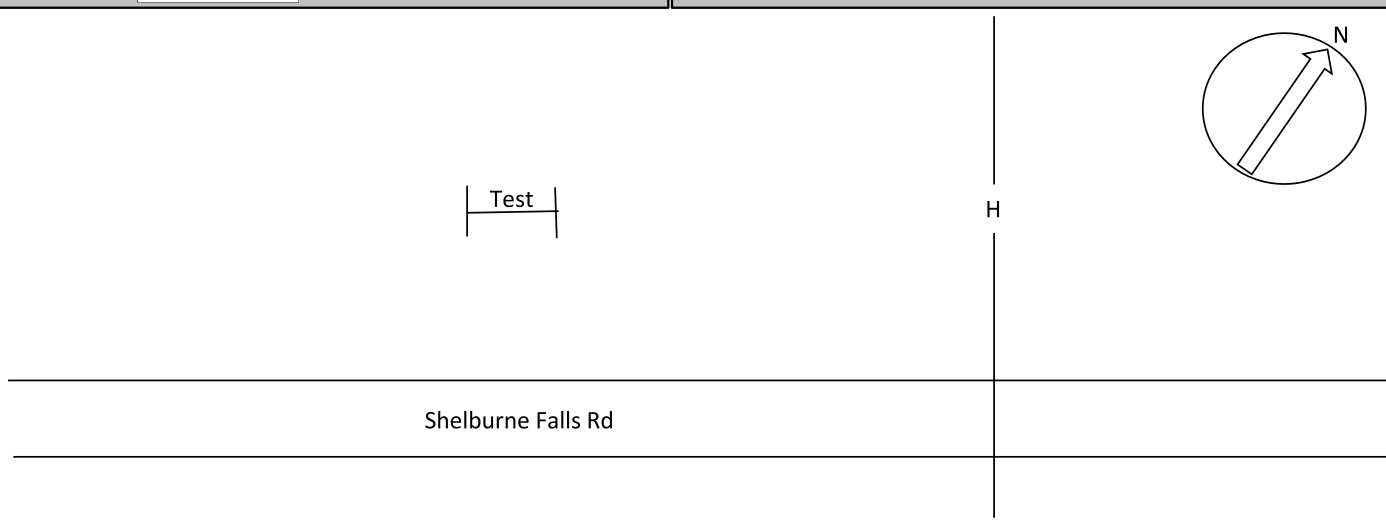
ARK Engineering & Technical Services, Inc.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 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







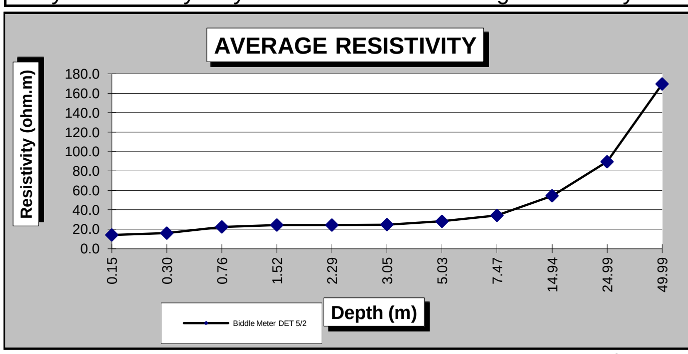
SOIL RESISTIVITY DATA

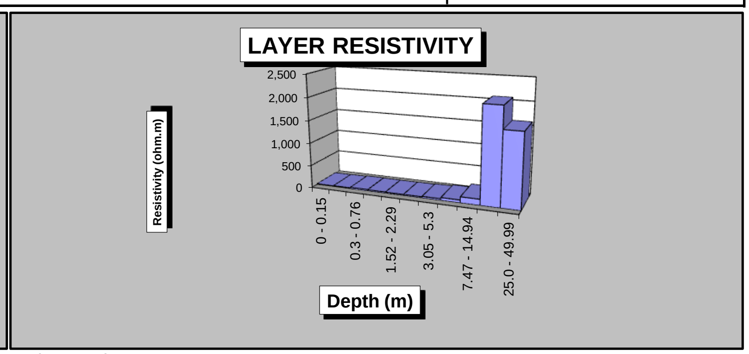
Project Name:	Vermont Gas Project
	12-144-20
Date:	5/1/2013
Location:	Mowed field off Charlotte Rd
	44 19.6814N, 73 7.9244W
Testers:	KJ, LM
Methodology:	$\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation:	Biddle Meter DET 5/2
Weather:	73F/Clear
Soil Description	Moist, Dark

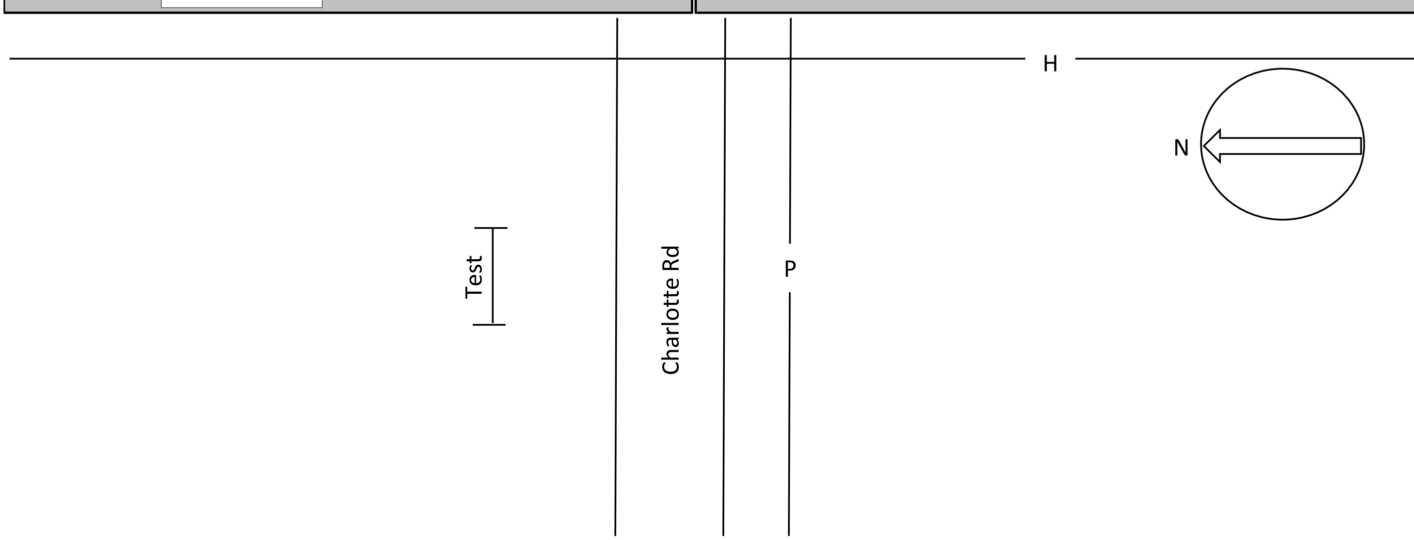
ARK ENGINEERING & TECHNICAL SERVICES, INC.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 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







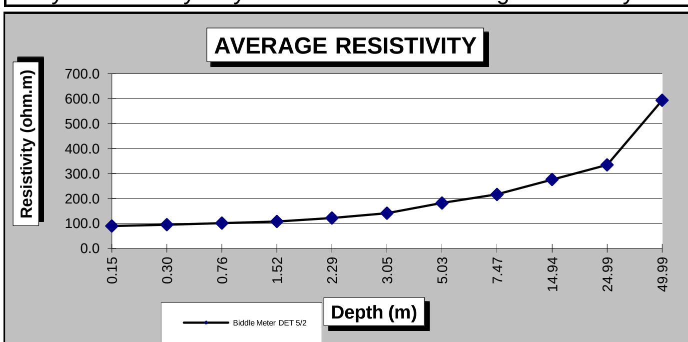
SOIL RESISTIVITY DATA

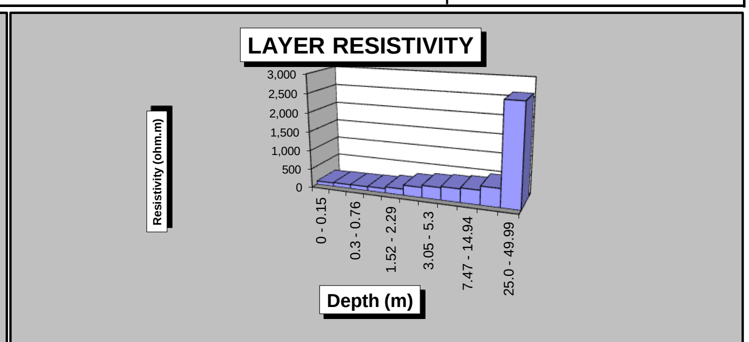
Project Name:	Vermont Gas Project
	12-144-21
Date:	5/1/2013
Location:	Rd Sd off Burritt Rd
	44 18.7647N, 73 8.1066W
Testers:	KJ, LM
Methodology:	$\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation:	Biddle Meter DET 5/2
Weather:	66F/Clear
Soil Description	Dry sand and rock

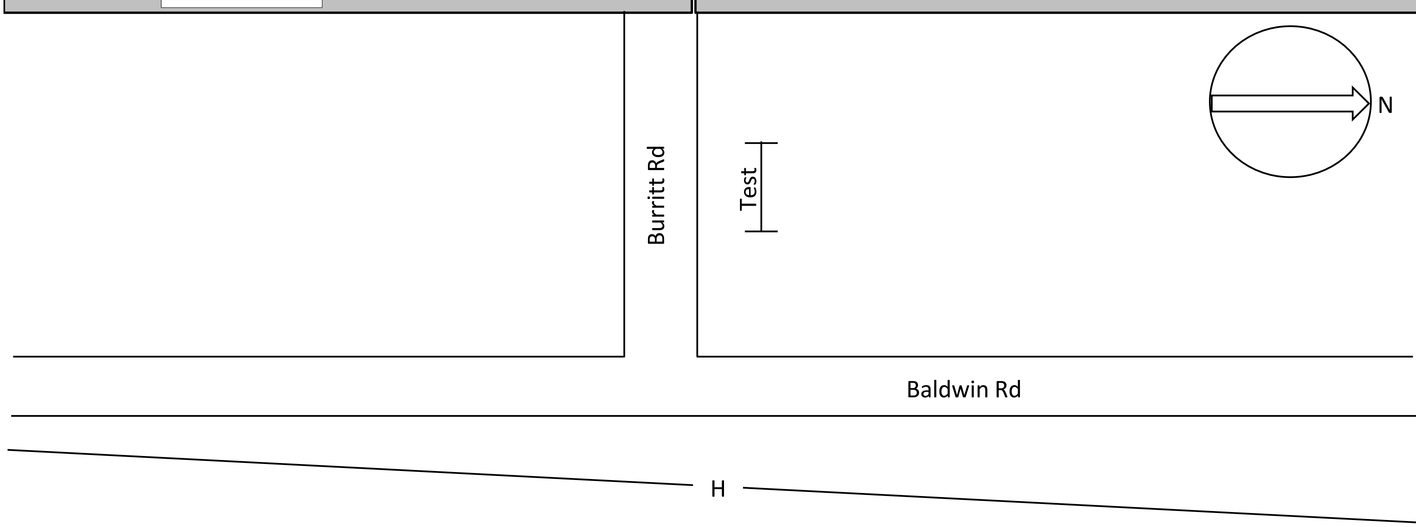
ARK
ENGINEERING & TECHNICAL SERVICES, INC.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 1/R) ohms	Spacing Factor	Layer Resistivity* Layer (m)	Layer Resistivity* 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







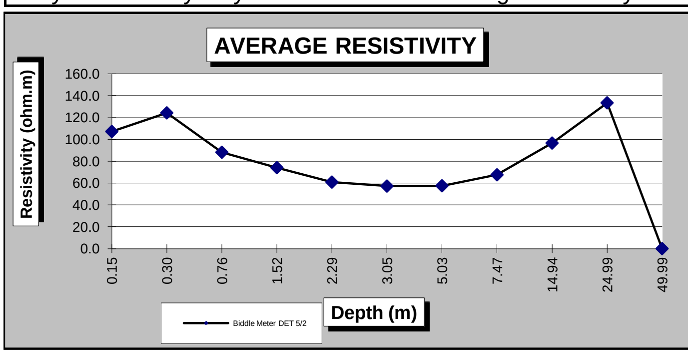
SOIL RESISTIVITY DATA

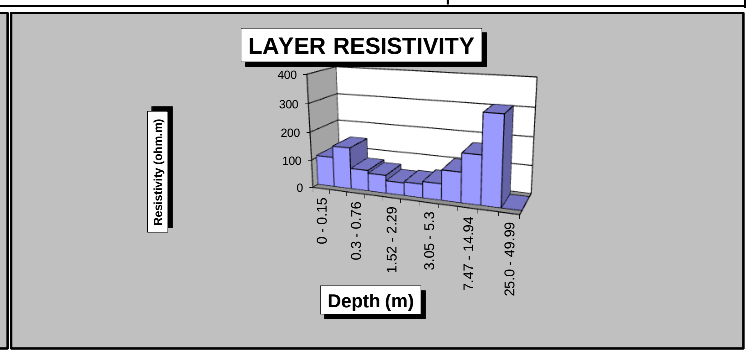
Project Name: Vermont Gas Project
12-144-22
Date: 5/6/2013
Location: Rd Sd off Meade Farm Rd
44 17.956N, 73 6.513W
Testers: KJ, LM
Methodology: $\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation: Biddle Meter DET 5/2
Weather: 70F/Clear
Soil Description Dark, moist and vegetation

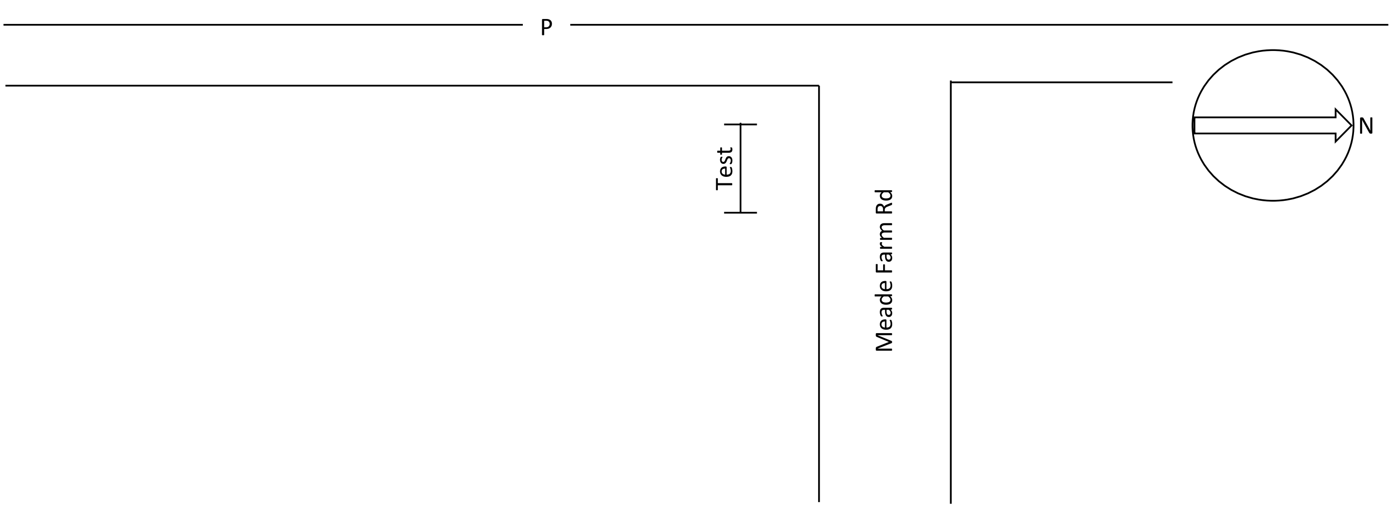
ARK ENGINEERING & TECHNICAL SERVICES, INC.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 1/R) ohms	Spacing Factor	Layer Resistivity* Layer (m)	Layer Resistivity* 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







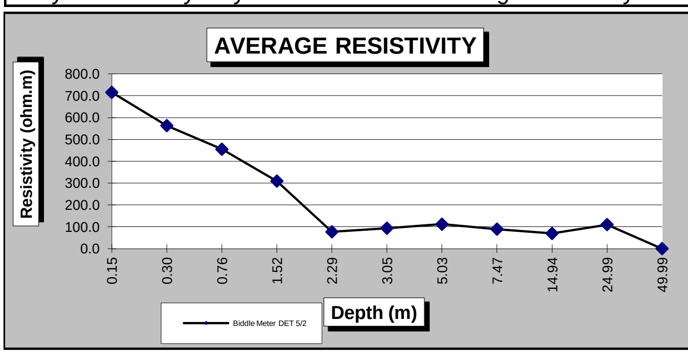
SOIL RESISTIVITY DATA

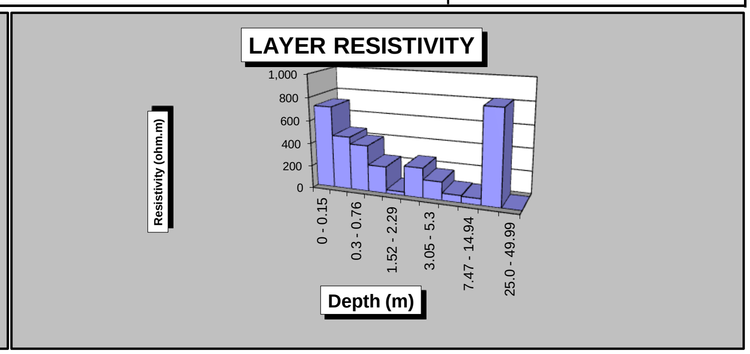
Project Name:	Vermont Gas Project
	12-144-23
Date:	5/6/2013
Location:	Rd Sd off Deer Run Ln
	44 17.238N, 73 7.823W
Testers:	KJ, LM
Methodology:	$\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation:	Biddle Meter DET 5/2
Weather:	60F/Clear
Soil Description	Dark, moist, and vegetation

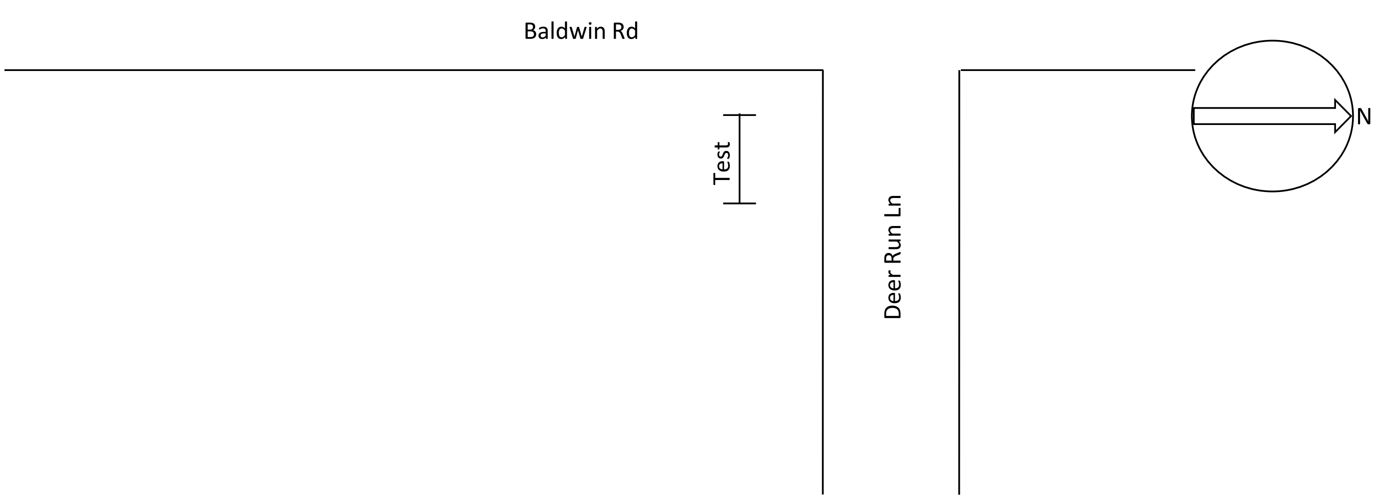
ARK ENGINEERING & TECHNICAL SERVICES, INC.

4 Pin Wenner Data					**Barnes Layer Analysis**					
Depth (d) ft	**Depth (d) m**	**R ohms**	**Spacing Factor**	**Resistivity ohm.m**	**1/R mhos**	**Δ 1/R mhos**	**1/(Δ 1/R) ohms**	**Spacing Factor**	**Layer Resistivity* Layer (m)**	**Layer Resistivity* 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







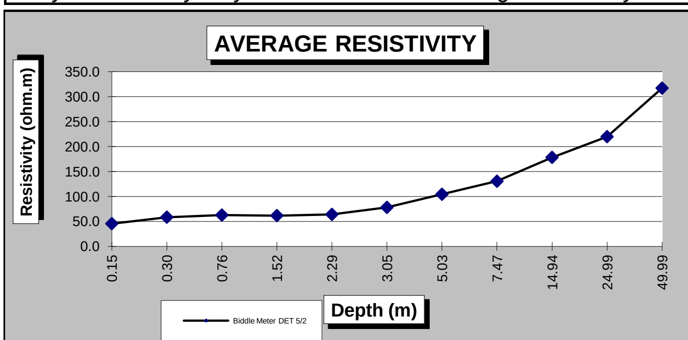
SOIL RESISTIVITY DATA

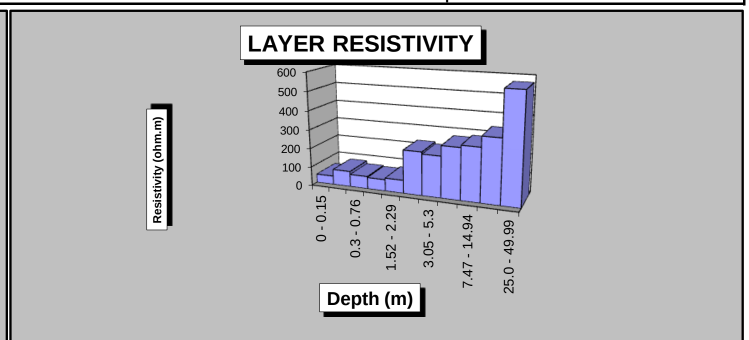
Project Name:	Vermont Gas Project
	12-144-24
Date:	5/3/2013
Location:	Rd Sd off Access Rd West of Baldwin Rd
	44 16.205N, 73 8.074W
Testers:	KJ, LM
Methodology:	$\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation:	Biddle Meter DET 5/2
Weather:	68F/Clear
Soil Description	Dry sand and rock

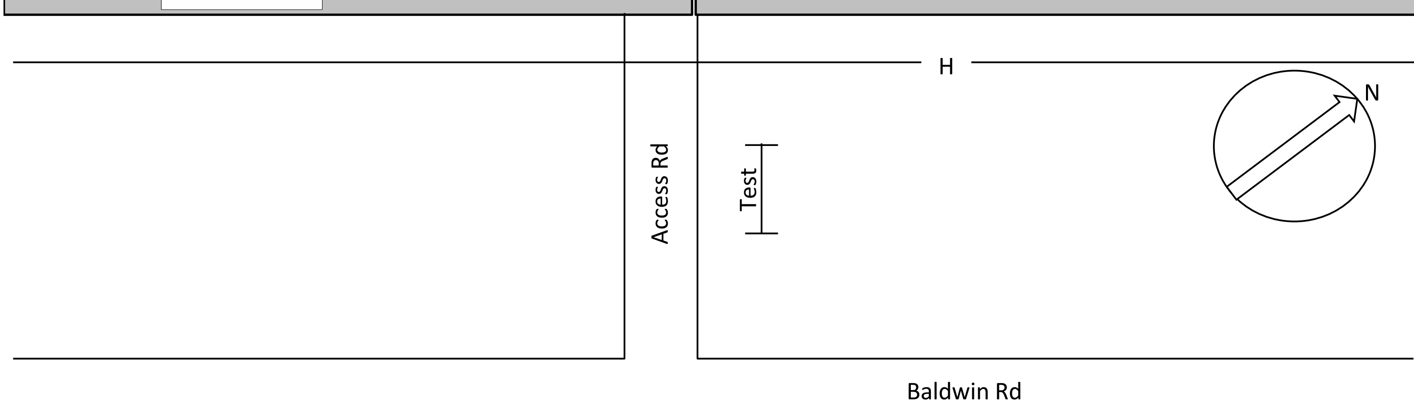
ARK Engineering & Technical Services, Inc.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 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







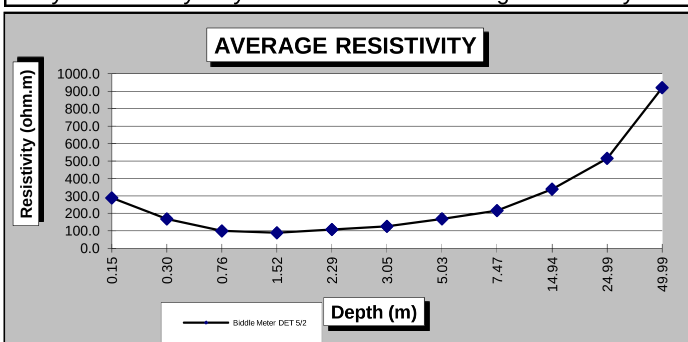
SOIL RESISTIVITY DATA

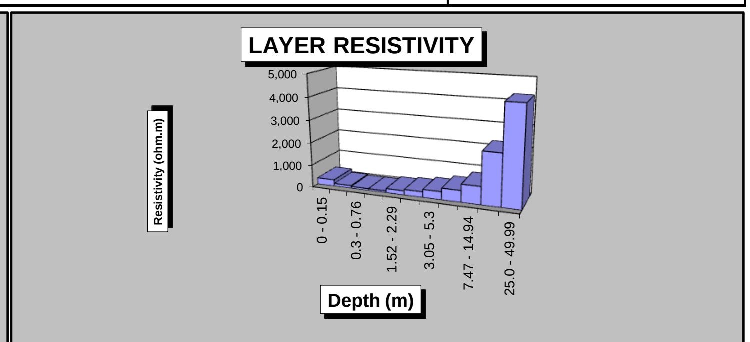
Project Name: Vermont Gas Project
12-144-25
Date: 5/3/2013
Location: Rd Sd off Pond Rd
44 15.096N, 73 8.382W
Testers: KJ, LM
Methodology: $\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation: Biddle Meter DET 5/2
Weather: 69F/Clear
Soil Description Dry sand and rock

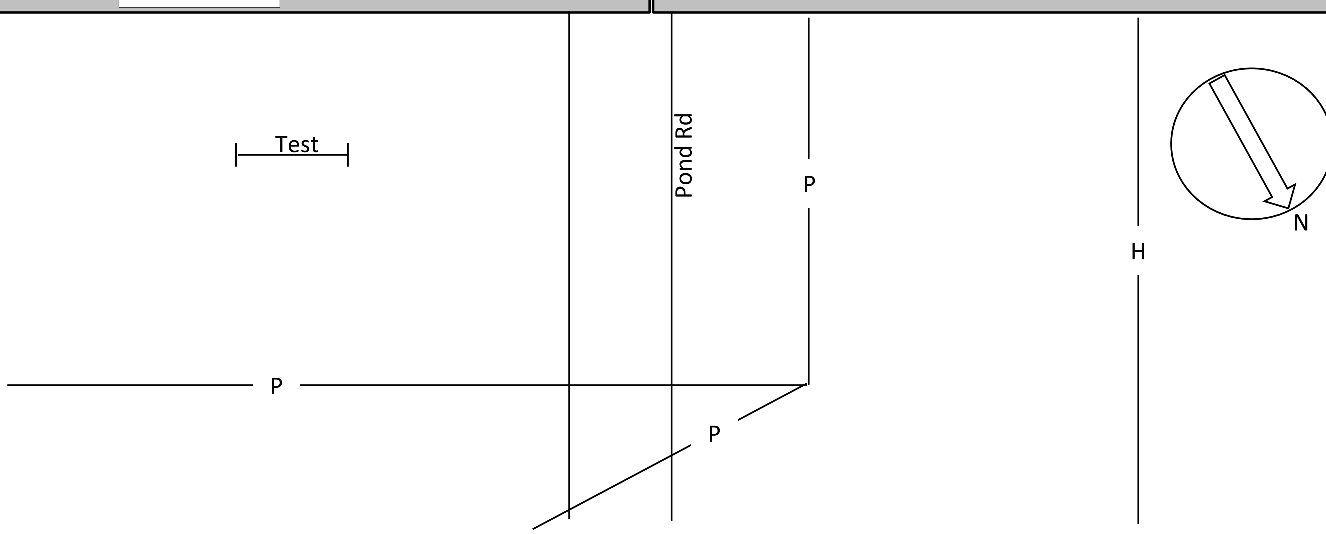
ARK Engineering & Technical Services, Inc.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 1/R) ohms	Spacing Factor	Layer Resistivity* Layer (m)	Layer Resistivity* 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







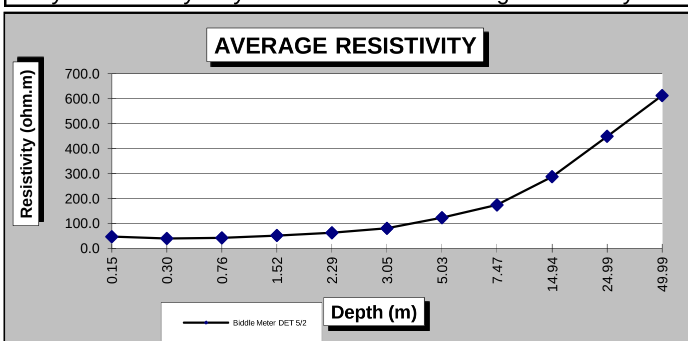
SOIL RESISTIVITY DATA

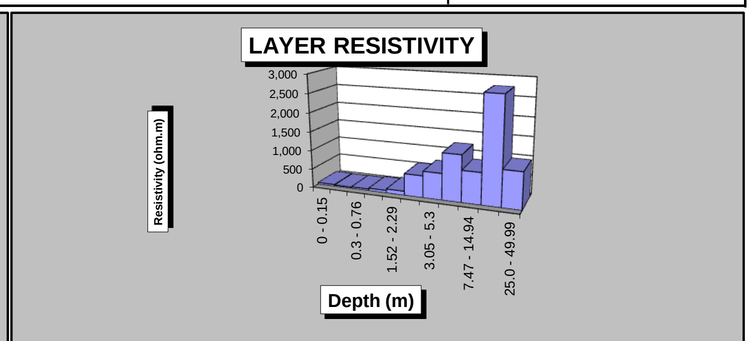
Project Name:	Vermont Gas Project
	12-144-26
Date:	5/4/2013
Location:	Rd Sd off Hollow Rd
	44 14.318N, 73 9.036W
Testers:	KJ, LM
Methodology:	$\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation:	Biddle Meter DET 5/2
Weather:	55F/Clear
Soil Description	Moist, dark soil

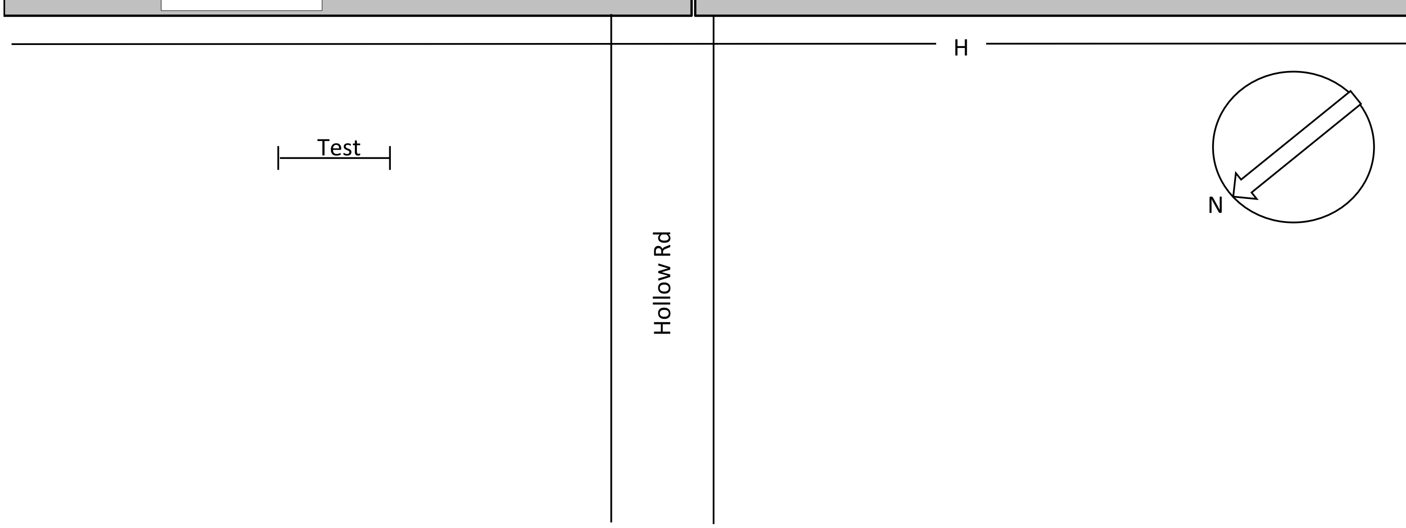
ARK ENGINEERING & TECHNICAL SERVICES, INC.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	**Depth (d) m**	**R ohms**	**Spacing Factor**	**Resistivity ohm.m**	**1/R mhos**	**Δ 1/R mhos**	**1/(Δ 1/R) ohms**	**Spacing Factor**	**Layer Resistivity* Layer (m)**	**Layer Resistivity* 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







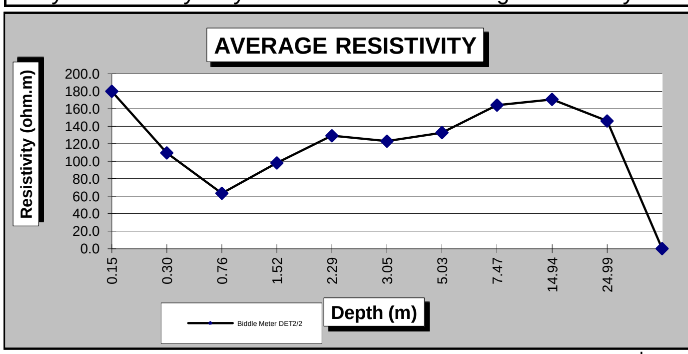
SOIL RESISTIVITY DATA

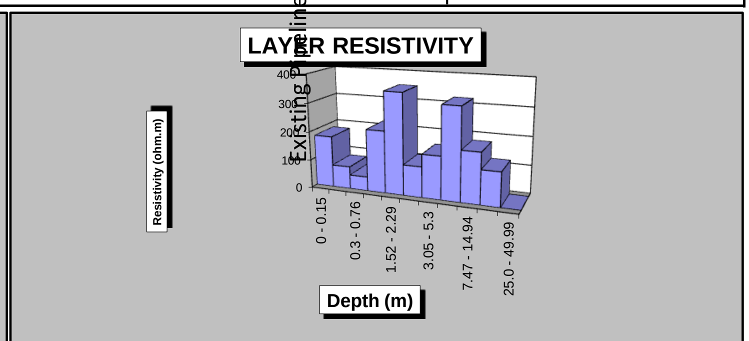
Project Name:	Vermont Gas Project
	12-144-27
Date:	5/6/2013
Location:	Rd Sd off Post Rd
	44 13.8614N, 73 9.1396W
Testers:	KJ, LM
Methodology:	$\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation:	Biddle Meter DET 5/2
Weather:	56F/Clear
Soil Description	Sand and rock

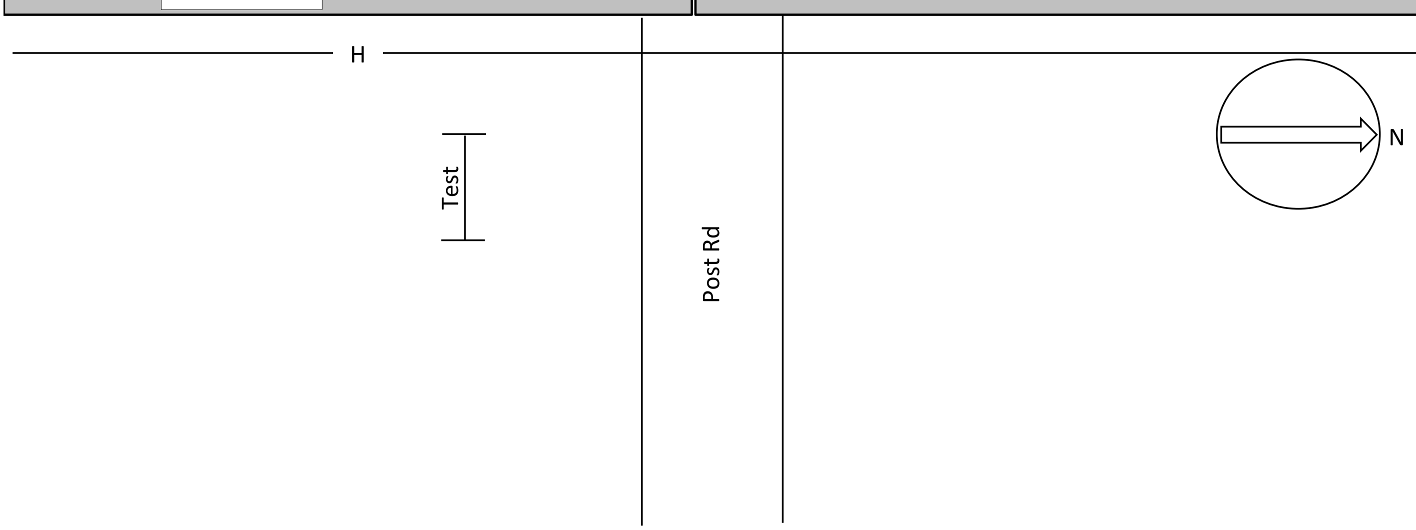
ARK ENGINEERING & TECHNICAL SERVICES, INC.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	**Depth (d) m**	**R ohms**	**Spacing Factor**	**Resistivity ohm.m**	**1/R mhos**	**Δ 1/R mhos**	**1/(Δ 1/R) ohms**	**Spacing Factor**	**Layer Resistivity* Layer (m)**	**Layer Resistivity* 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







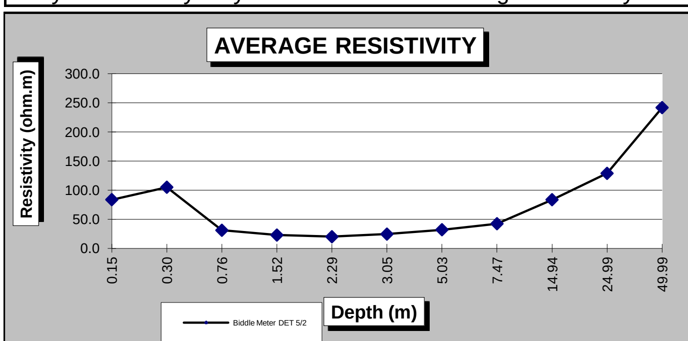
SOIL RESISTIVITY DATA

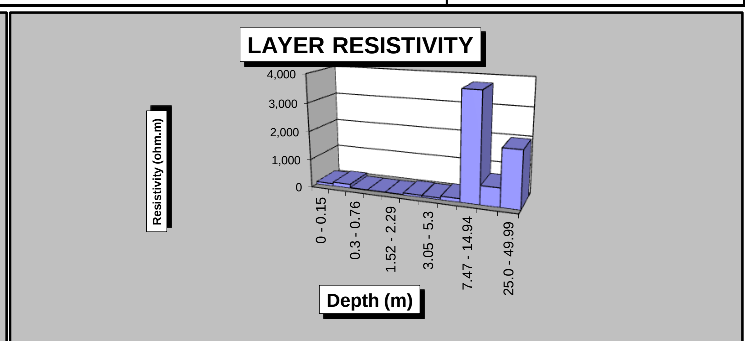
Project Name:	Vermont Gas Project
	12-144-28
Date:	5/3/2013
Location:	Rd Sd off Monkton Rd
	44 12.9201N, 73 9.5695W
Testers:	KJ, LM
Methodology:	$\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation:	Biddle Meter DET 5/2
Weather:	59F/Clear
Soil Description	Moist, dark soil and vegetation

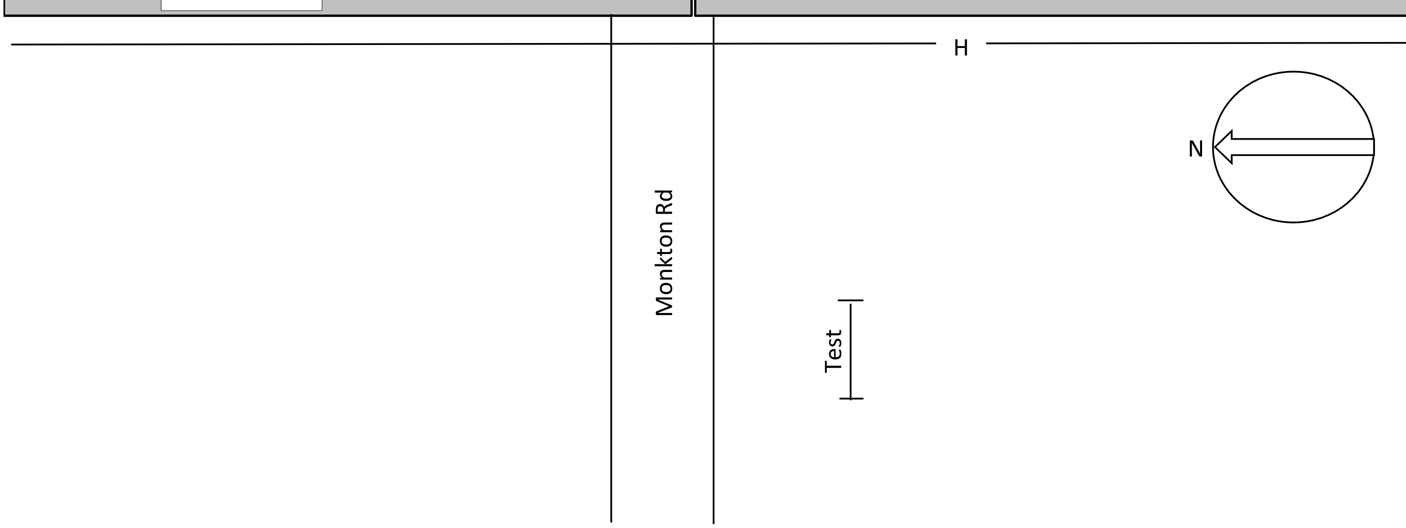
ARK ENGINEERING & TECHNICAL SERVICES, INC.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 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







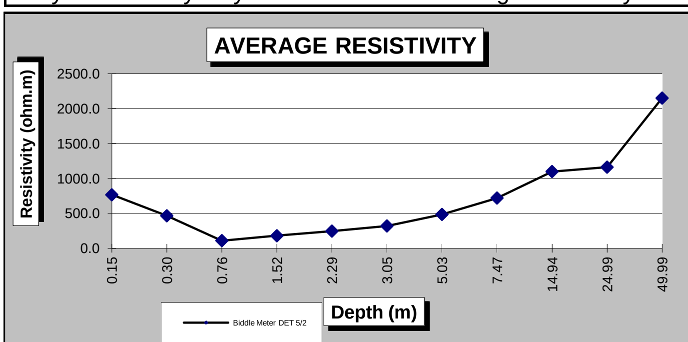
SOIL RESISTIVITY DATA

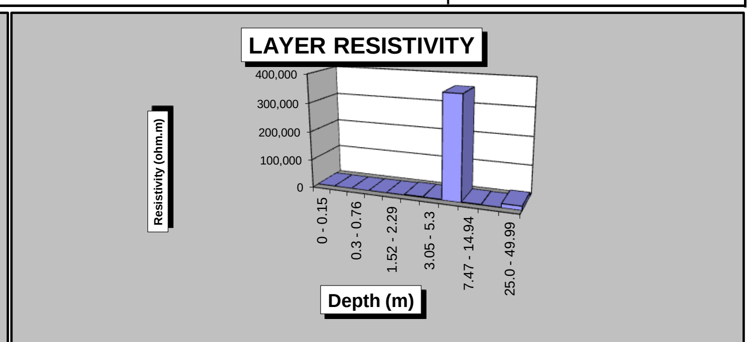
Project Name:	Vermont Gas Project
	12-144-29
Date:	5/4/2013
Location:	Access Rd off Monkton Rd
	44 11.9620N, 73 10.1339W
Testers:	KJ, LM
Methodology:	ρ = 2πdR, per ASTM G 57 & Barnes Method
Instrumentation:	Biddle Meter DET 5/2
Weather:	60F/Clear
Soil Description	Dry, rocky soil

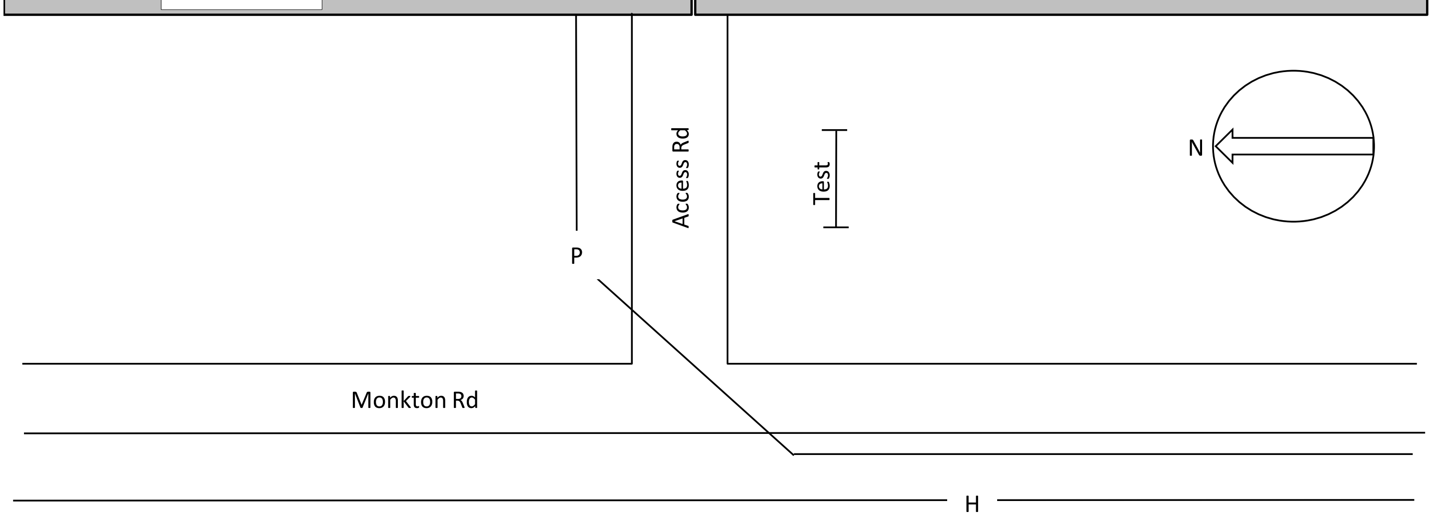
ARK ENGINEERING & TECHNICAL SERVICES, INC.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d)	Depth (d)	R	Spacing	Resistivity	1/R	Δ 1/R	1/(Δ 1/R)	Spacing	Layer Resistivity*	
ft	m	ohms	Factor	ohm.m	mhos	mhos	ohms	Factor	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







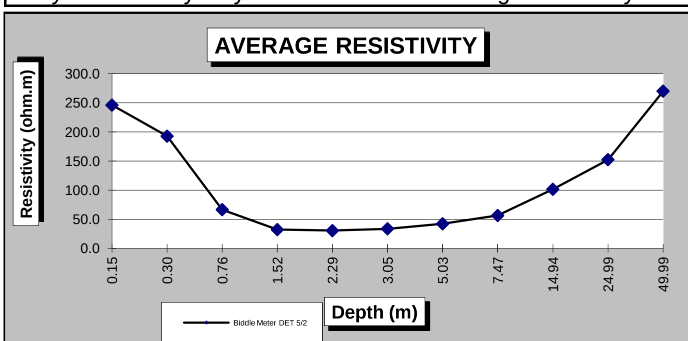
SOIL RESISTIVITY DATA

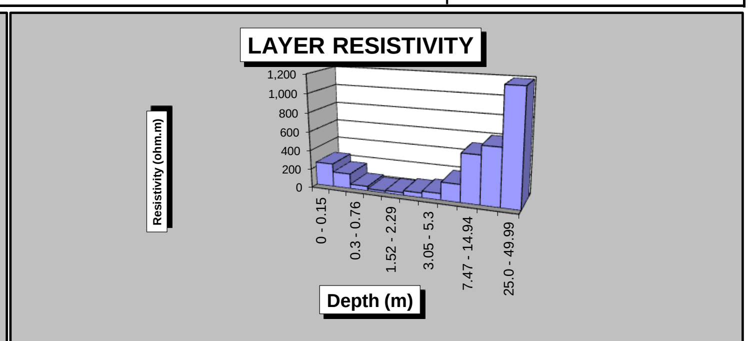
Project Name:	Vermont Gas Project
	12-144-30
Date:	5/4/2013
Location:	Rd Sd off Parks Hubert Rd
	44 11.3774N, 73 10.1006W
Testers:	KJ, LM
Methodology:	$\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation:	Biddle Meter DET 5/2
Weather:	63F/Clear
Soil Description	Dry sand and rock

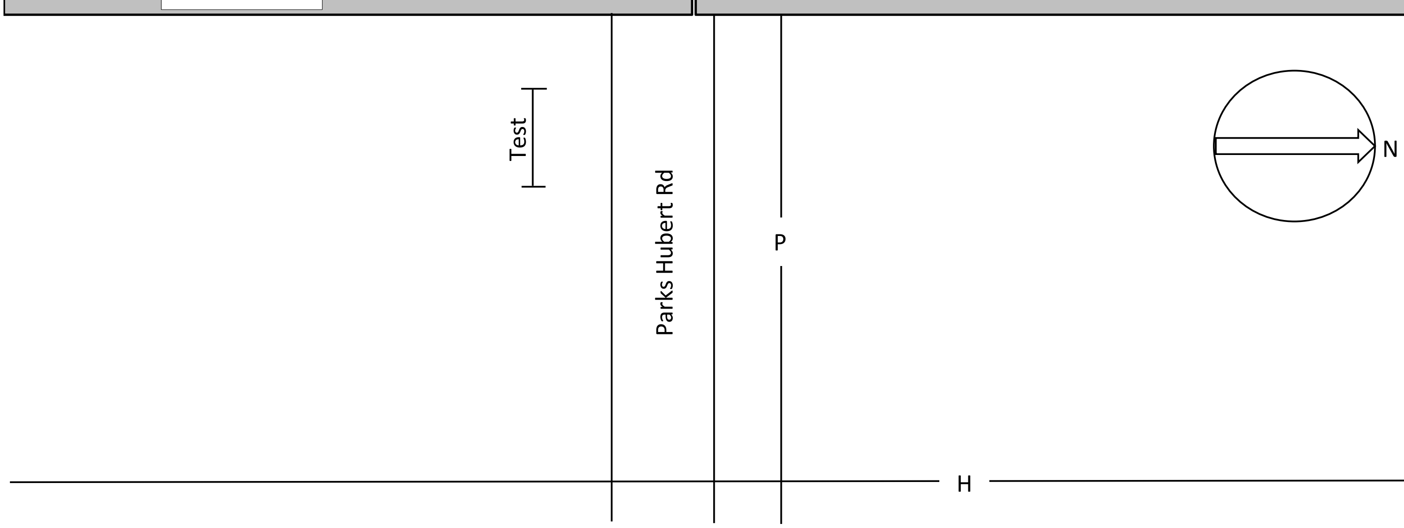
ARK ENGINEERING & TECHNICAL SERVICES, INC.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 1/R) ohms	Spacing Factor	Layer Resistivity* Layer (m)	Layer Resistivity* 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







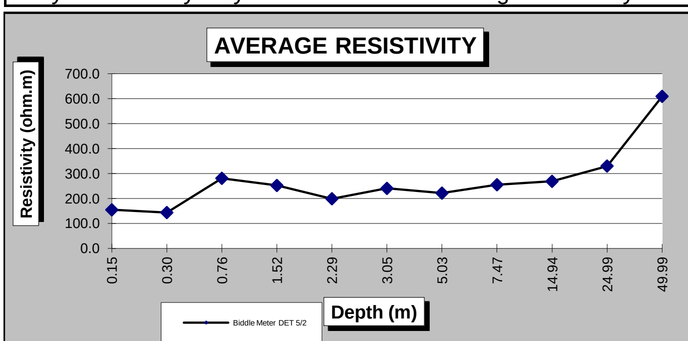
SOIL RESISTIVITY DATA

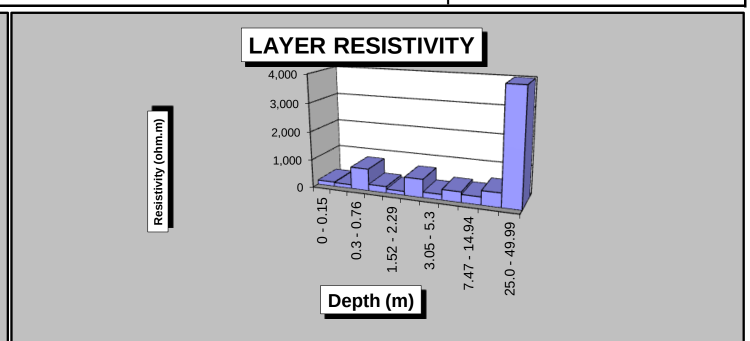
Project Name:	Vermont Gas Project
	12-144-31
Date:	5/4/2013
Location:	Rd Sd off NorthSt
	44 10.3319N, 73 9.1138W
Testers:	KJ, LM
Methodology:	$\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation:	Biddle Meter DET 5/2
Weather:	64F/Clear
Soil Description	Moist and rocky

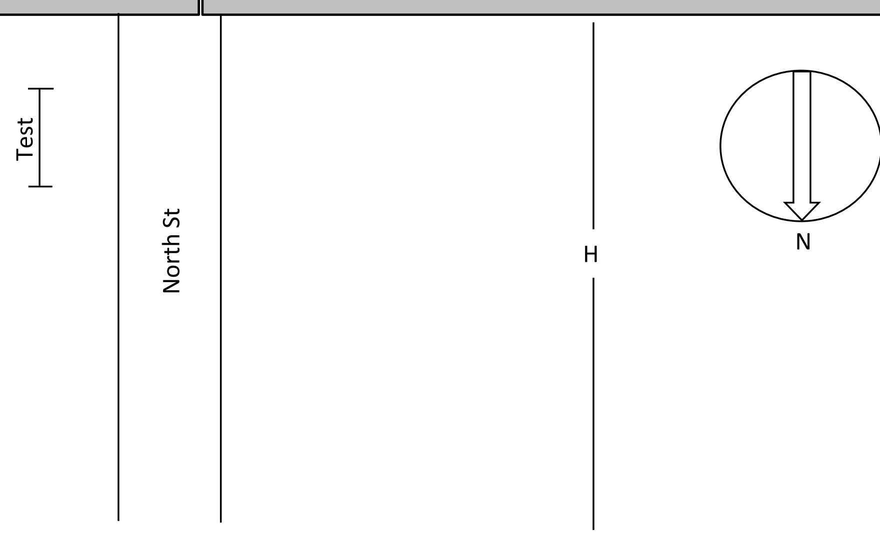
ARK ENGINEERING & TECHNICAL SERVICES, INC.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 1/R) ohms	Spacing Factor	Layer Resistivity* Layer (m)	Layer Resistivity* 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







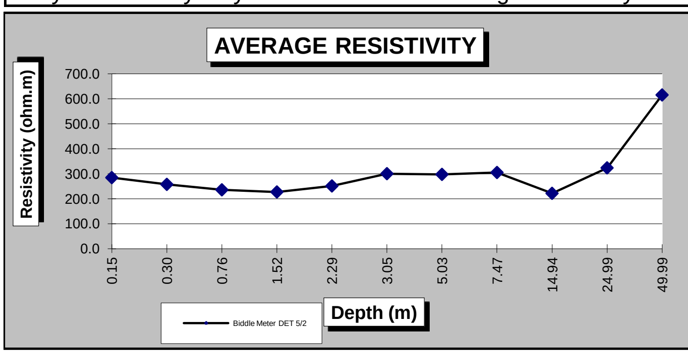
SOIL RESISTIVITY DATA

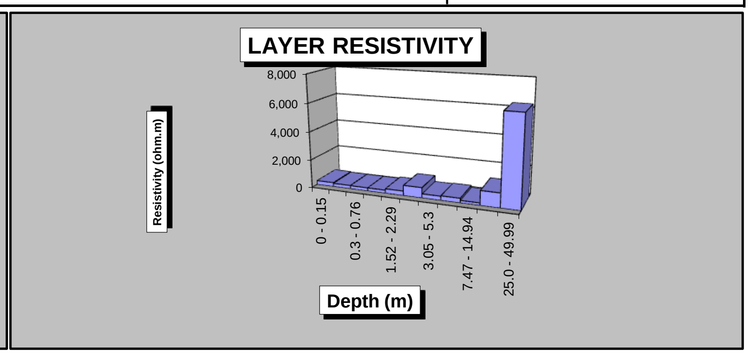
Project Name: Vermont Gas Project
12-144-32
Date: 5/4/2013
Location: Planted Field off North St
44 9.1029N, 73 9.5749W
Testers: KJ, LM
Methodology: $\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation: Biddle Meter DET 5/2
Weather: 64F/Clear
Soil Description Dry, rocky soil

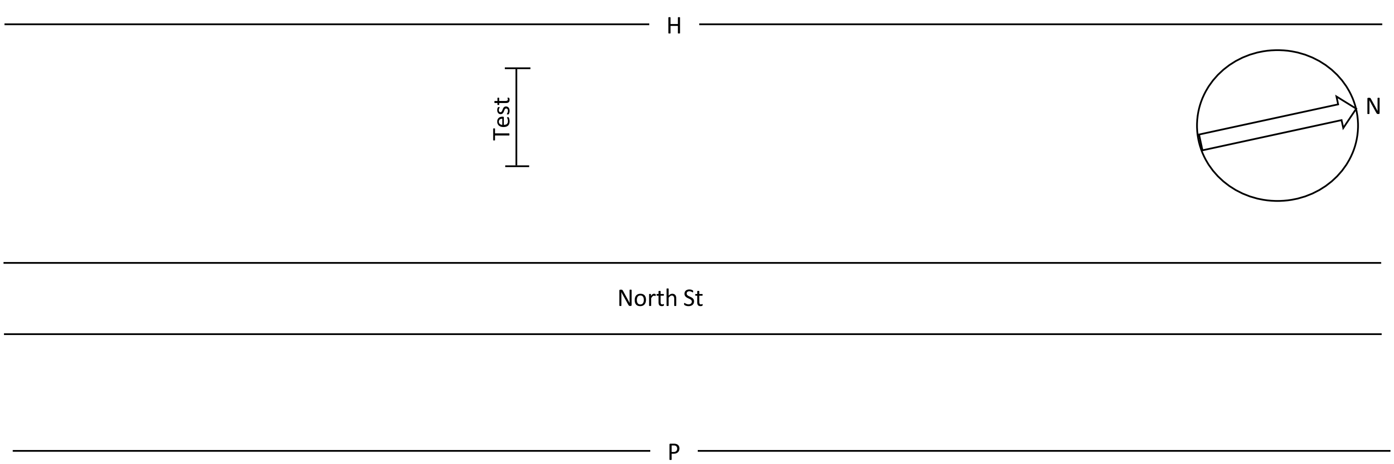
ARK Engineering & Technical Services, Inc.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 1/R) ohms	Spacing Factor	Layer Resistivity* Layer (m)	Layer Resistivity* 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







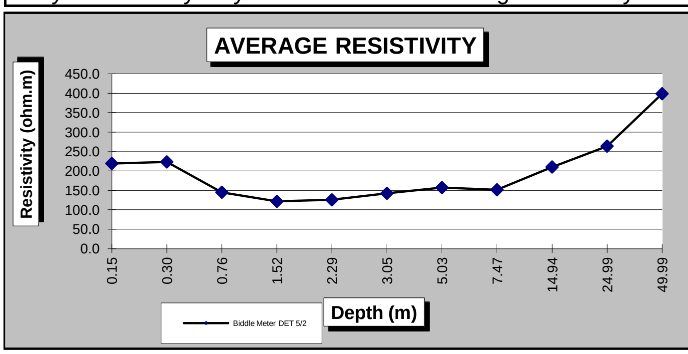
SOIL RESISTIVITY DATA

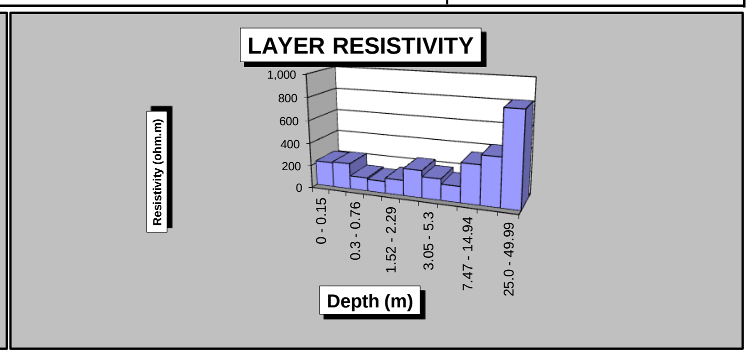
Project Name: Vermont Gas Project
12-144-33
Date: 5/4/2013
Location: Rd Sd off Quarry Rd
44 8.4956N, 73 9.6391W
Testers: KJ, LM
Methodology: $\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation: Biddle Meter DET 5/2
Weather: 62F/Clear
Soil Description Dry sand, rock and vegetation

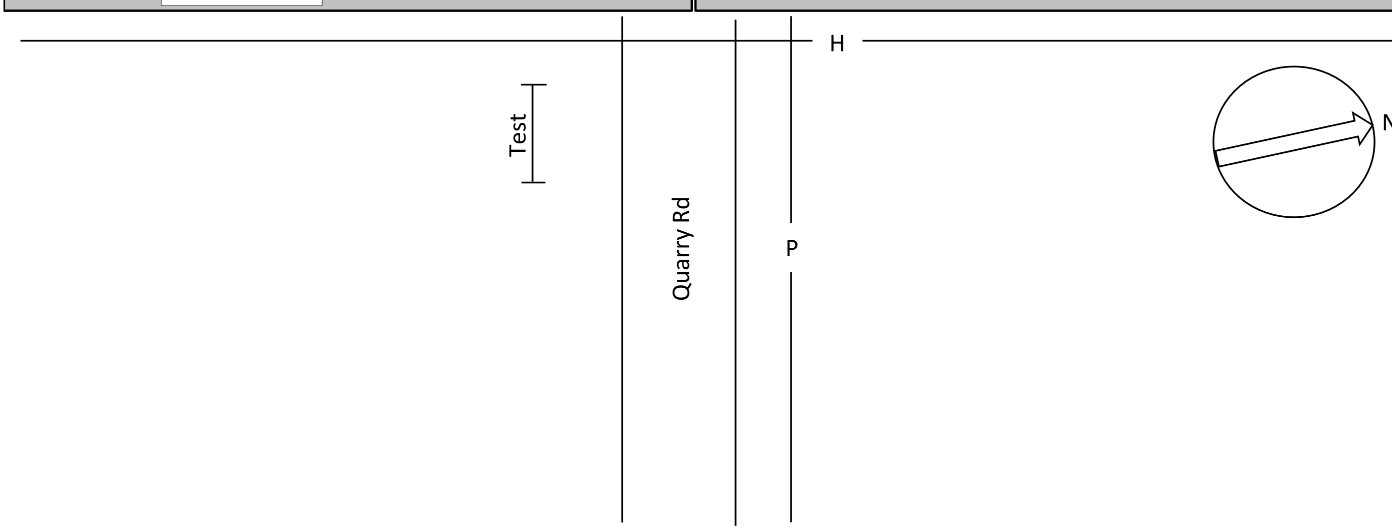
ARK Engineering & Technical Services, Inc.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 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







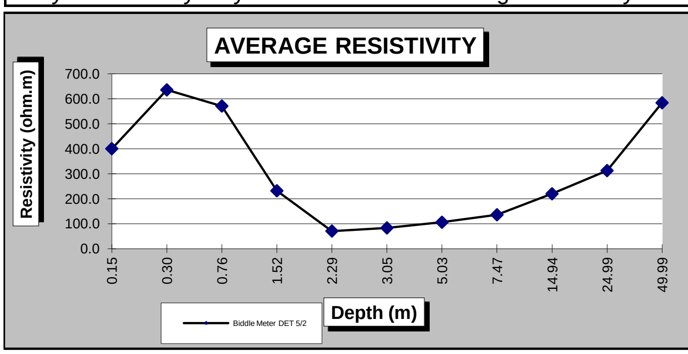
SOIL RESISTIVITY DATA

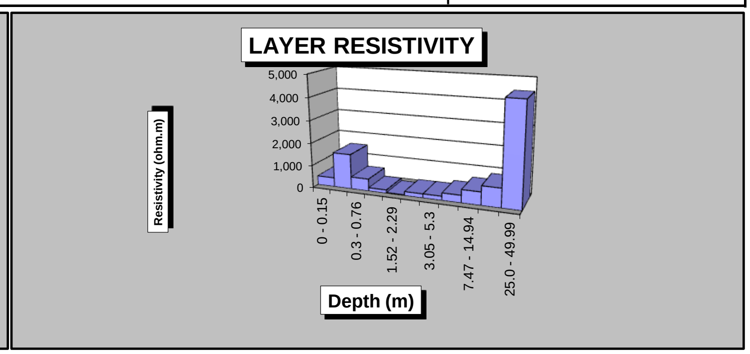
Project Name:	Vermont Gas Project
	12-144-34
Date:	5/4/2013
Location:	Rd Sd off Main St
	44 7.4123N, 73 9.8050W
Testers:	KJ, LM
Methodology:	$\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation:	Biddle Meter DET 5/2
Weather:	72F/Clear
Soil Description	Dry sand, rock and vegetation

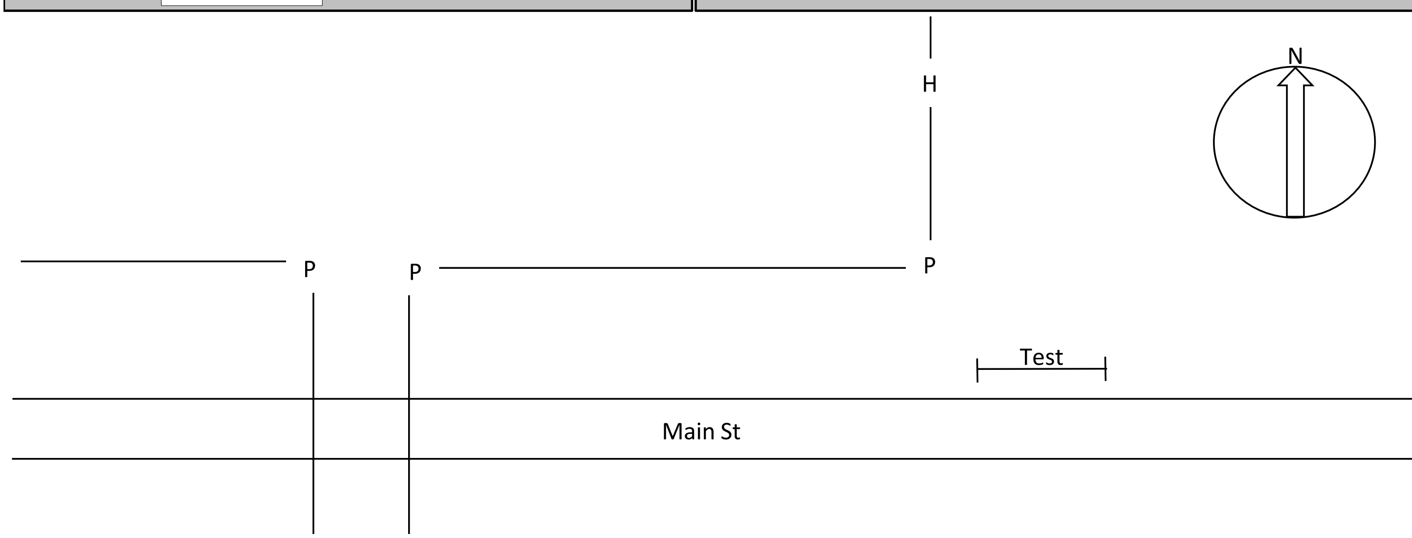
ARK Engineering & Technical Services, Inc.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d)	Depth (d)	R	Spacing	Resistivity	1/R	Δ 1/R	1/(Δ 1/R)	Spacing	Layer Resistivity*	
ft	m	ohms	Factor	ohm.m	mhos	mhos	ohms	Factor	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







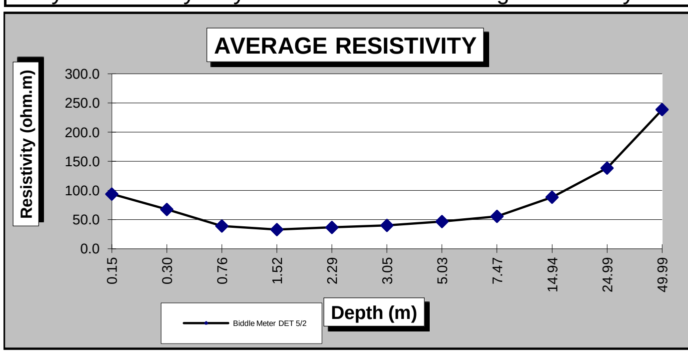
SOIL RESISTIVITY DATA

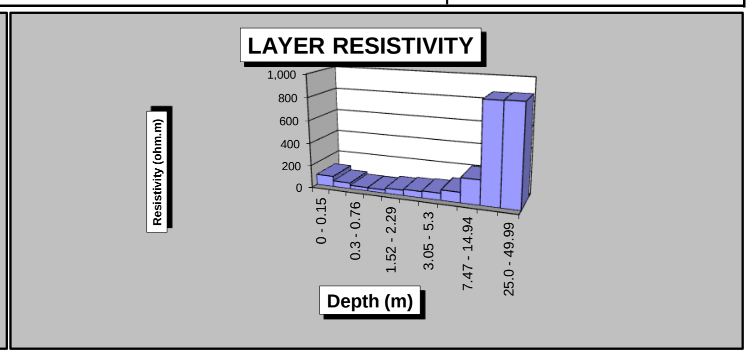
Project Name: Vermont Gas Project
12-144-35
Date: 5/5/2013
Location: Rd Sd off Town Hill Rd
44 6.5084N, 73 10.0670W
Testers: KJ, LM
Methodology: ρ = 2πdR, per ASTM G 57 & Barnes Method
Instrumentation: Biddle Meter DET 5/2
Weather: 56F/Clear
Soil Description Hard dry and vegetation

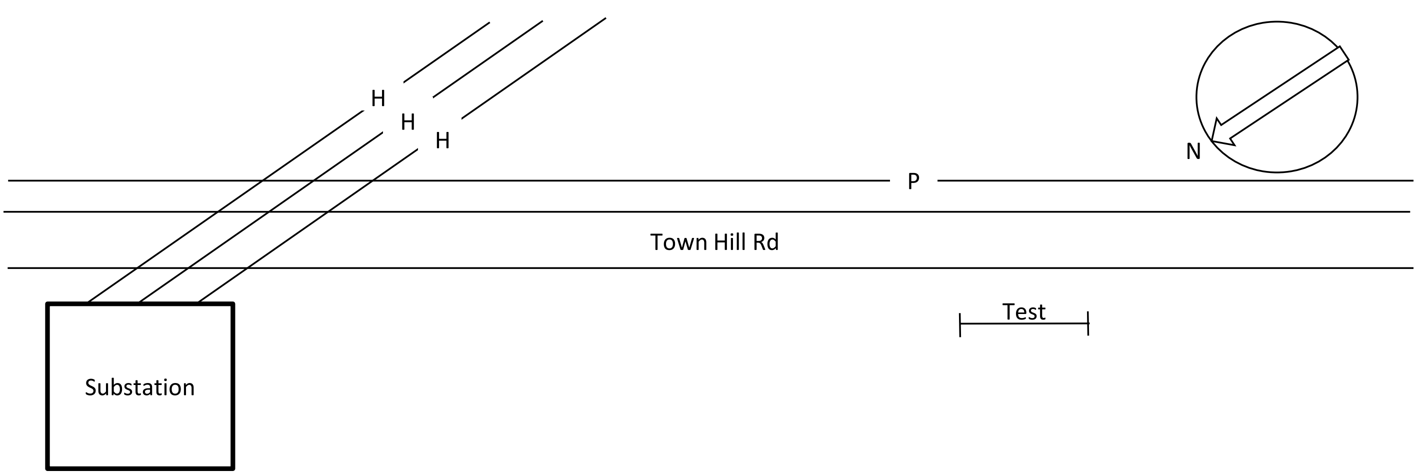
ARK Engineering & Technical Services, Inc.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 1/R) ohms	Spacing Factor	Layer Resistivity* Layer (m)	Layer Resistivity* 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







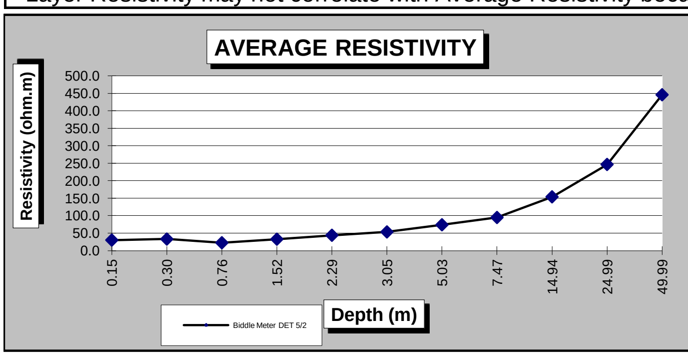
SOIL RESISTIVITY DATA

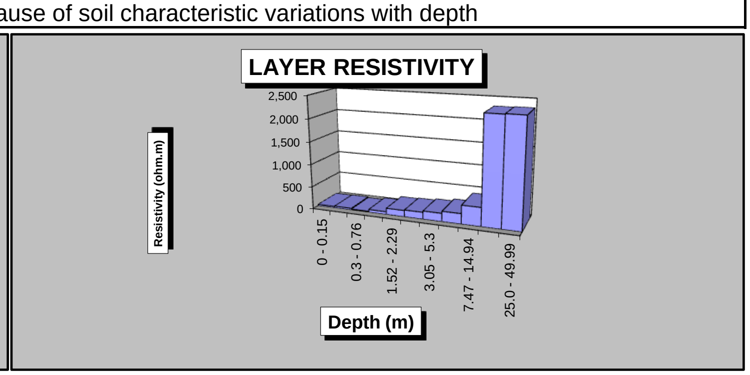
Project Name: Vermont Gas Project
12-144-36
Date: 5/5/2013
Location: Rd Sd off Ethan Allen Hwy
44 5.5455N, 73 10.4509W
Testers: KJ, LM
Methodology: ρ = 2πdR, per ASTM G 57 & Barnes Method
Instrumentation: Biddle Meter DET 5/2
Weather: 56F/Clear
Soil Description Hard dry and vegetation

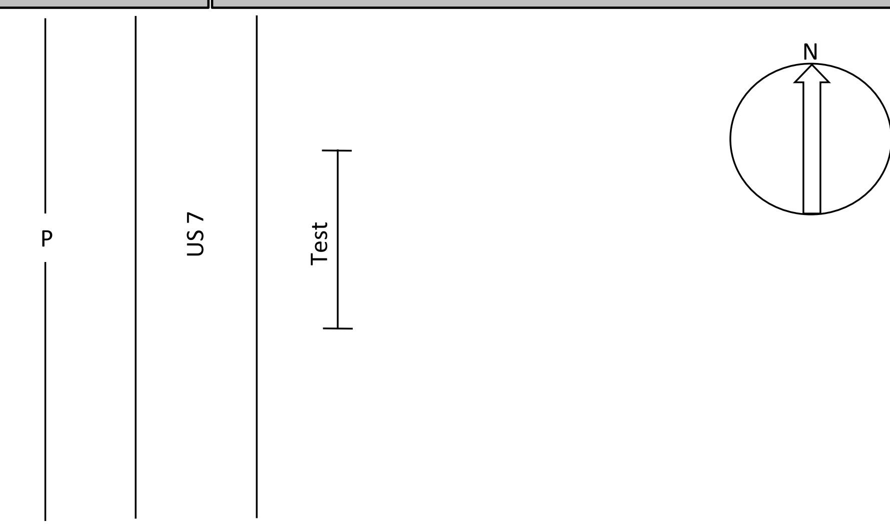
ARK ENGINEERING & TECHNICAL SERVICES, INC.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 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







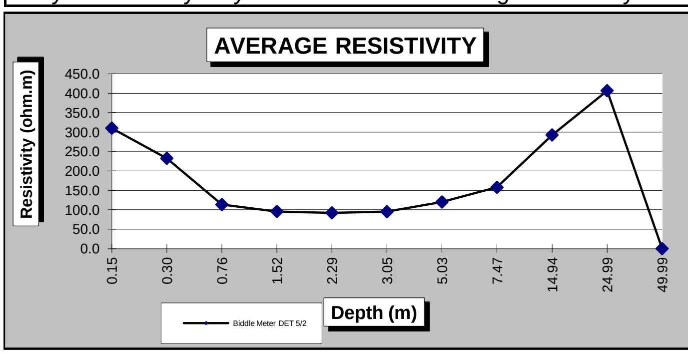
SOIL RESISTIVITY DATA

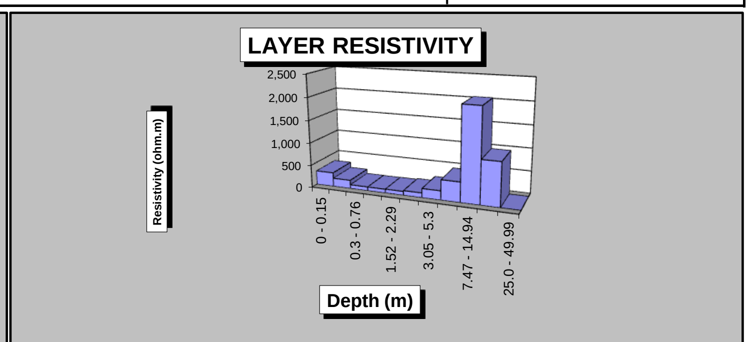
Project Name: Vermont Gas Project
12-144-37
Date: 5/5/2013
Location: Rd Sd off Hunt Rd
44 4.5951N, 73 9.5652W
Testers: KJ, LM
Methodology: $\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation: Biddle Meter DET 5/2
Weather: 57F/Clear
Soil Description Hard packed dark soil

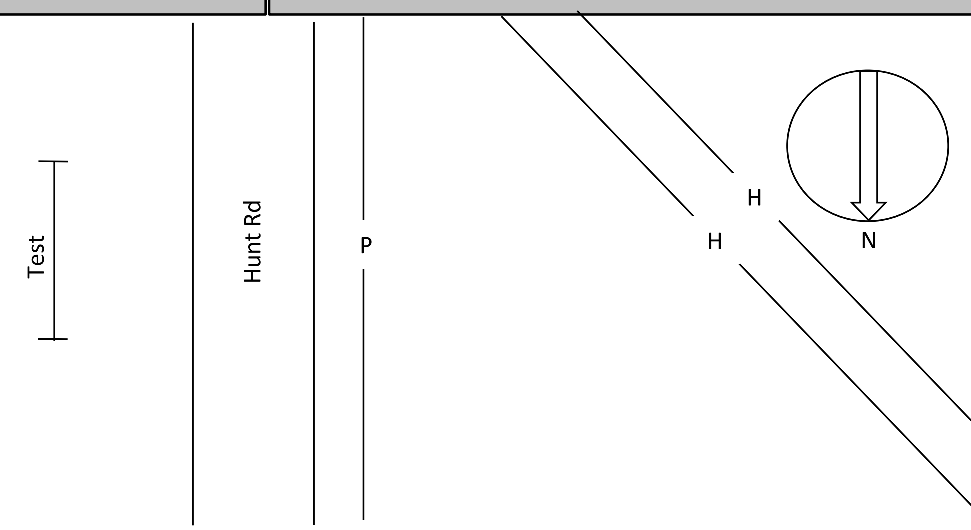
ARK Engineering & Technical Services, Inc.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 1/R) ohms	Spacing Factor	Layer Resistivity* Layer (m)	Layer Resistivity* 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







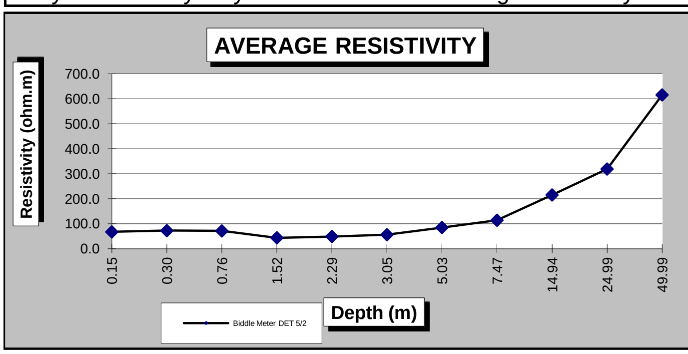
SOIL RESISTIVITY DATA

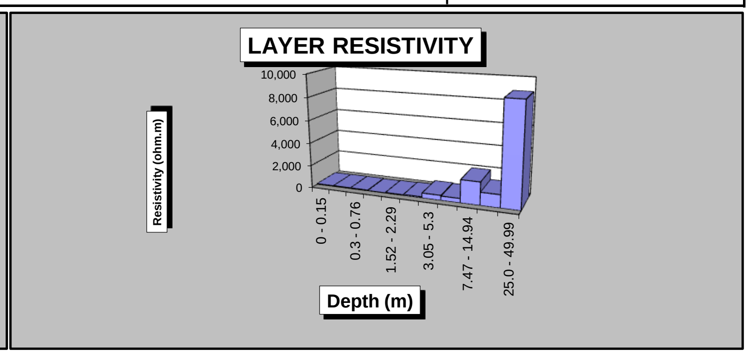
Project Name: Vermont Gas Project
12-144-38
Date: 5/5/2013
Location: Open Field off River Rd
44 3.5072N, 73 9.5358W
Testers: KJ, LM
Methodology: $\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation: Biddle Meter DET 5/2
Weather: 59F/Clear
Soil Description Hard packed dark soil

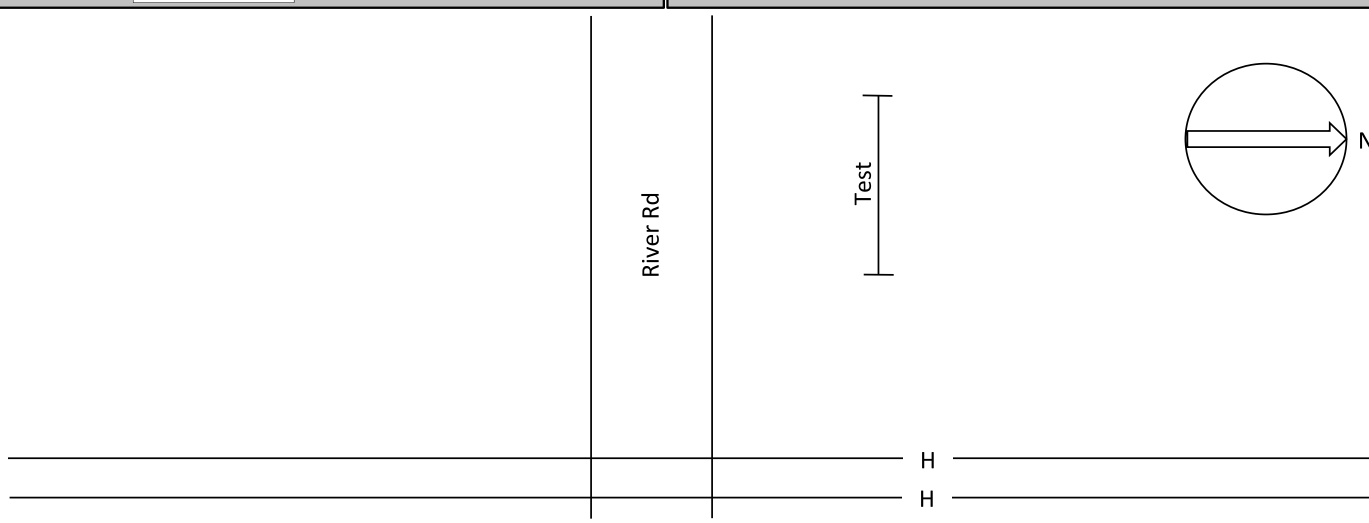
ARK ENGINEERING & TECHNICAL SERVICES, INC.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 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







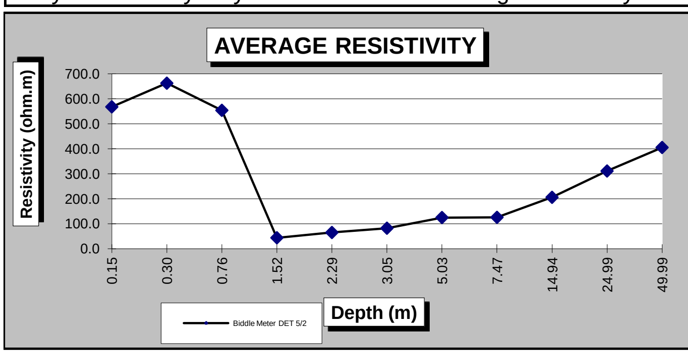
SOIL RESISTIVITY DATA

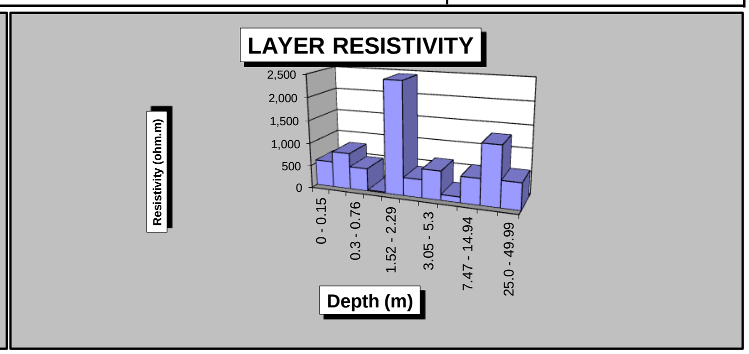
Project Name:	Vermont Gas Project
	12-144-39
Date:	5/5/2013
Location:	Rd Sd off US 7
	44 2.9550N, 73 9.8744W
Testers:	KJ, LM
Methodology:	$\rho = 2\pi dR$, per ASTM G 57 & Barnes Method
Instrumentation:	Biddle Meter DET 5/2
Weather:	59F/Clear
Soil Description	Sandy, large rocks, and vegetation

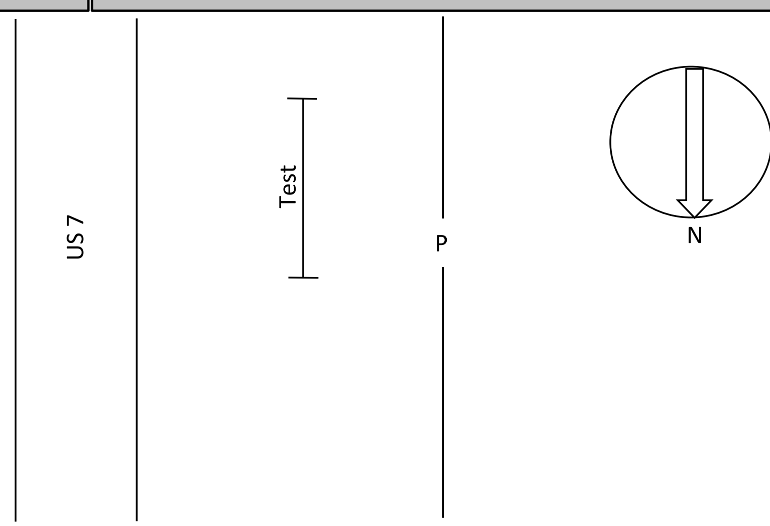
ARK Engineering & Technical Services, Inc.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 1/R) ohms	Spacing Factor	Layer Resistivity* Layer (m)	Layer Resistivity* 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







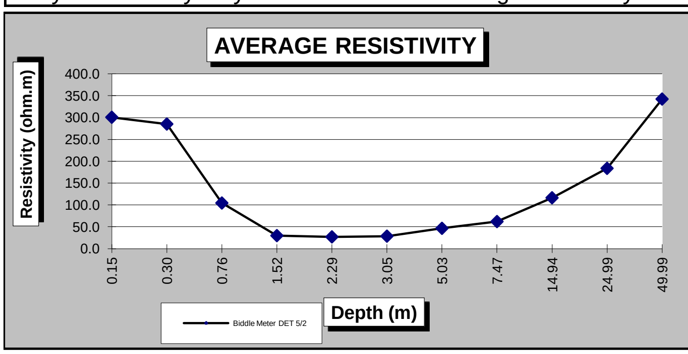
SOIL RESISTIVITY DATA

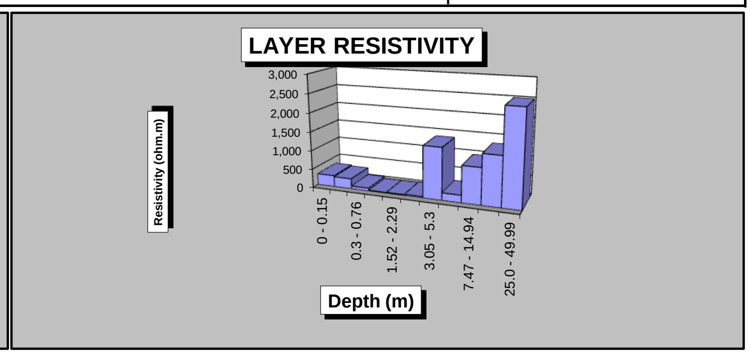
Project Name: Vermont Gas Project
12-144-40
Date: 5/5/2013
Location: Rd Sd off US 7
44 2.3630N, 73 9.7127W
Testers: KJ, LM
Methodology: ρ = 2πdR, per ASTM G 57 & Barnes Method
Instrumentation: Biddle Meter DET 5/2
Weather: 61F/Clear
Soil Description Hard packed, rocky and vegetation

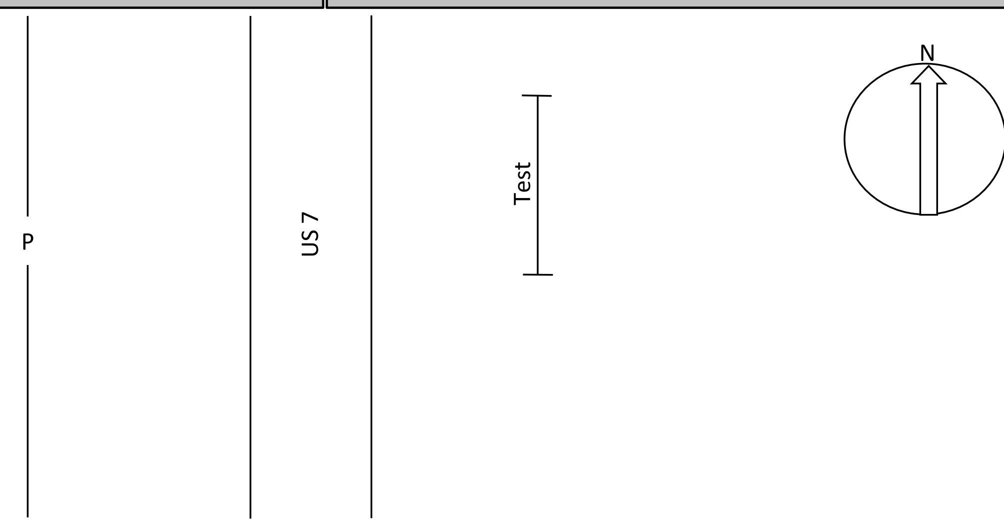
ARK ENGINEERING & TECHNICAL SERVICES, INC.

4 Pin Wenner Data					Barnes Layer Analysis					
Depth (d) ft	Depth (d) m	R ohms	Spacing Factor	Resistivity ohm.m	1/R mhos	Δ 1/R mhos	1/(Δ 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



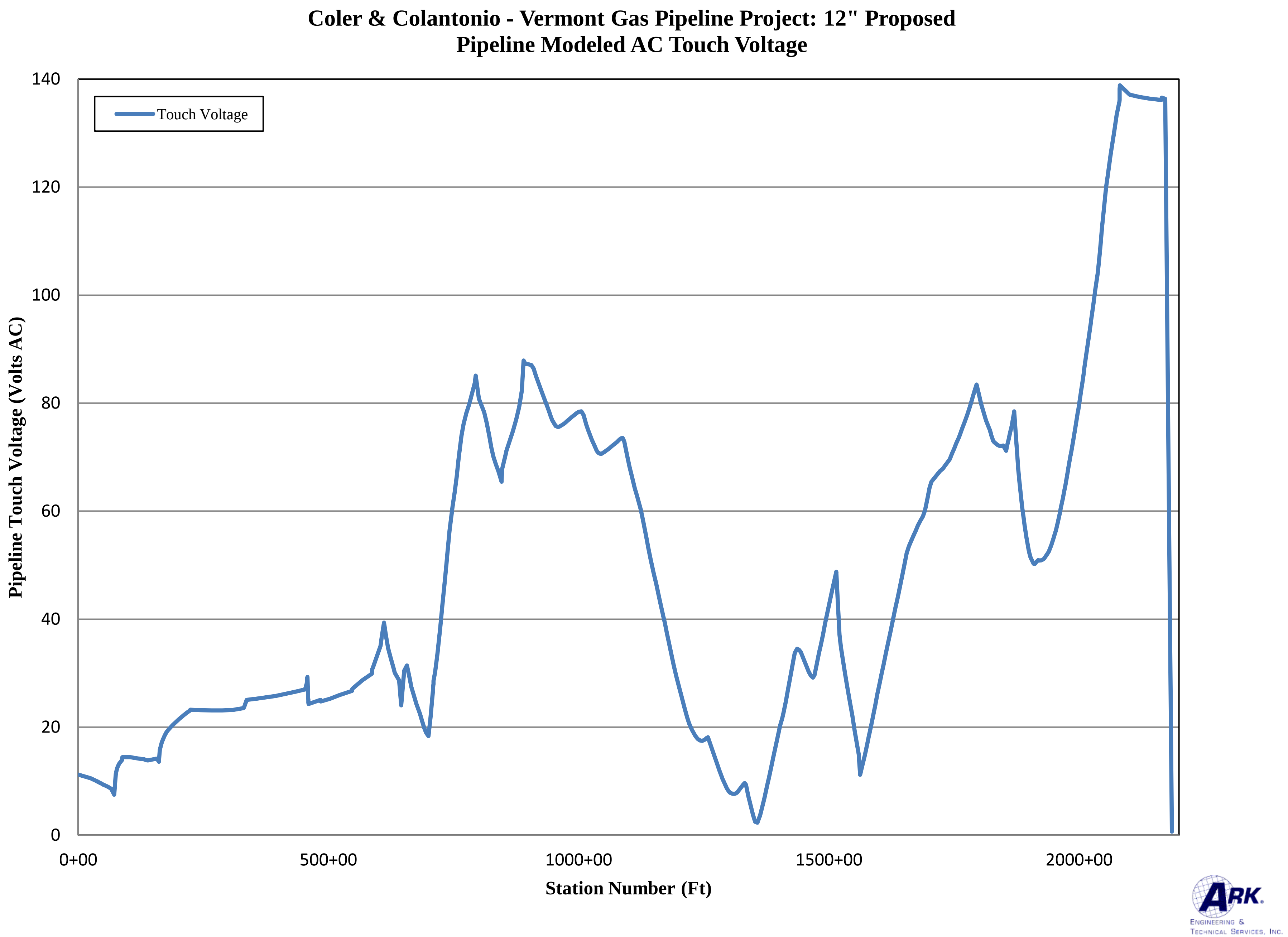




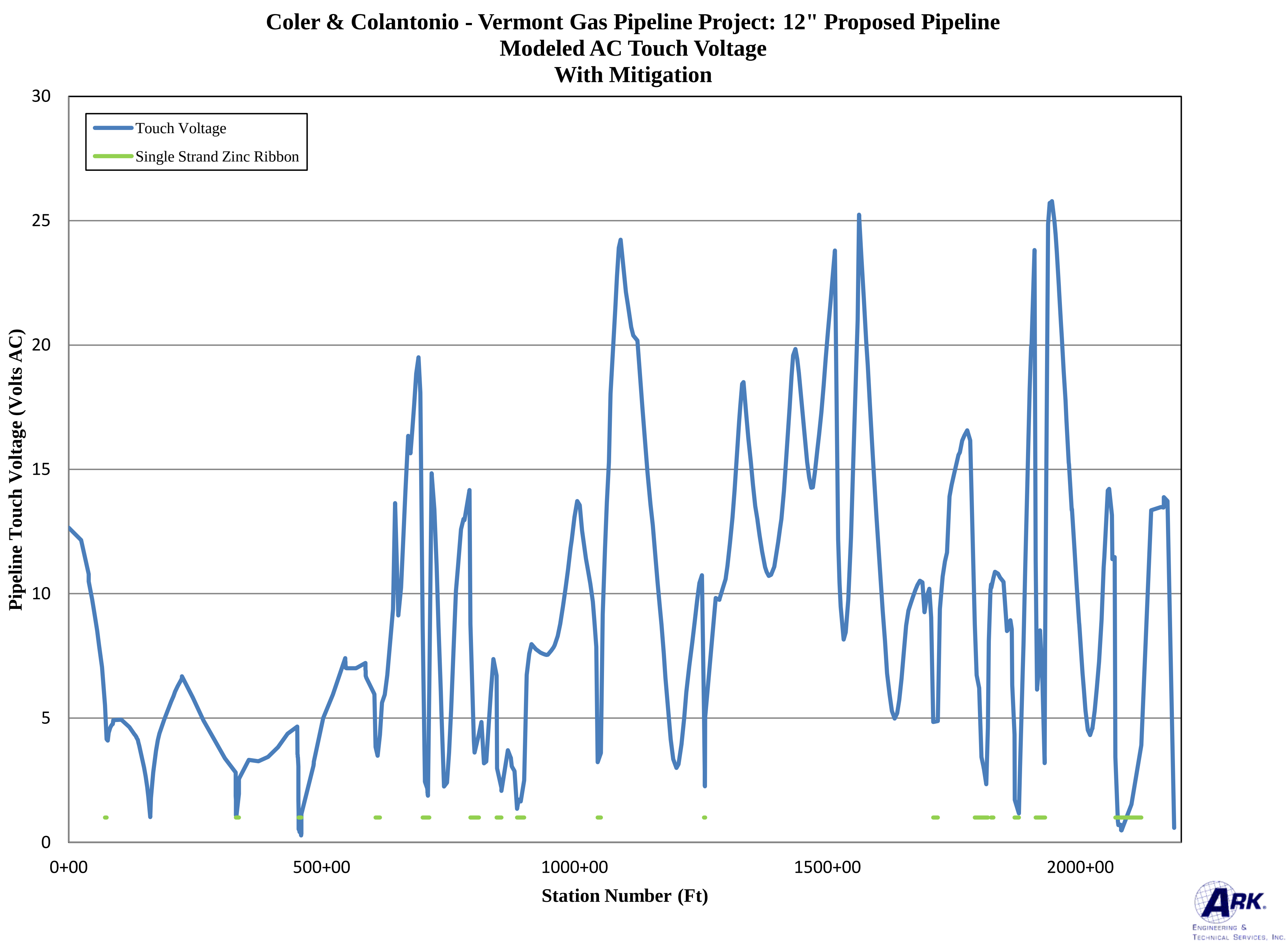
APPENDIX B –

PIPELINE STEADY STATE, AC CURRENT DENSITY & FAULT PLOTS

STEADY STATE INDUCED

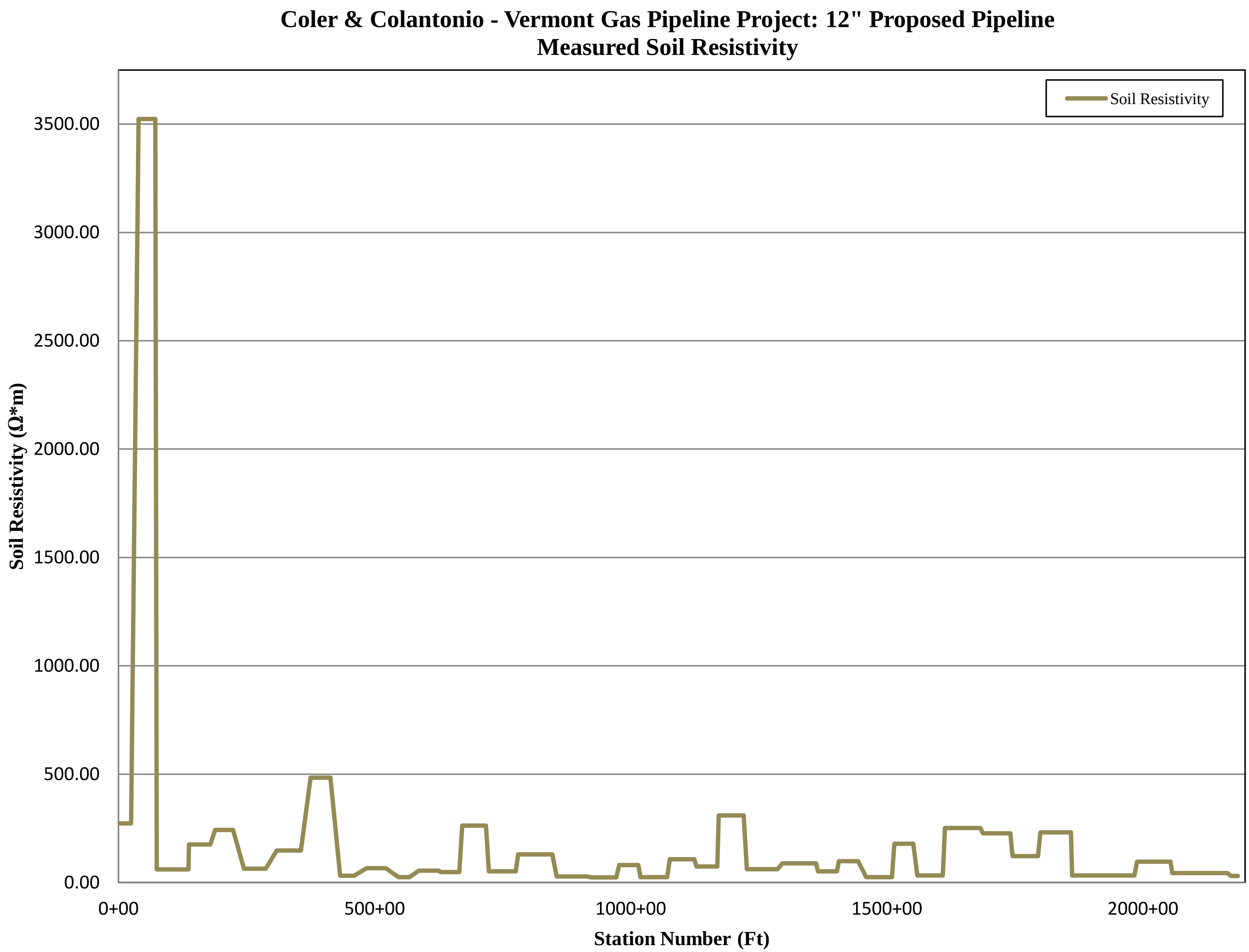


Coler & Colantonio - Vermont Gas Pipeline Project: 12" Proposed Pipeline Modeled AC Touch Voltage
Touch Voltage
140
120
100
80
60
40
20
0
0+00
500+00
1000+00
1500+00
2000+00
Pipeline Touch Voltage (Volts AC)
Station Number (Ft)
ARK
Engineering & Technical Services, Inc.



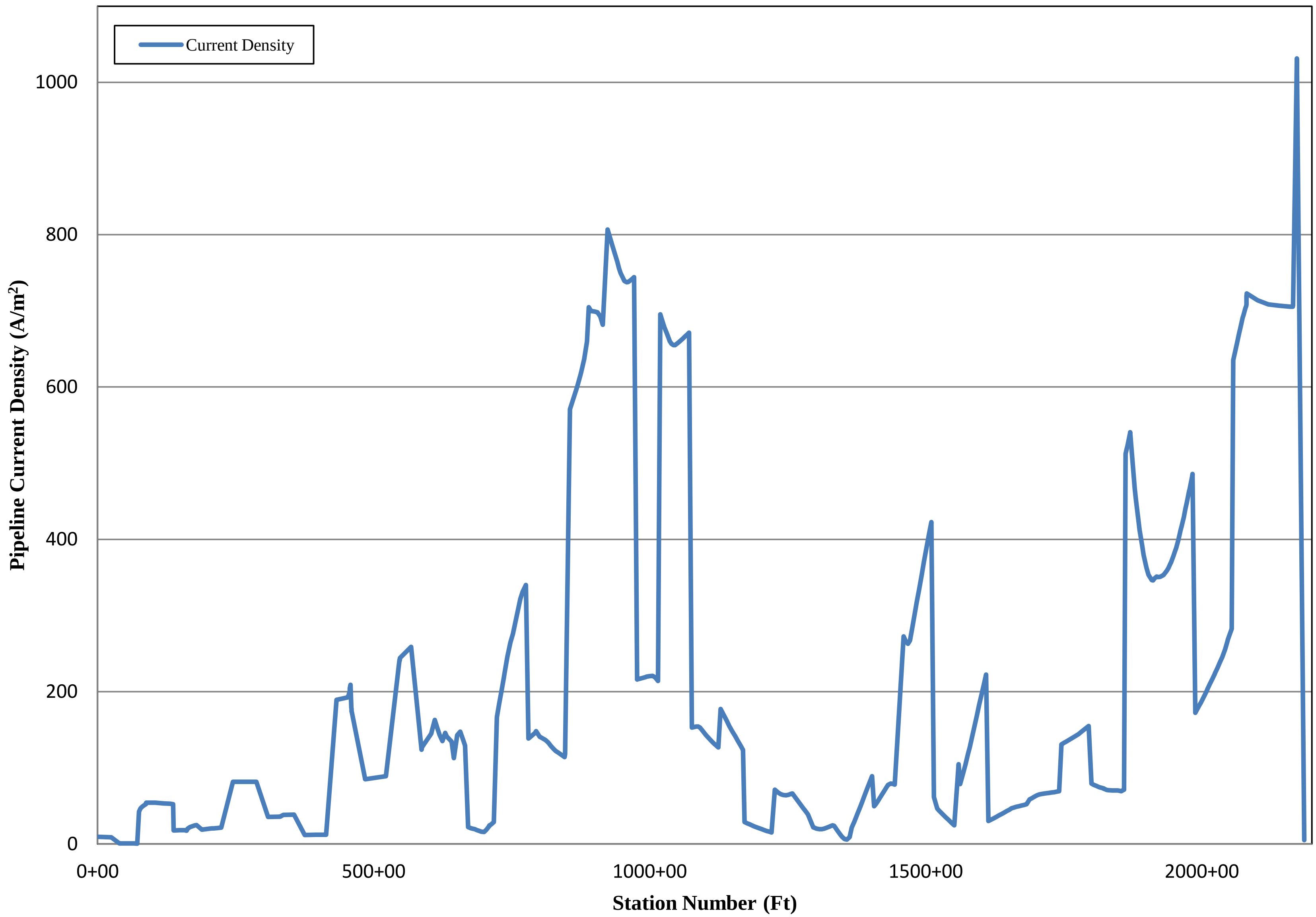
Coler & Colantonio - Vermont Gas Pipeline Project: 12" Proposed Pipeline
Modeled AC Touch Voltage
With Mitigation
Touch Voltage
Single Strand Zinc Ribbon
Pipeline Touch Voltage (Volts AC)
0
5
10
15
20
25
30
0+00
500+00
1000+00
1500+00
2000+00
Station Number (Ft)
ARK
Engineering & Technical Services, Inc.

CURRENT DENSITY

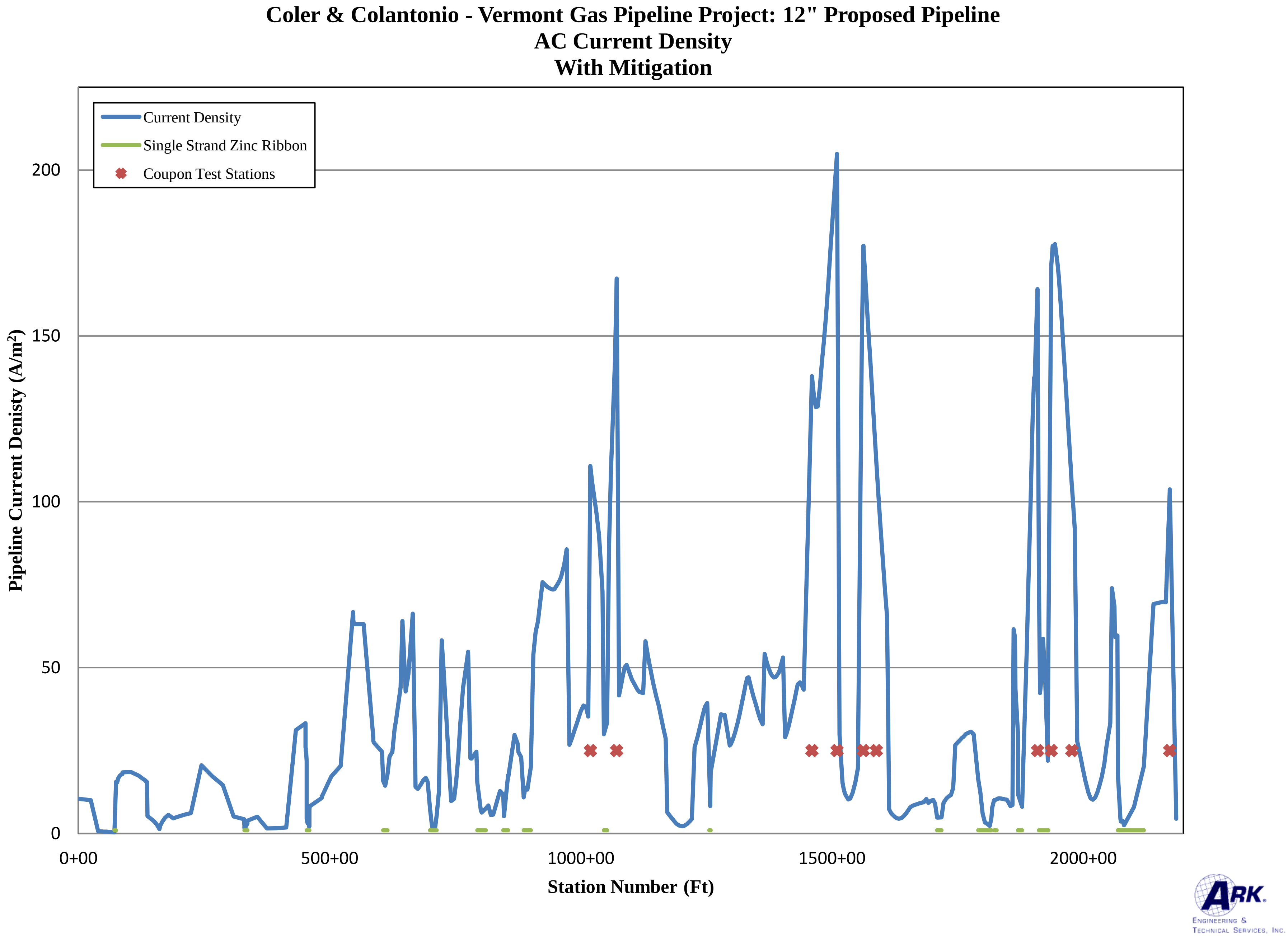


Coler & Colantonio - Vermont Gas Pipeline Project: 12" Proposed Pipeline
Measured Soil Resistivity
Soil Resistivity
Soil Resistivity (Ω*m)
3500.00
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
0+00
500+00
1000+00
1500+00
2000+00
Station Number (Ft)

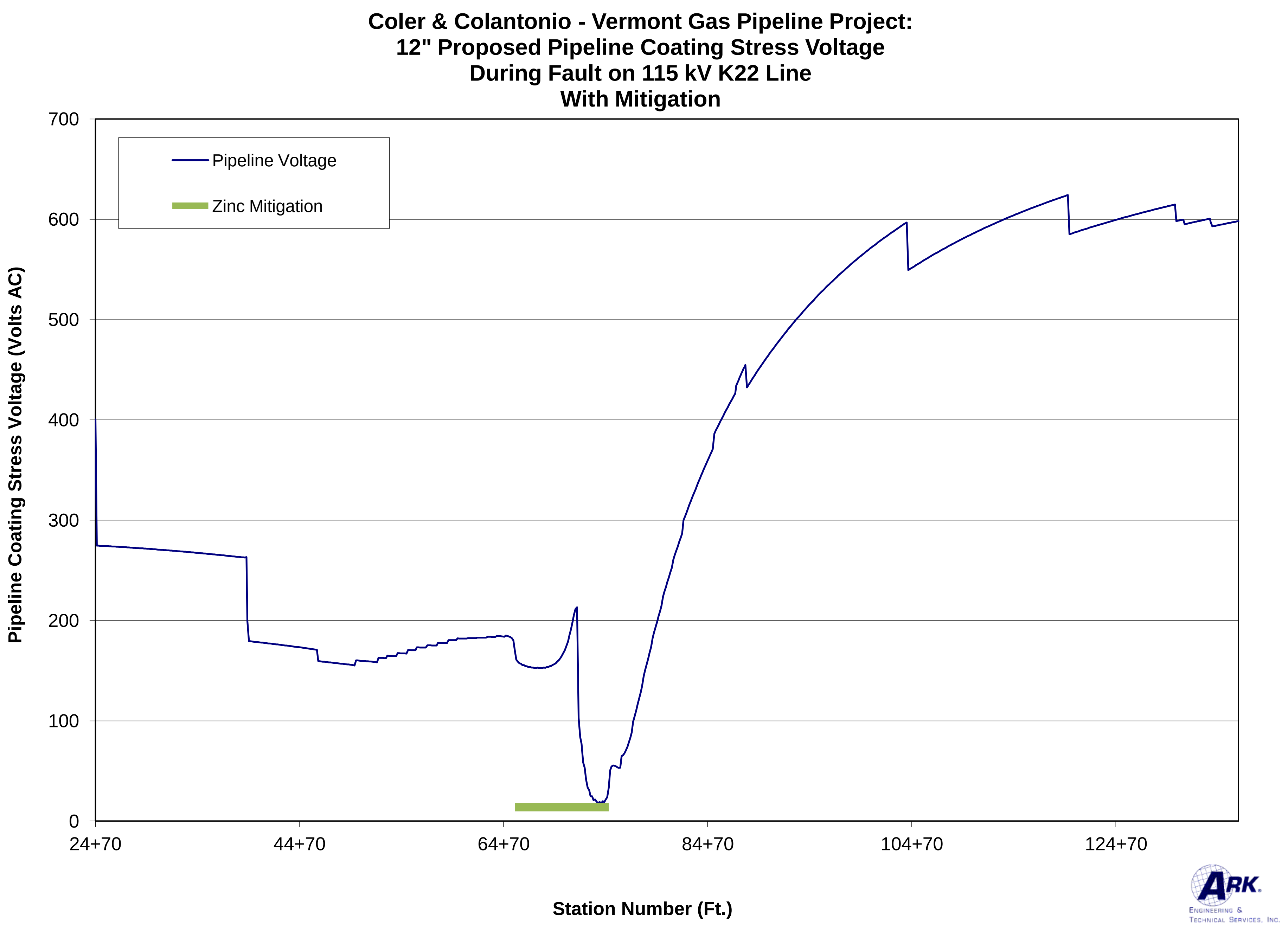
Coler & Colantonio - Vermont Gas Pipeline Project: 12" Proposed Pipeline
AC Current Density

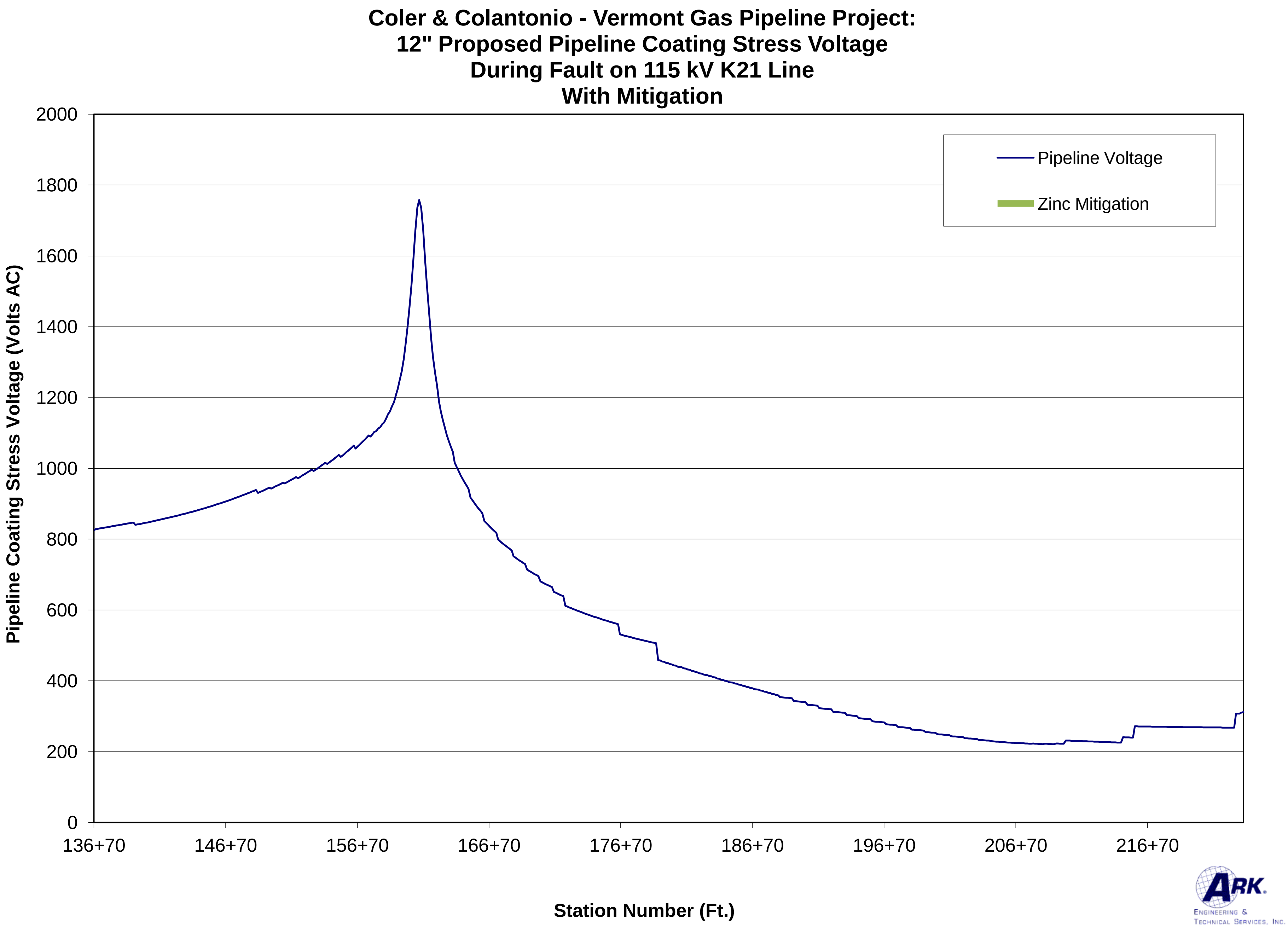


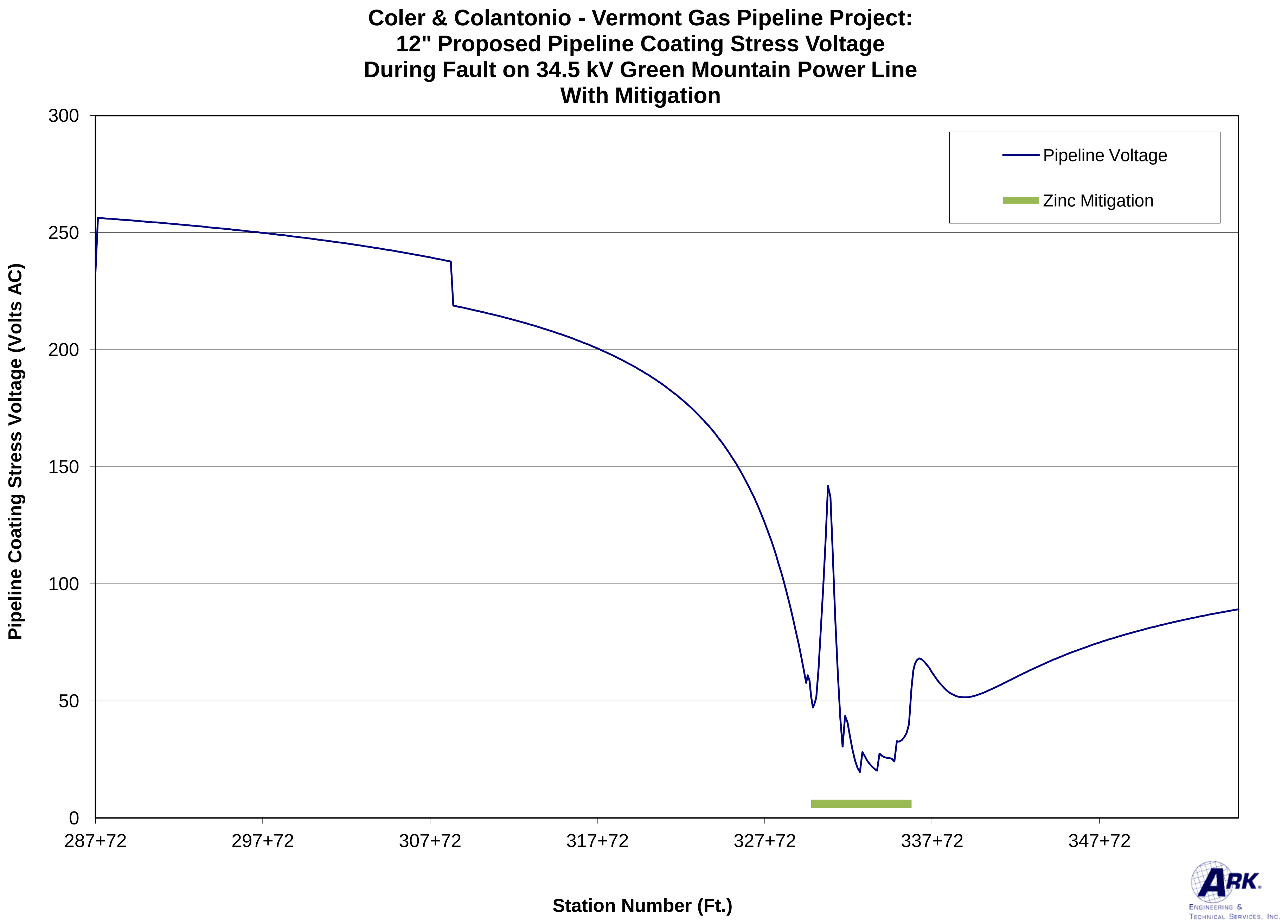
ARK
Engineering &
Technical Services, Inc.

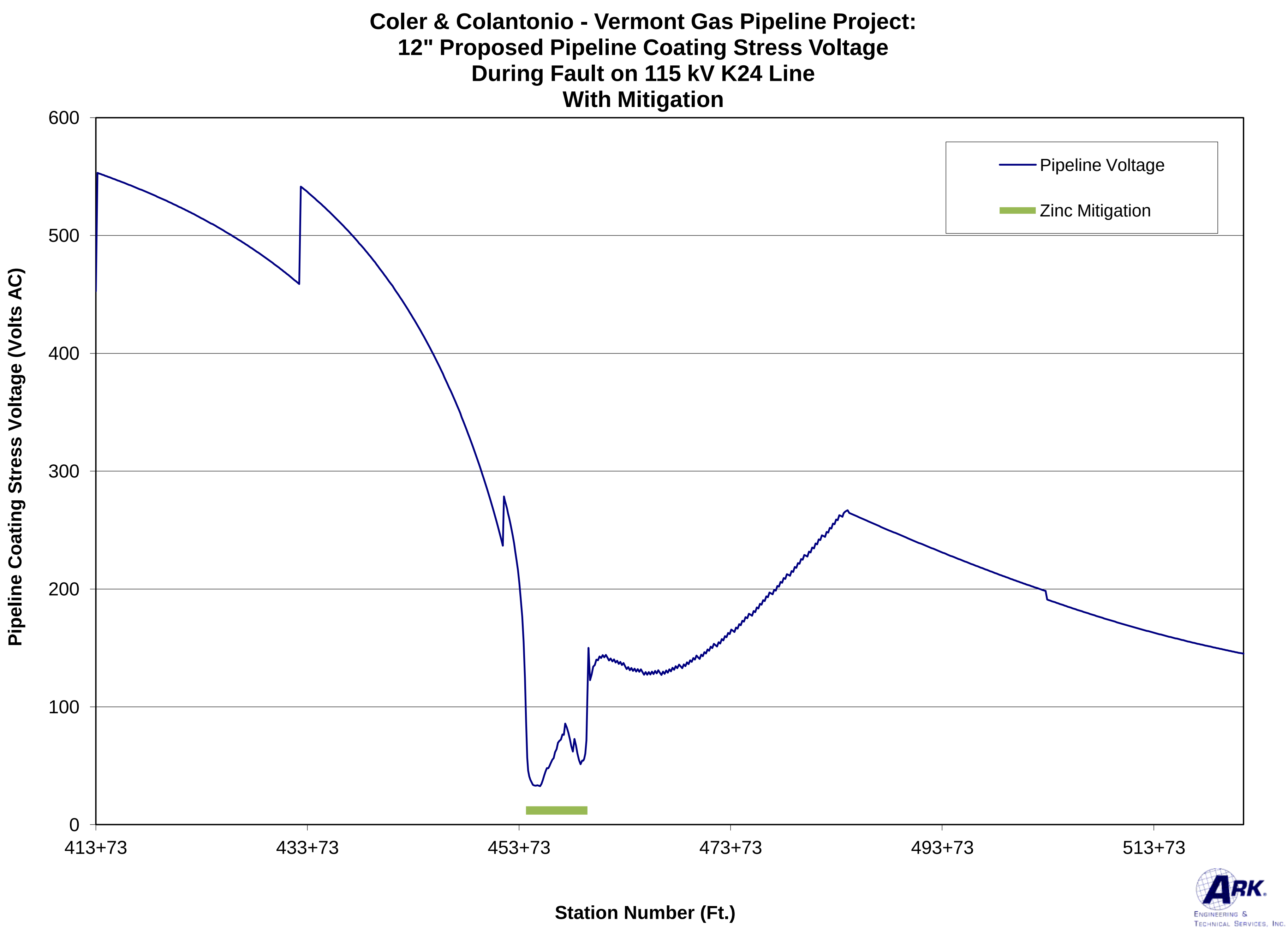

Coler & Colantonio - Vermont Gas Pipeline Project: 12" Proposed Pipeline
AC Current Density
With Mitigation
Current Density
Single Strand Zinc Ribbon
Coupon Test Stations
Pipeline Current Denisty (A/m²)
200
150
100
50
0
0+00
500+00
1000+00
1500+00
2000+00
Station Number (Ft)
ARK
Engineering & Technical Services, Inc.

FAULT – COATING STRESS VOLTAGE

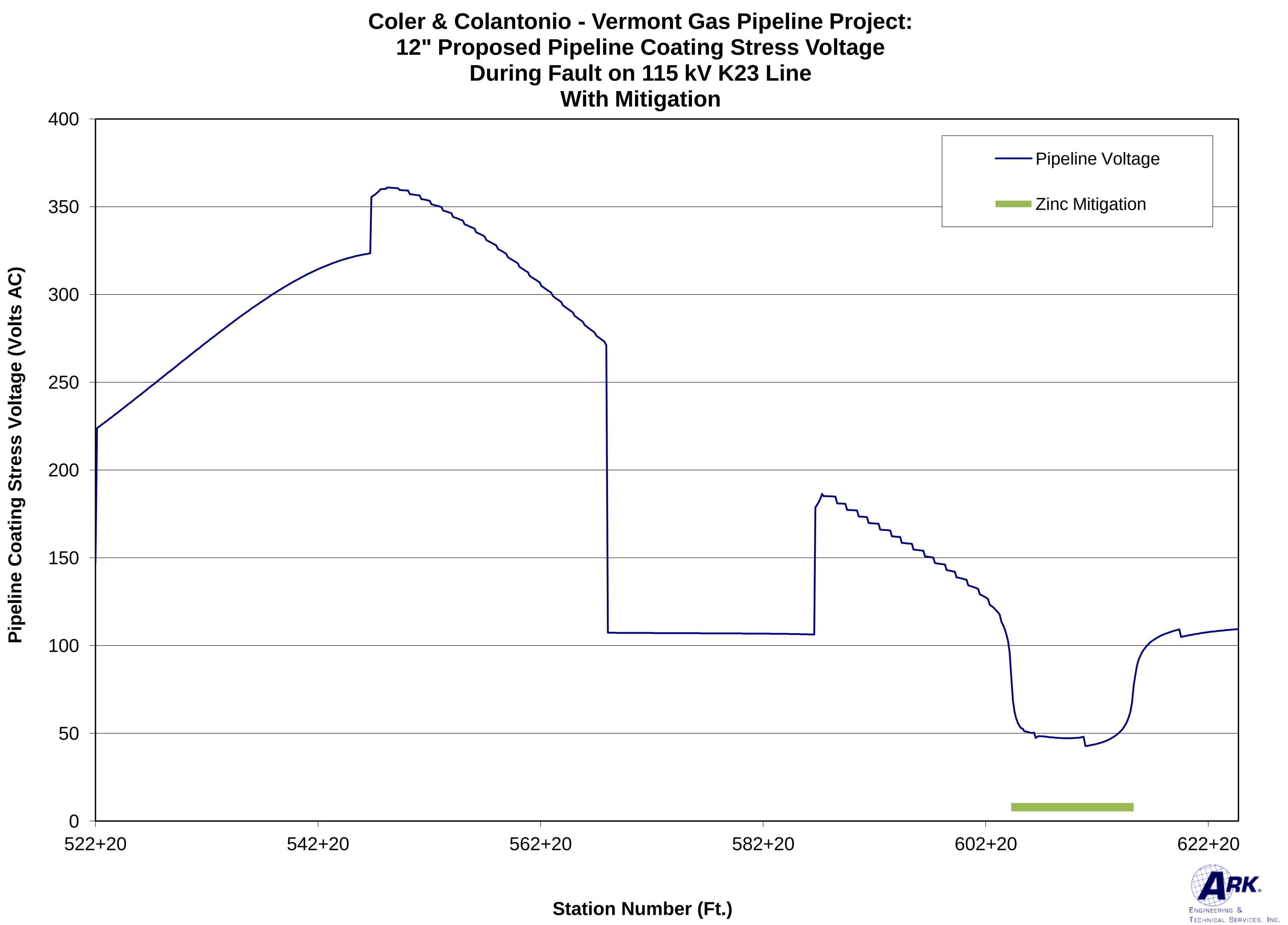

Coler & Colantonio - Vermont Gas Pipeline Project:
12" Proposed Pipeline Coating Stress Voltage
During Fault on 115 kV K22 Line
With Mitigation
Pipeline Voltage
Zinc Mitigation
Pipeline Coating Stress Voltage (Volts AC)
700
600
500
400
300
200
100
0
24+70
44+70
64+70
84+70
104+70
124+70
Station Number (Ft.)
ARK
Engineering & Technical Services, Inc.

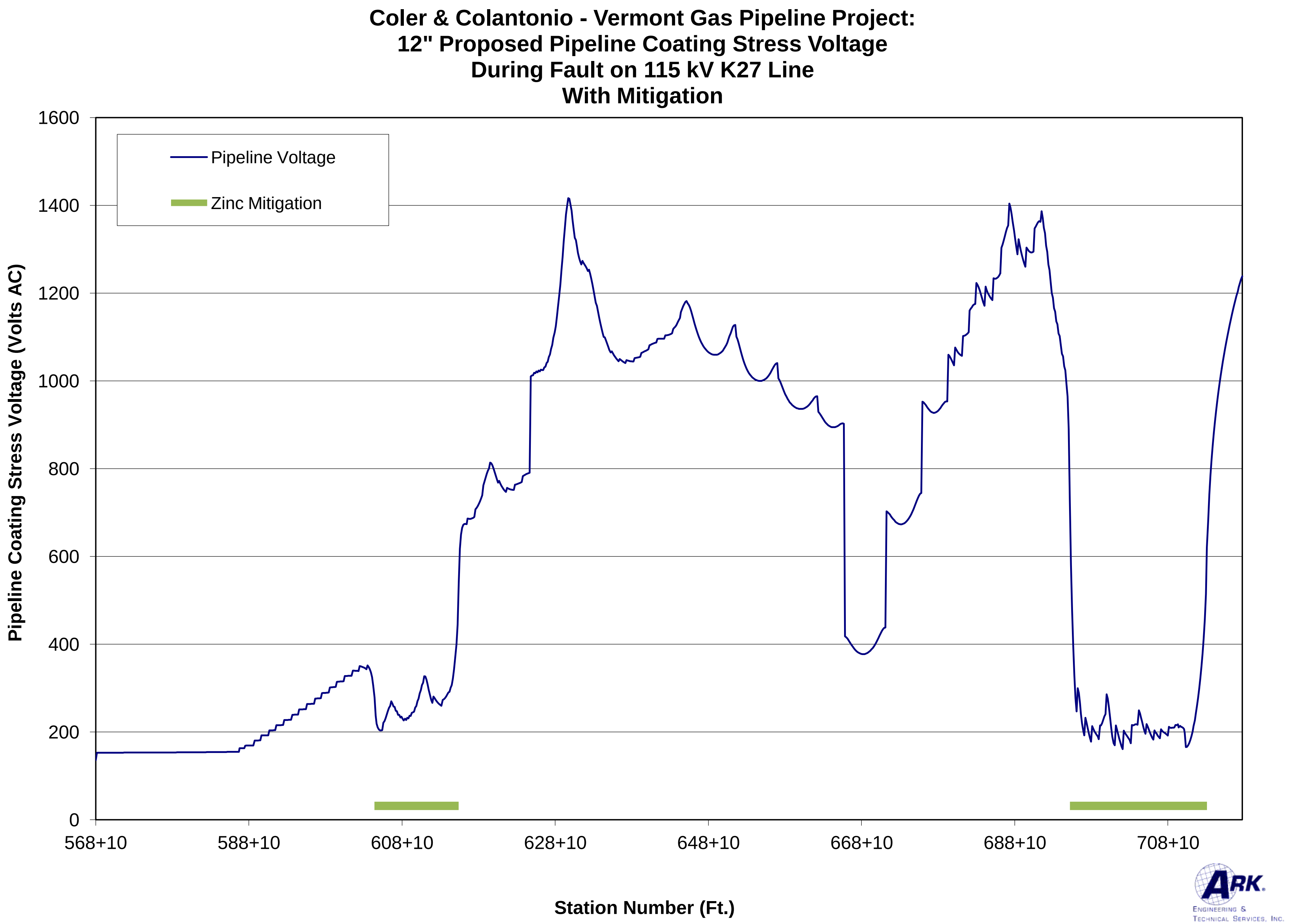

Coler & Colantonio - Vermont Gas Pipeline Project:
12" Proposed Pipeline Coating Stress Voltage
During Fault on 115 kV K21 Line
With Mitigation
Pipeline Coating Stress Voltage (Volts AC)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
136+70
146+70
156+70
166+70
176+70
186+70
196+70
206+70
216+70
Station Number (Ft.)
Pipeline Voltage
Zinc Mitigation
ARK
Engineering & Technical Services, Inc.


Coler & Colantonio - Vermont Gas Pipeline Project:
12" Proposed Pipeline Coating Stress Voltage
During Fault on 34.5 kV Green Mountain Power Line
With Mitigation
Pipeline Voltage
Zinc Mitigation
Pipeline Coating Stress Voltage (Volts AC)
300
250
200
150
100
50
0
287+72
297+72
307+72
317+72
327+72
337+72
347+72
Station Number (Ft.)
ARK
Engineering & Technical Services, Inc.

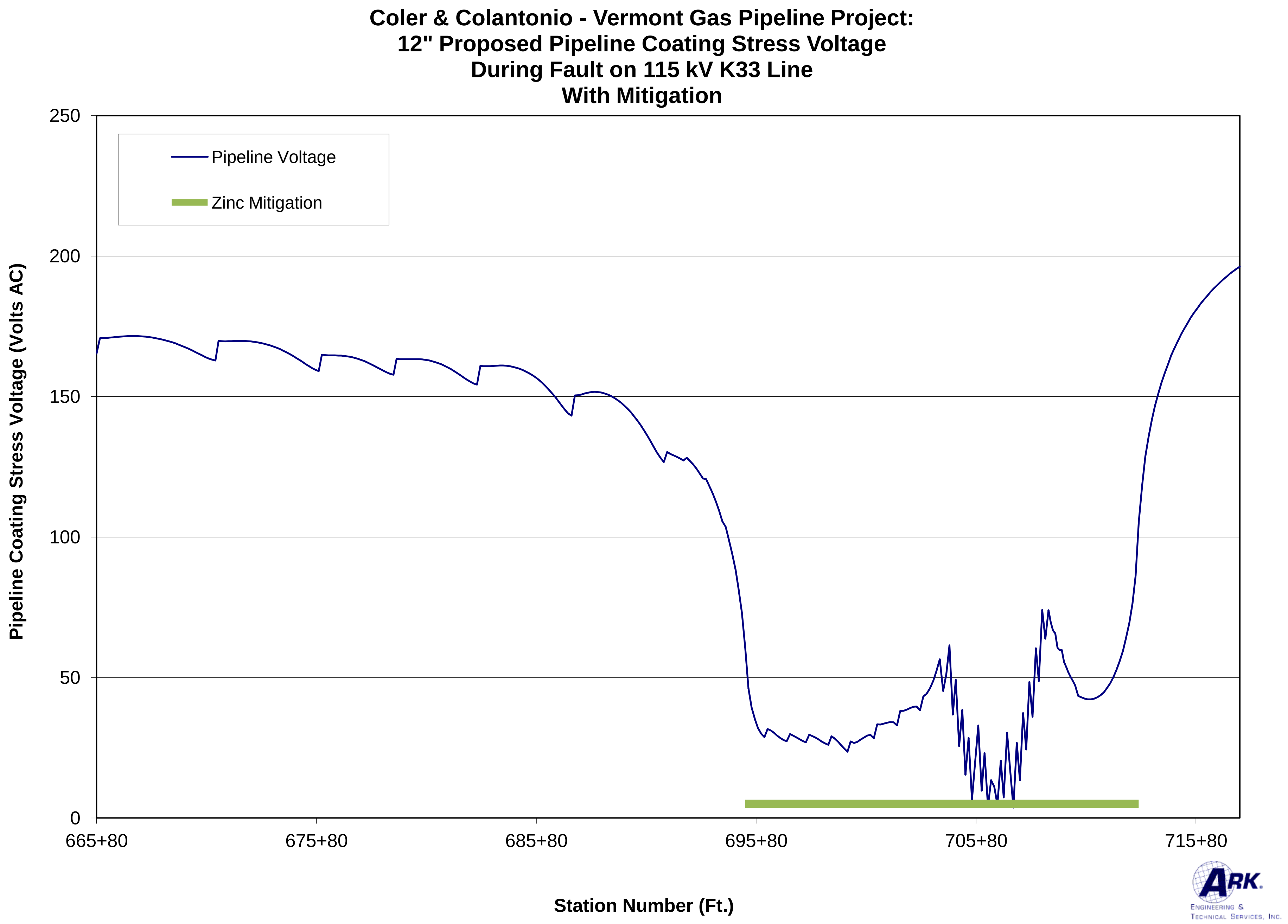


Coler & Colantonio - Vermont Gas Pipeline Project:
12" Proposed Pipeline Coating Stress Voltage
During Fault on 115 kV K24 Line
With Mitigation
Pipeline Coating Stress Voltage (Volts AC)
600
500
400
300
200
100
0
413+73
433+73
453+73
473+73
493+73
513+73
Station Number (Ft.)
Pipeline Voltage
Zinc Mitigation
ARK
Engineering & Technical Services, Inc.

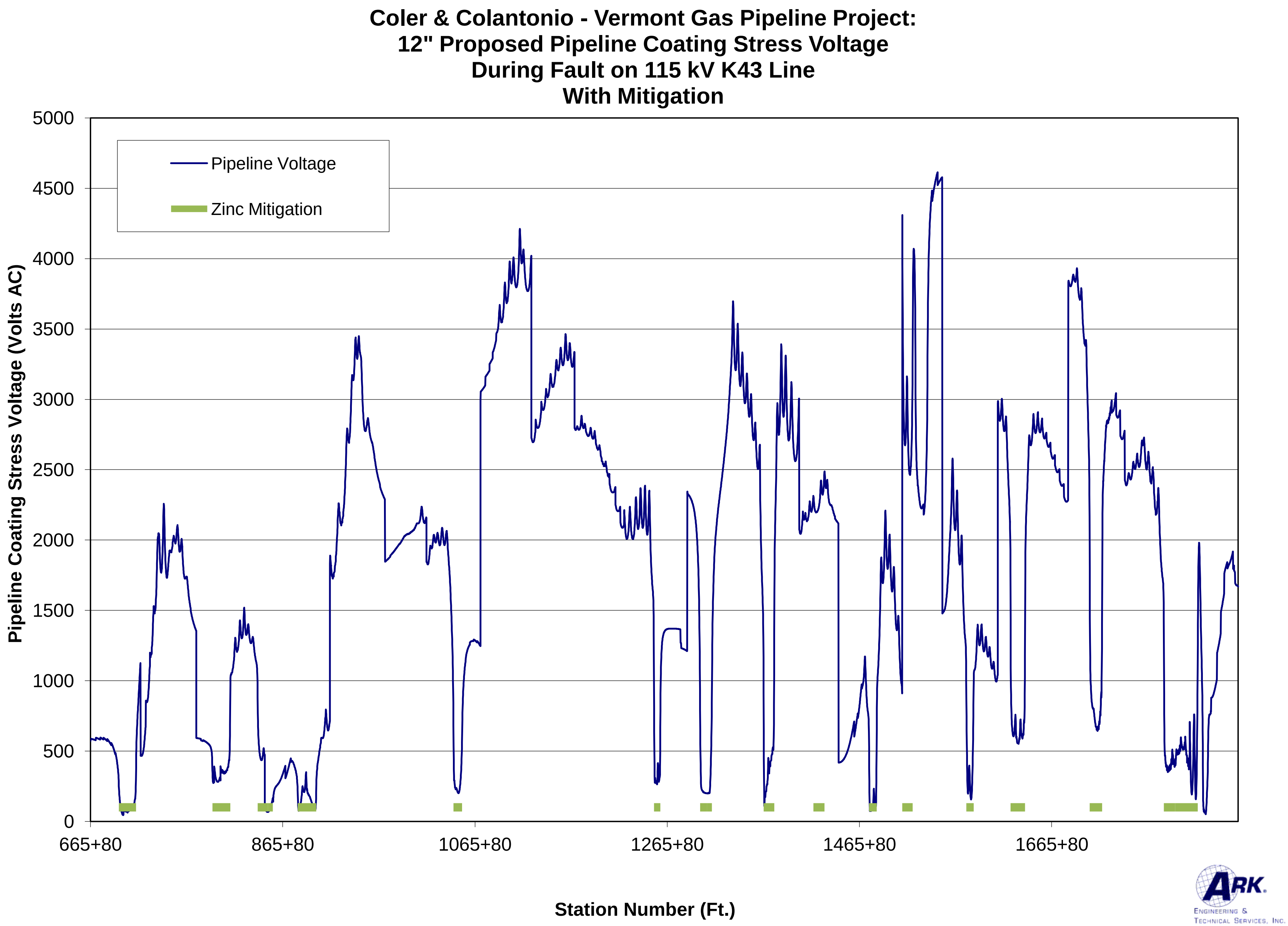

Coler & Colantonio - Vermont Gas Pipeline Project:
12" Proposed Pipeline Coating Stress Voltage
During Fault on 115 kV K23 Line
With Mitigation
Pipeline Voltage
Zinc Mitigation
Pipeline Coating Stress Voltage (Volts AC)
0
50
100
150
200
250
300
350
400
522+20
542+20
562+20
582+20
602+20
622+20
Station Number (Ft.)
ARK
Engineering & Technical Services, Inc.

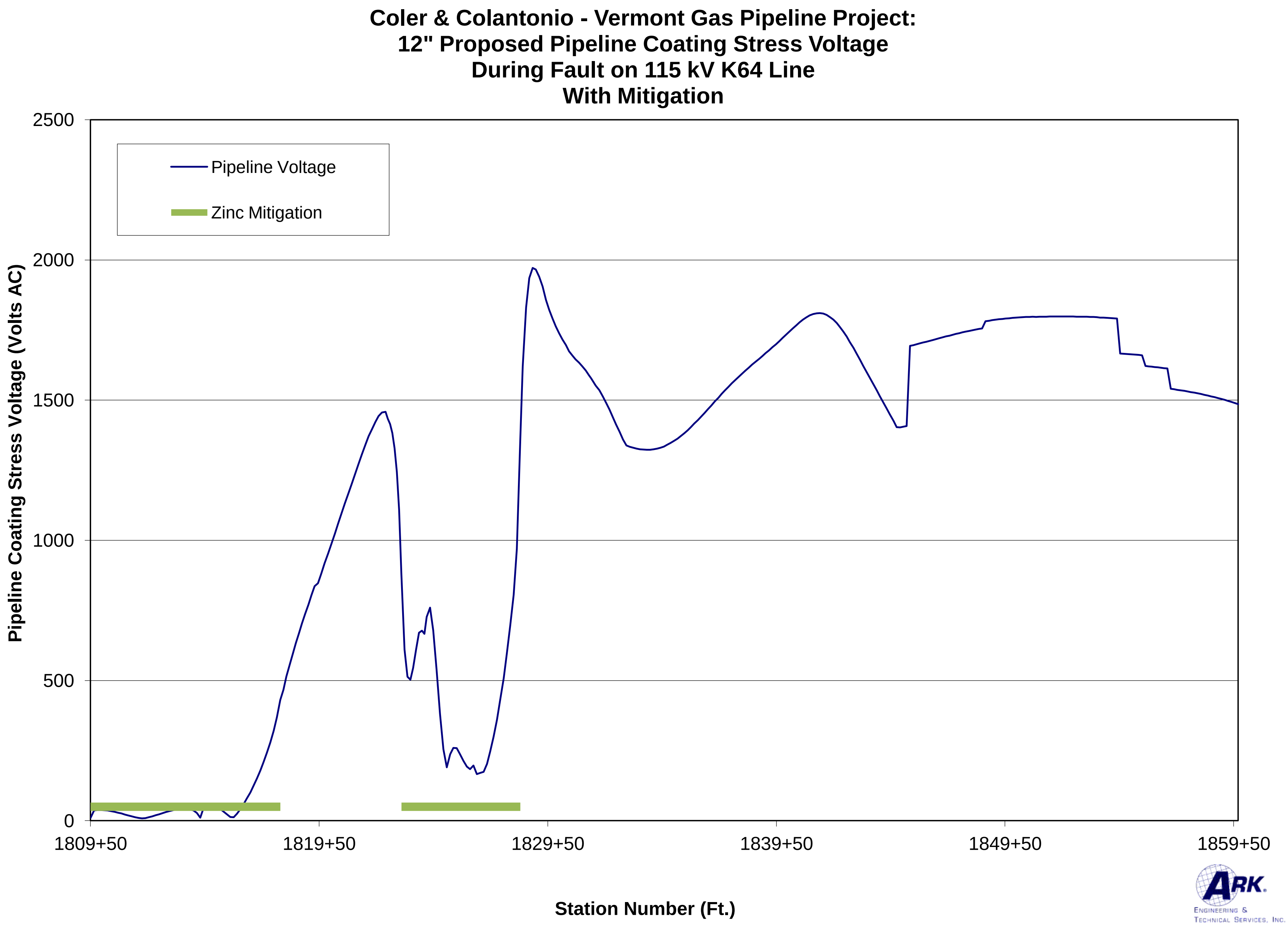


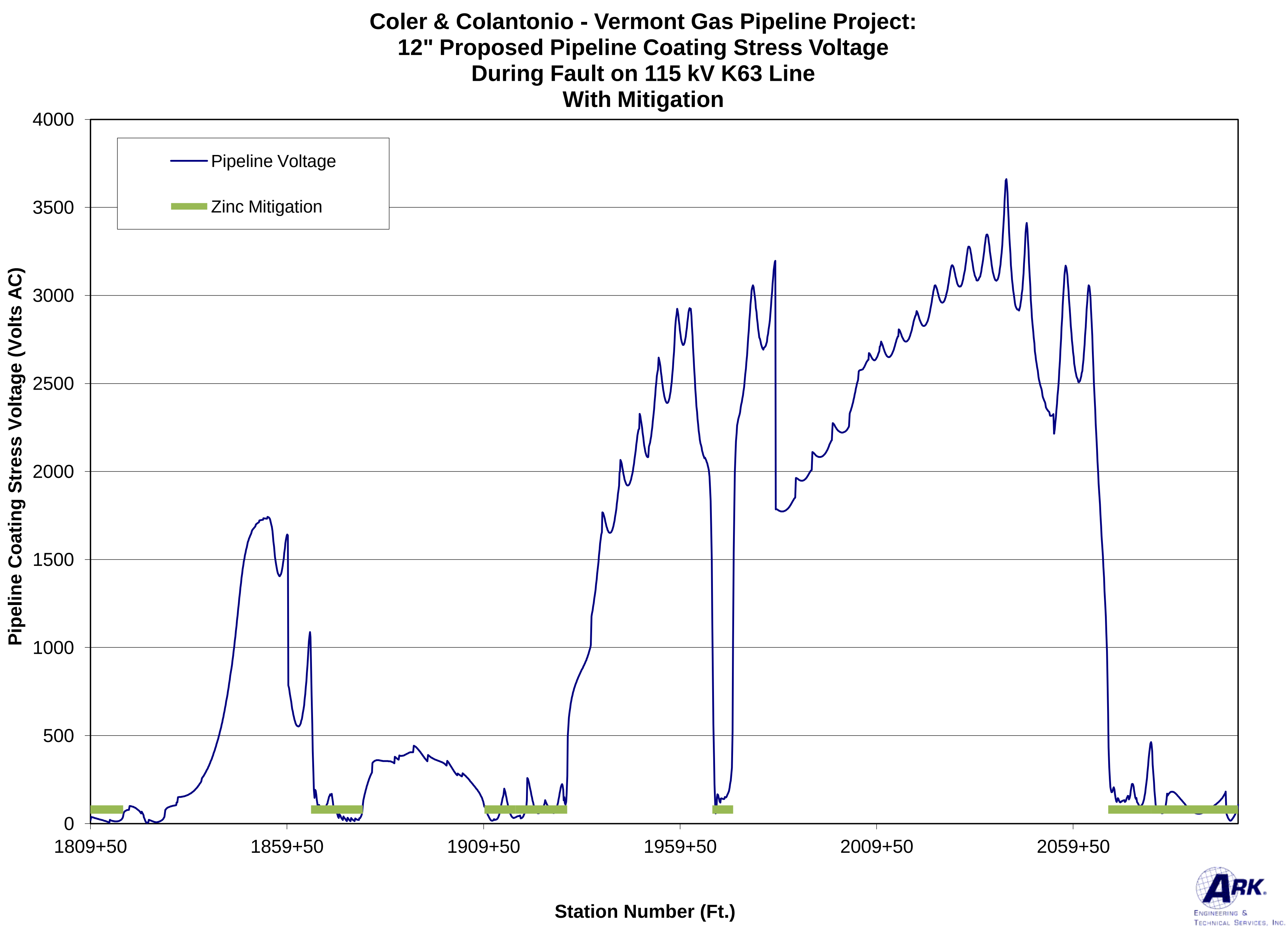
Coler & Colantonio - Vermont Gas Pipeline Project:
12" Proposed Pipeline Coating Stress Voltage
During Fault on 115 kV K27 Line
With Mitigation
Pipeline Voltage
Zinc Mitigation
Pipeline Coating Stress Voltage (Volts AC)
1600
1400
1200
1000
800
600
400
200
0
568+10
588+10
608+10
628+10
648+10
668+10
688+10
708+10
Station Number (Ft.)
ARK
Engineering & Technical Services, Inc.

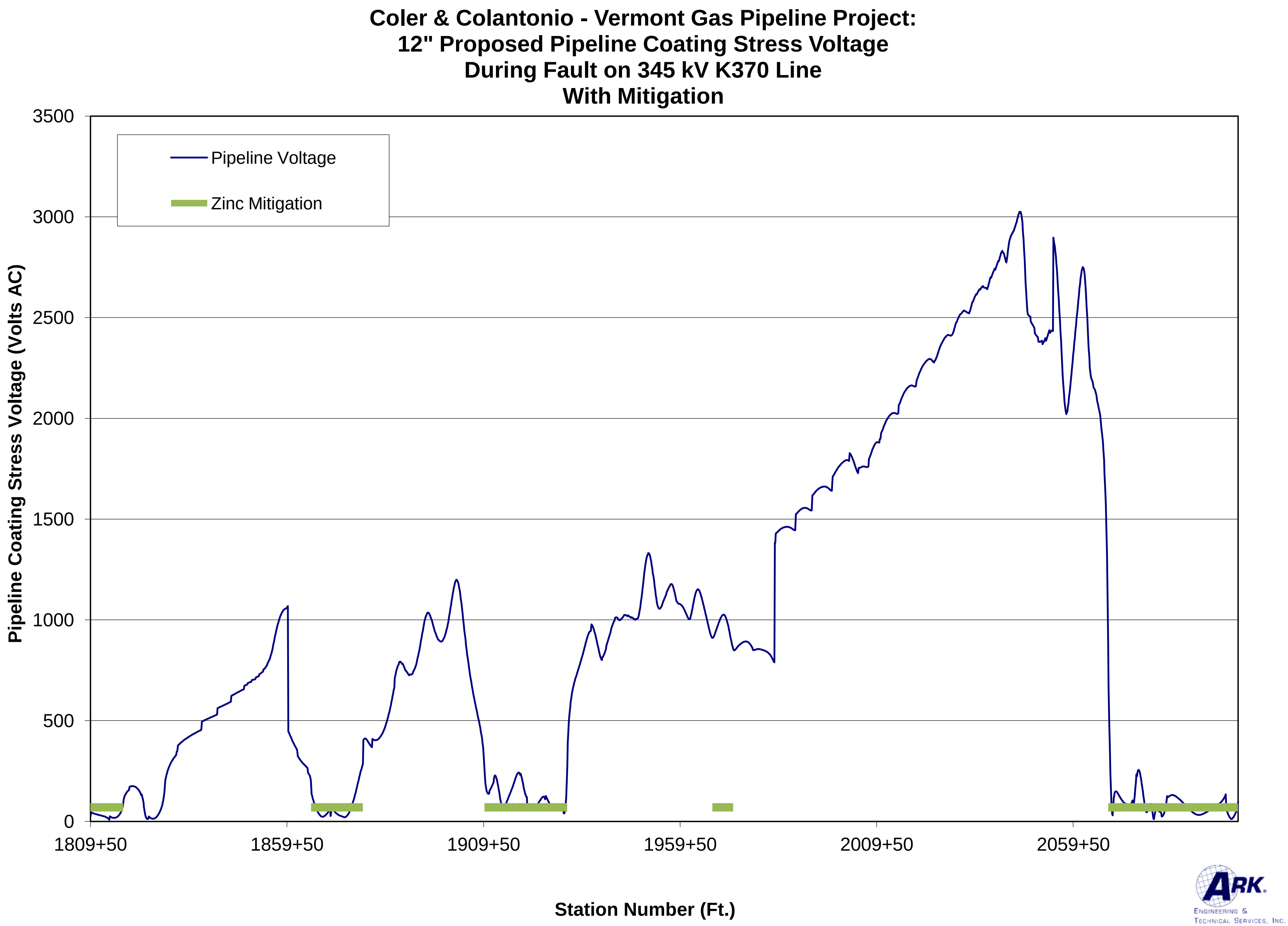


Coler & Colantonio - Vermont Gas Pipeline Project:
12" Proposed Pipeline Coating Stress Voltage
During Fault on 115 kV K33 Line
With Mitigation
Pipeline Voltage
Zinc Mitigation
Pipeline Coating Stress Voltage (Volts AC)
250
200
150
100
50
0
665+80
675+80
685+80
695+80
705+80
715+80
Station Number (Ft.)
ARK
Engineering & Technical Services, Inc.


Coler & Colantonio - Vermont Gas Pipeline Project:
12" Proposed Pipeline Coating Stress Voltage
During Fault on 115 kV K43 Line
With Mitigation
Pipeline Voltage
Zinc Mitigation
Pipeline Coating Stress Voltage (Volts AC)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
665+80
865+80
1065+80
1265+80
1465+80
1665+80
Station Number (Ft.)
ARK
Engineering & Technical Services, Inc.

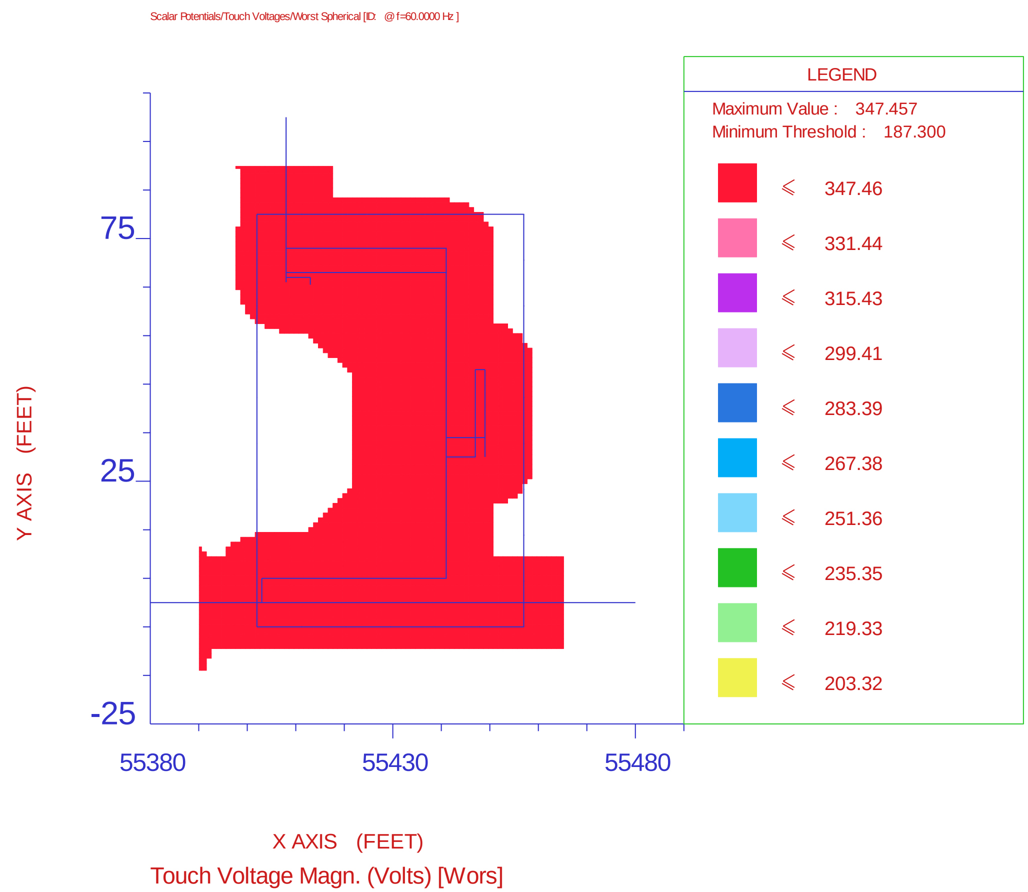

Coler & Colantonio - Vermont Gas Pipeline Project:
12" Proposed Pipeline Coating Stress Voltage
During Fault on 115 kV K64 Line
With Mitigation
Pipeline Voltage
Zinc Mitigation
Pipeline Coating Stress Voltage (Volts AC)
2500
2000
1500
1000
500
0
1809+50
1819+50
1829+50
1839+50
1849+50
1859+50
Station Number (Ft.)
ARK
Engineering &
Technical Services, Inc.


Coler & Colantonio - Vermont Gas Pipeline Project:
12" Proposed Pipeline Coating Stress Voltage
During Fault on 115 kV K63 Line
With Mitigation
Pipeline Voltage
Zinc Mitigation
Pipeline Coating Stress Voltage (Volts AC)
4000
3500
3000
2500
2000
1500
1000
500
0
1809+50
1859+50
1909+50
1959+50
2009+50
2059+50
Station Number (Ft.)
ARK
Engineering &
Technical Services, Inc.


Coler & Colantonio - Vermont Gas Pipeline Project:
12" Proposed Pipeline Coating Stress Voltage
During Fault on 345 kV K370 Line
With Mitigation
Pipeline Voltage
Zinc Mitigation
Pipeline Coating Stress Voltage (Volts AC)
3500
3000
2500
2000
1500
1000
500
0
1809+50
1859+50
1909+50
1959+50
2009+50
2059+50
Station Number (Ft.)
ARK
Engineering & Technical Services, Inc.

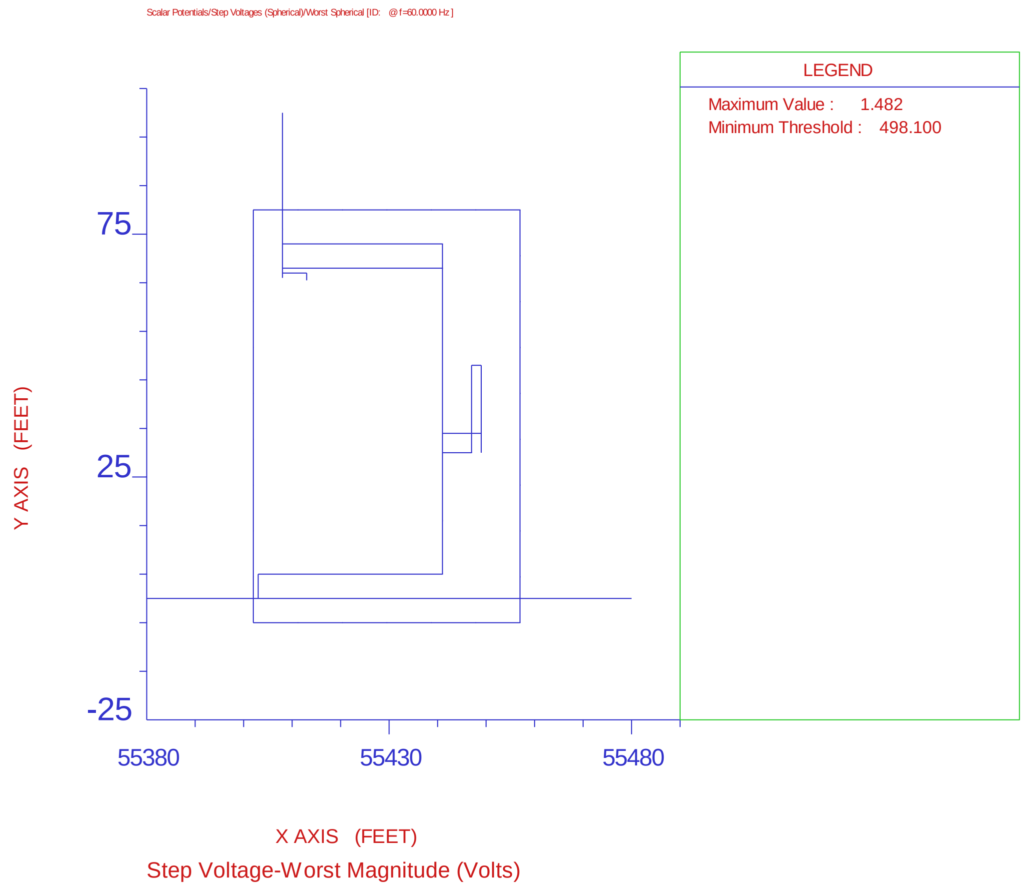
FAULT – TOUCH & STEP VOLTAGES

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.



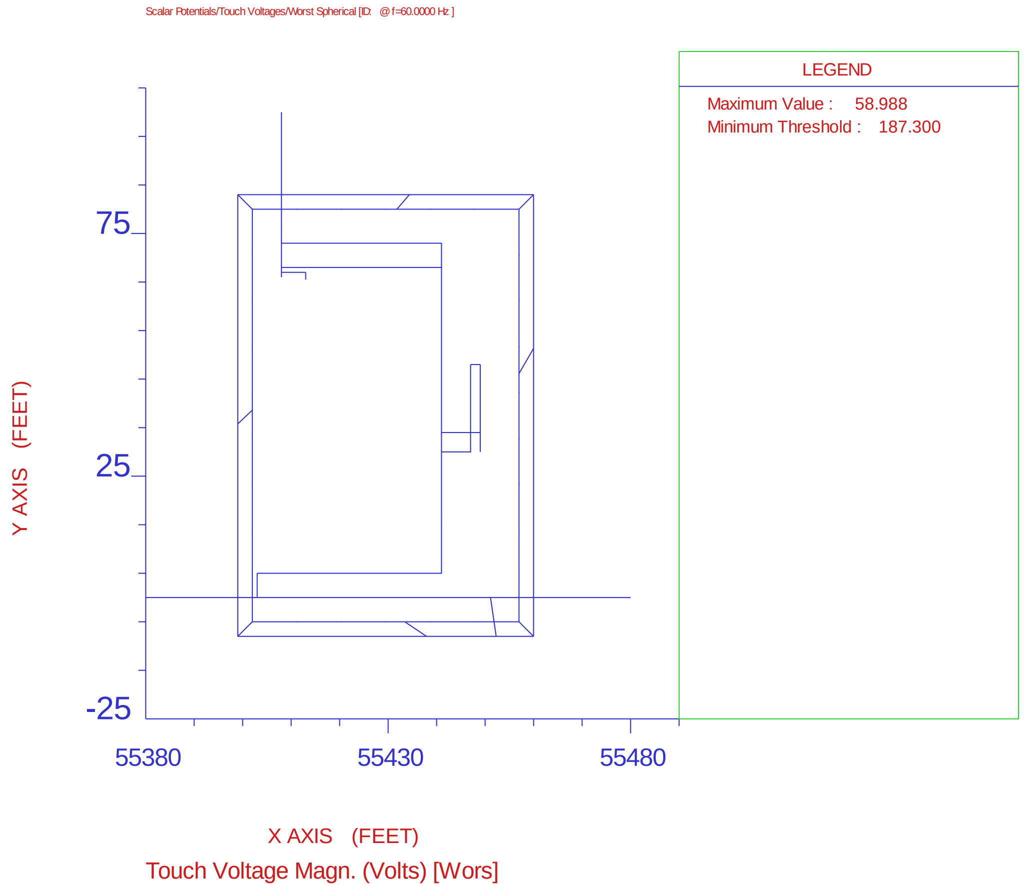
ARK Engineering & Technical Services, Inc.

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.

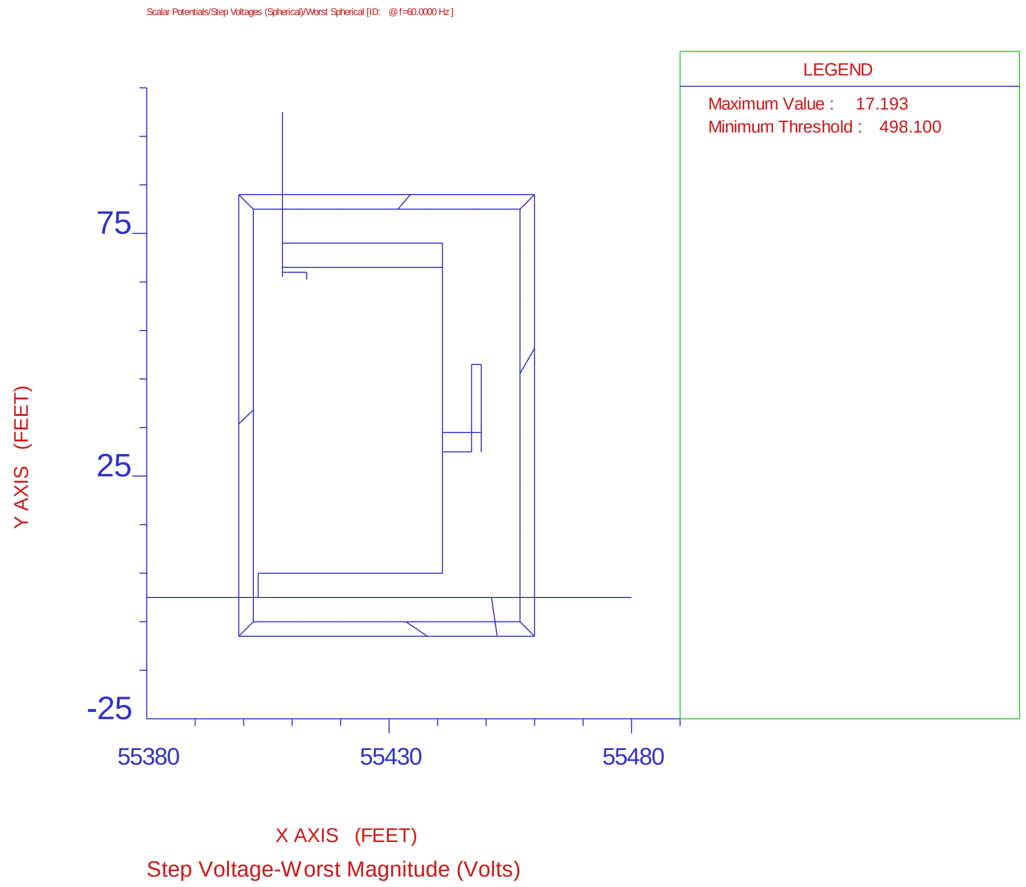


ARK
Engineering & Technical Services, Inc.

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

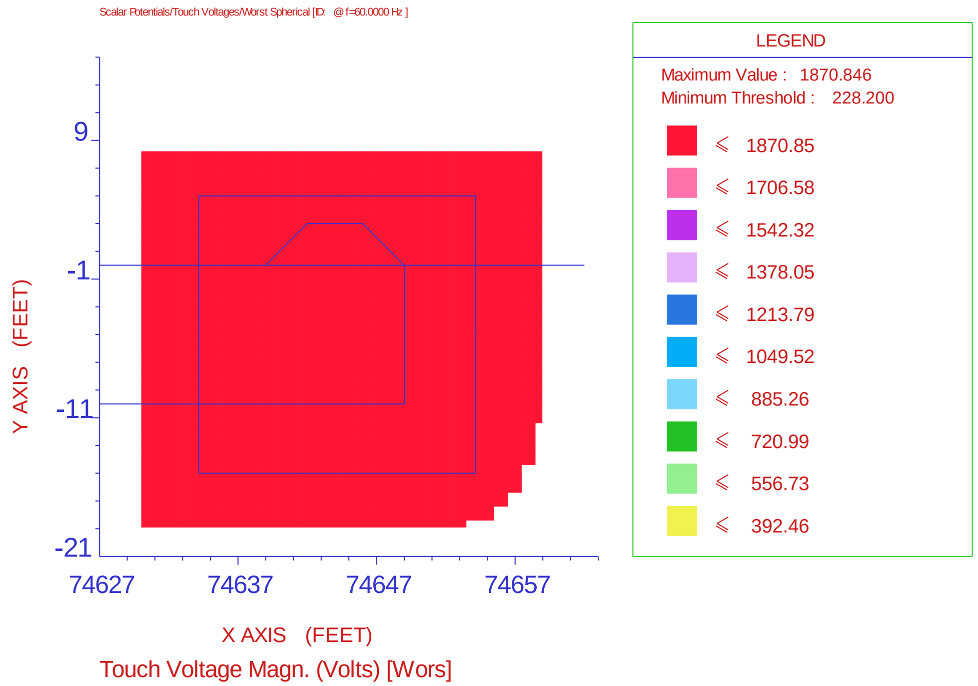


Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline
Williston M&R @ MP 10.43
Faulted at Velco 115 kV K23 Tower
Step Voltages – Safety Limit 498.1 Volts.
With Mitigation



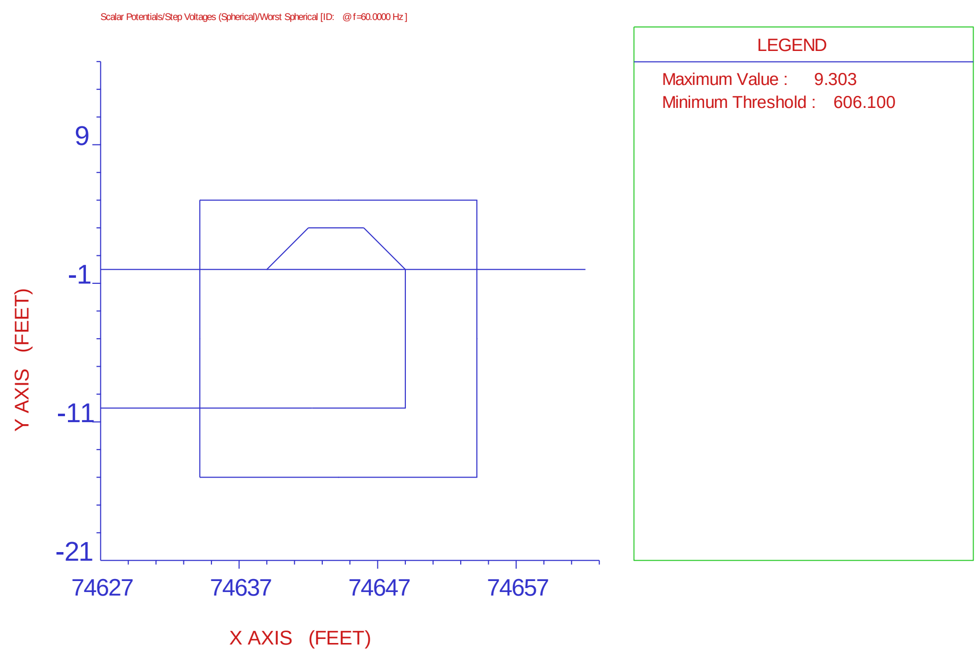
ARK Engineering & Technical Services, Inc.

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.



ARK Engineering & Technical Services, Inc.

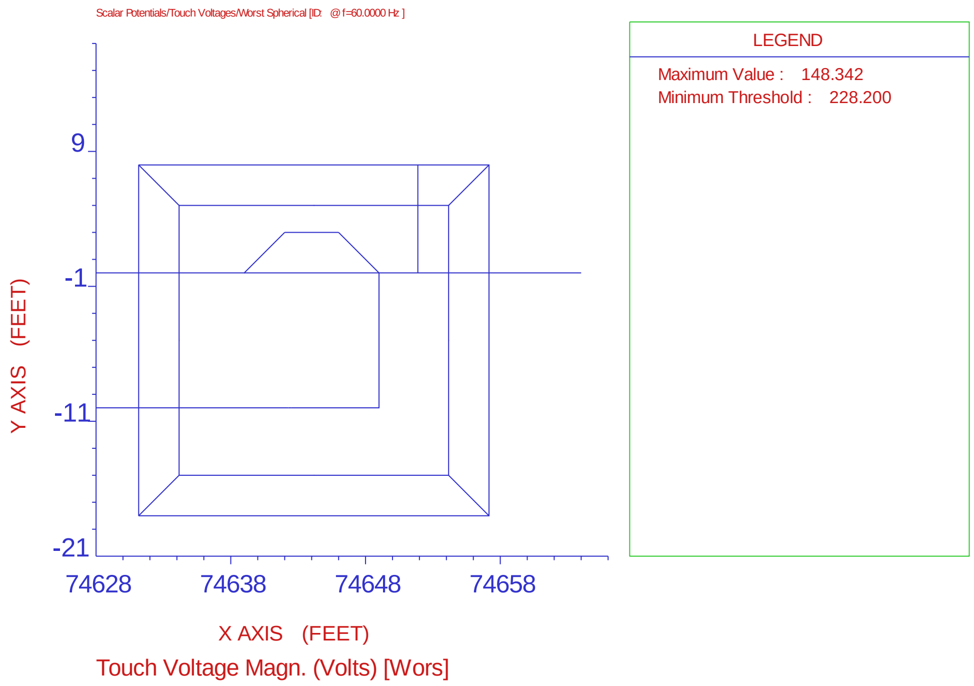
Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline
MLV-2 @ MP 14.3
Faulted at Velco 115 kV K43 Tower
Step Voltages – Safety Limit 606.1 Volts.



Step Voltage-Worst Magnitude (Volts)

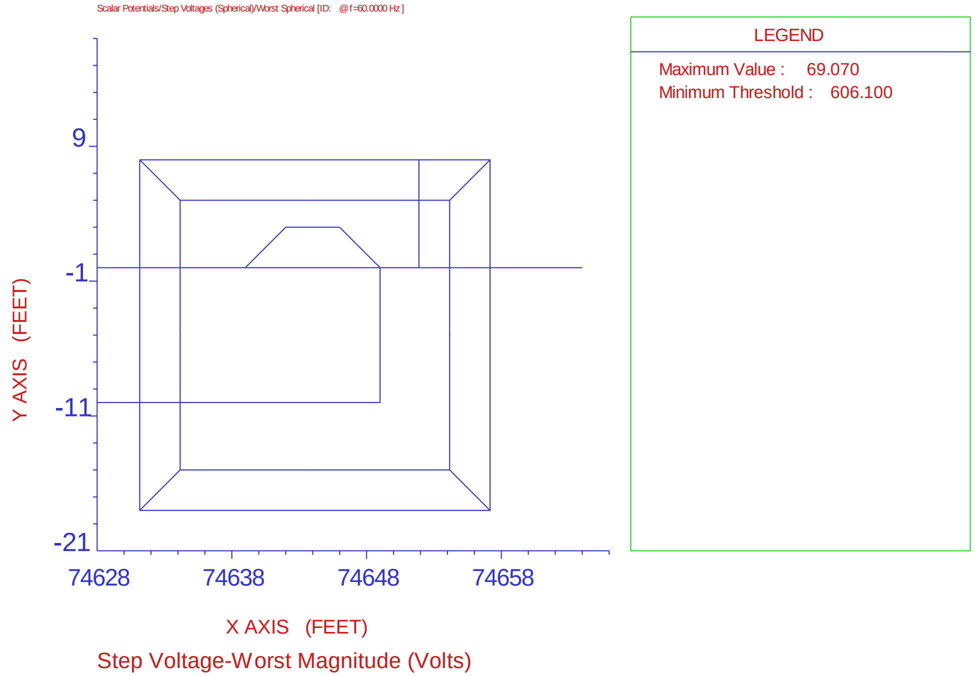
ARK Engineering & Technical Services, Inc.

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



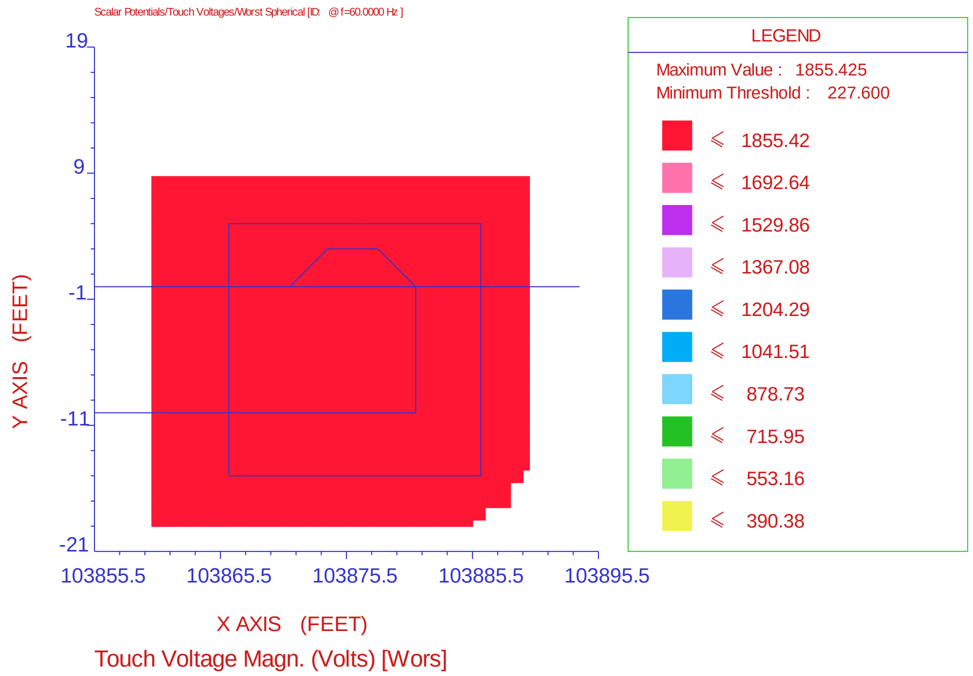
ARK Engineering & Technical Services, Inc.

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

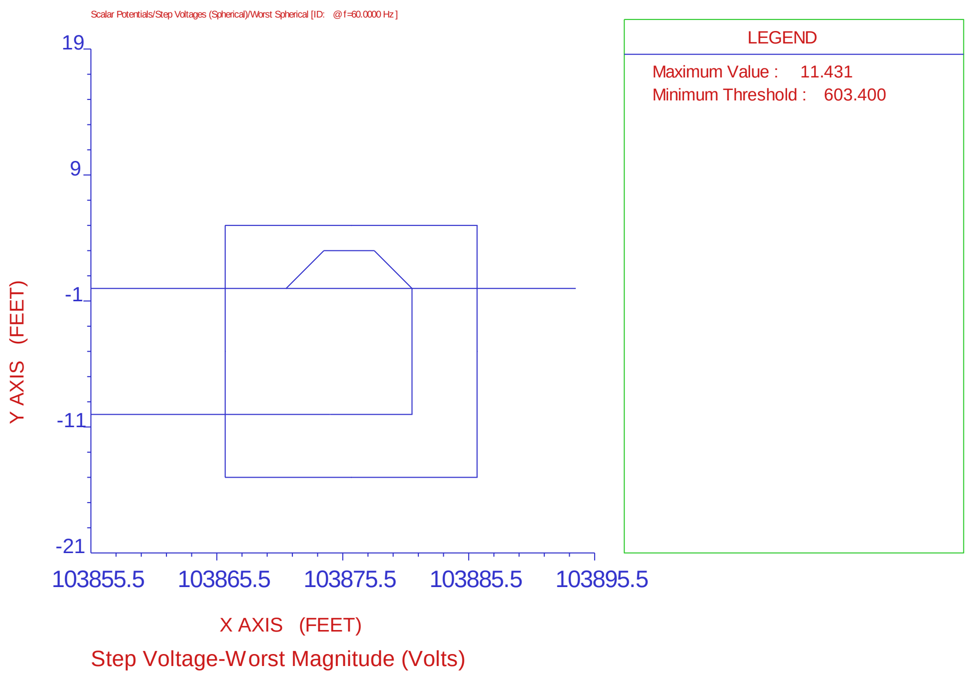


ARK Engineering & Technical Services, Inc.

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.

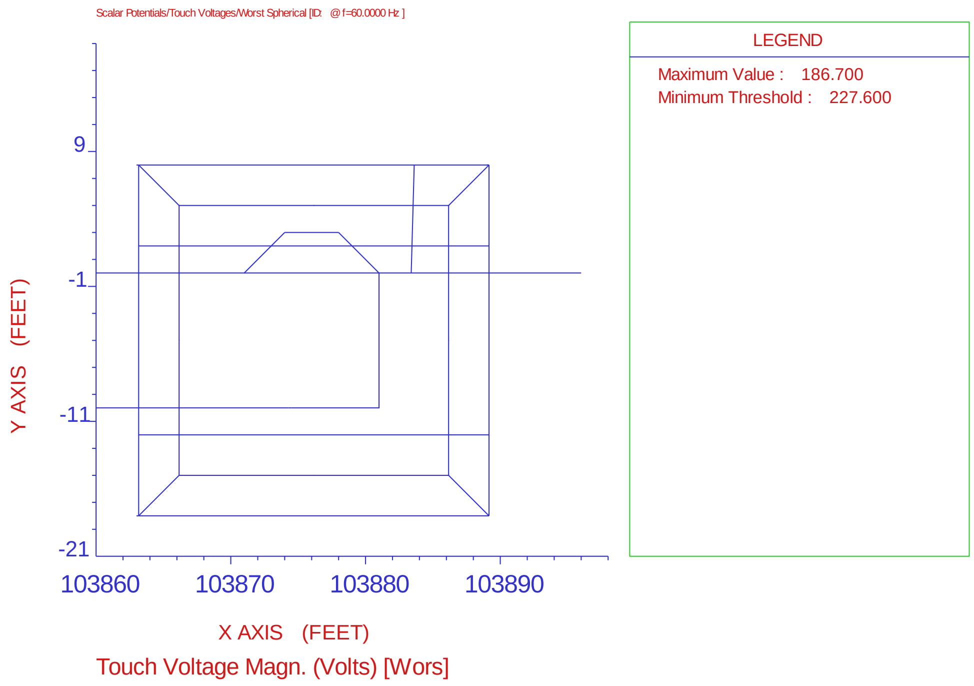


Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline
MLV-3 @ MP 19.81
Faulted at Velco 115 kV K43 Tower
Step Voltages – Safety Limit 603.4 Volts.



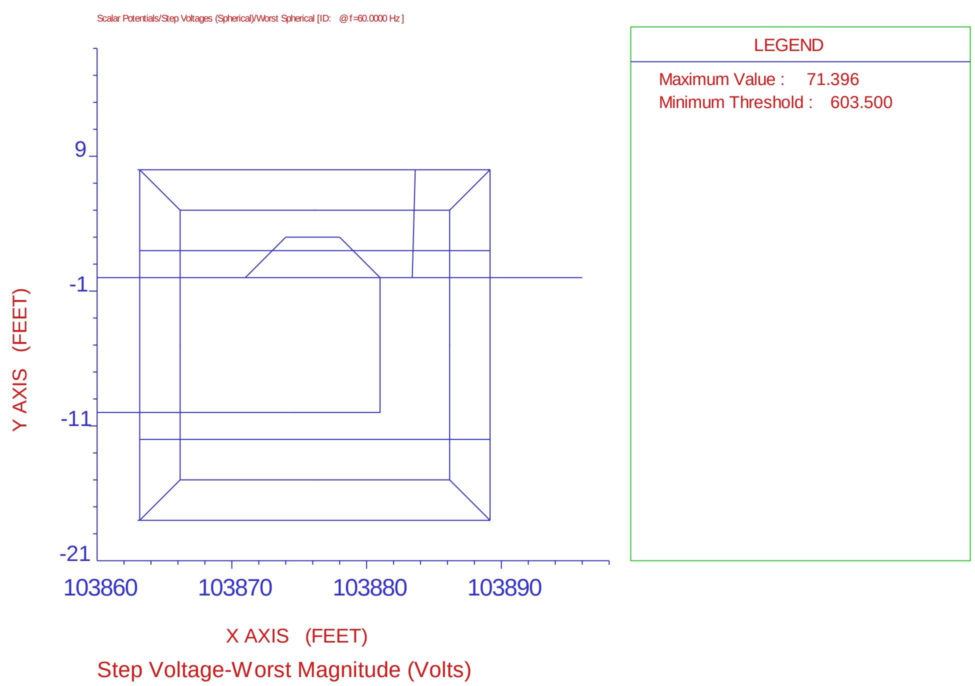
ARK Engineering & Technical Services, Inc.

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



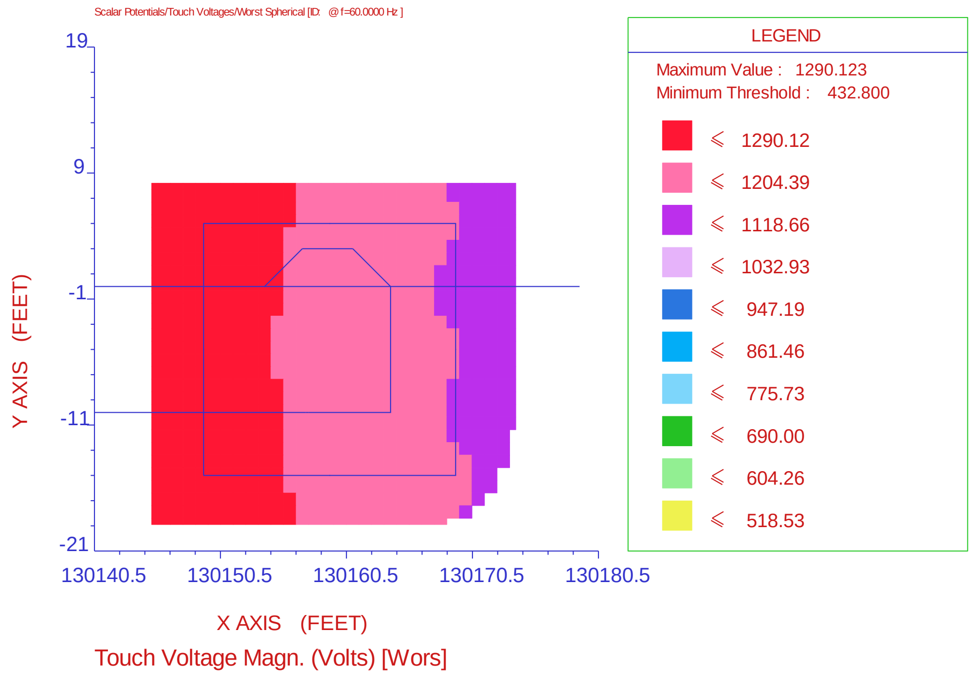
ARK Engineering & Technical Services, Inc.

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



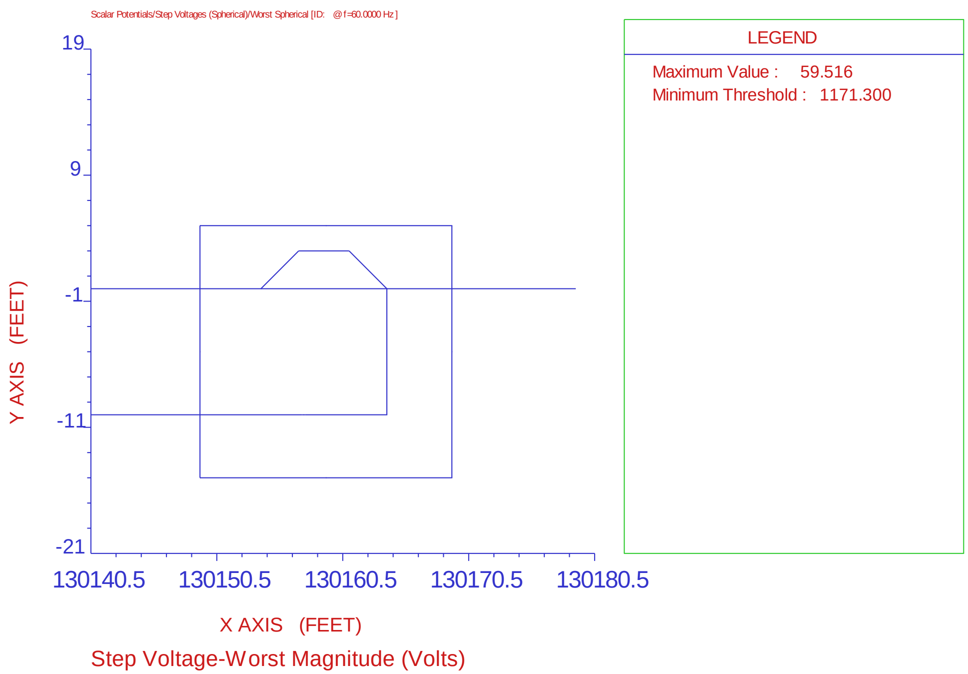
ARK Engineering & Technical Services, Inc.

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.



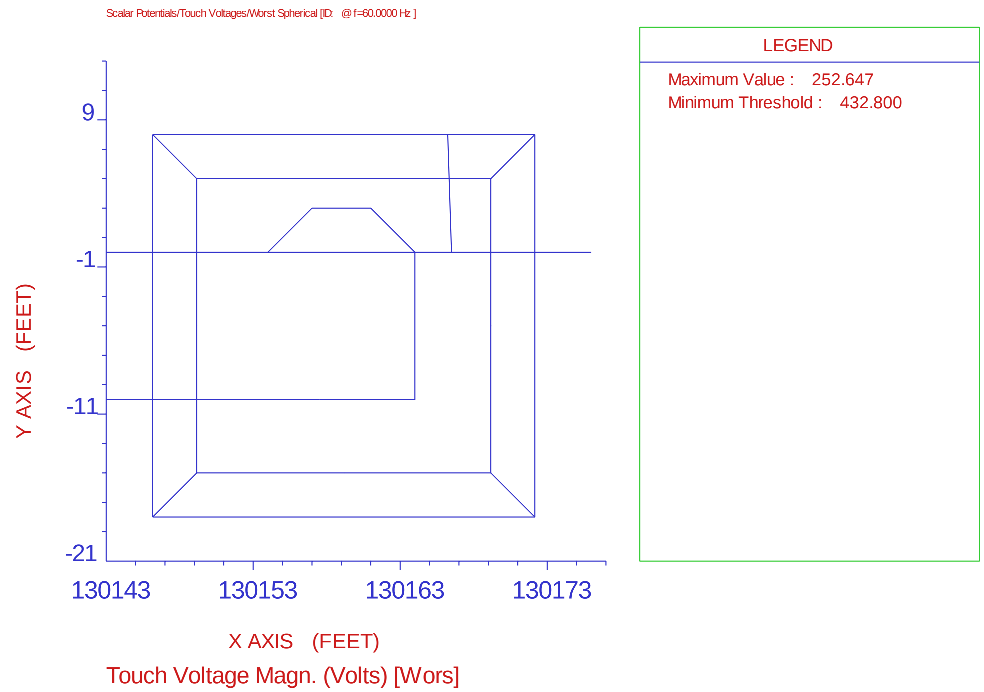
ARK Engineering & Technical Services, Inc.

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.



ARK Engineering & Technical Services, Inc.

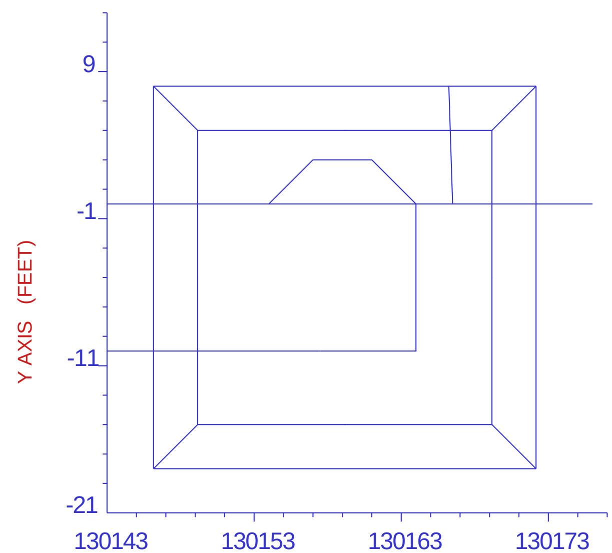
Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline
MLV-4 @ MP 24.8
Faulted at Velco 115 kV K43 Tower
Touch Voltages – Safety Limit 432.8 Volts.
With Mitigation



ARK Engineering & Technical Services, Inc.

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

Scalar Potentials/Step Voltages (Spherical)/Worst Spherical [ID: @ f =60.0000 Hz]

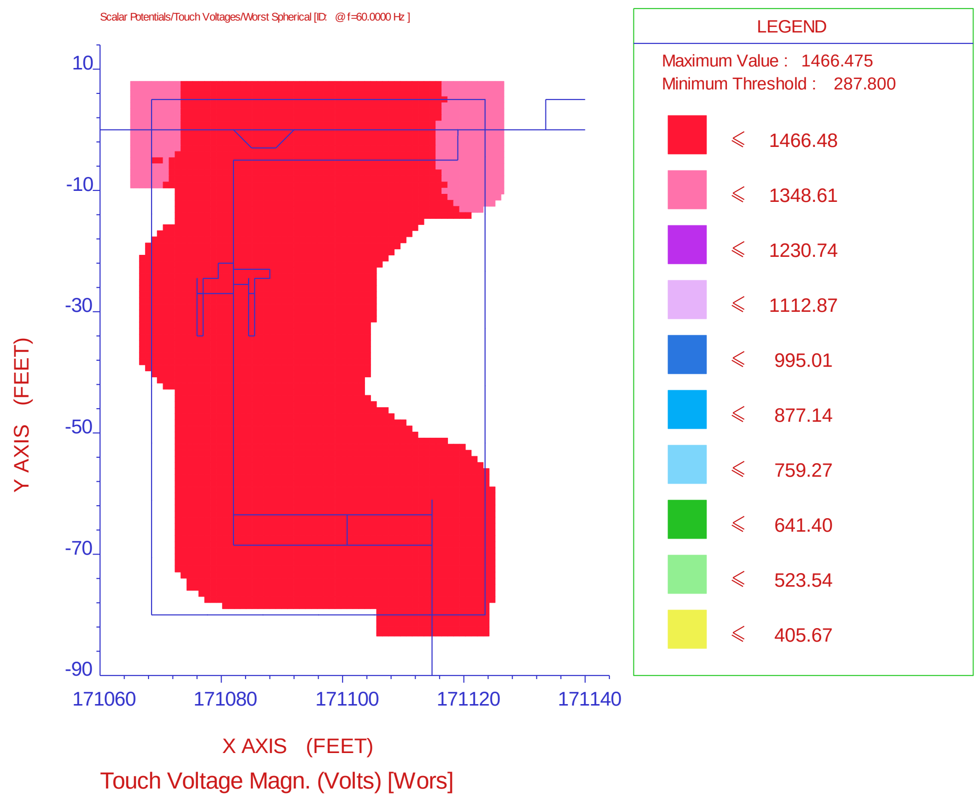


Step Voltage-Worst Magnitude (Volts)

LEGEND	
Maximum Value :	102.229
Minimum Threshold :	1171.300

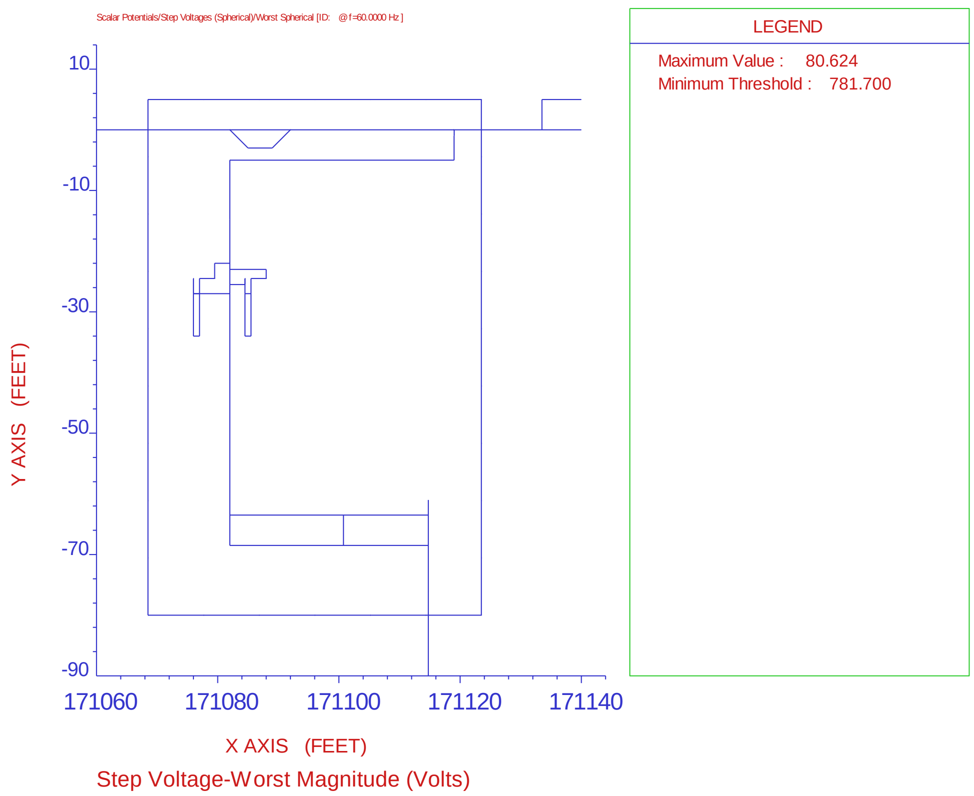
ARK Engineering & Technical Services, Inc.

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.



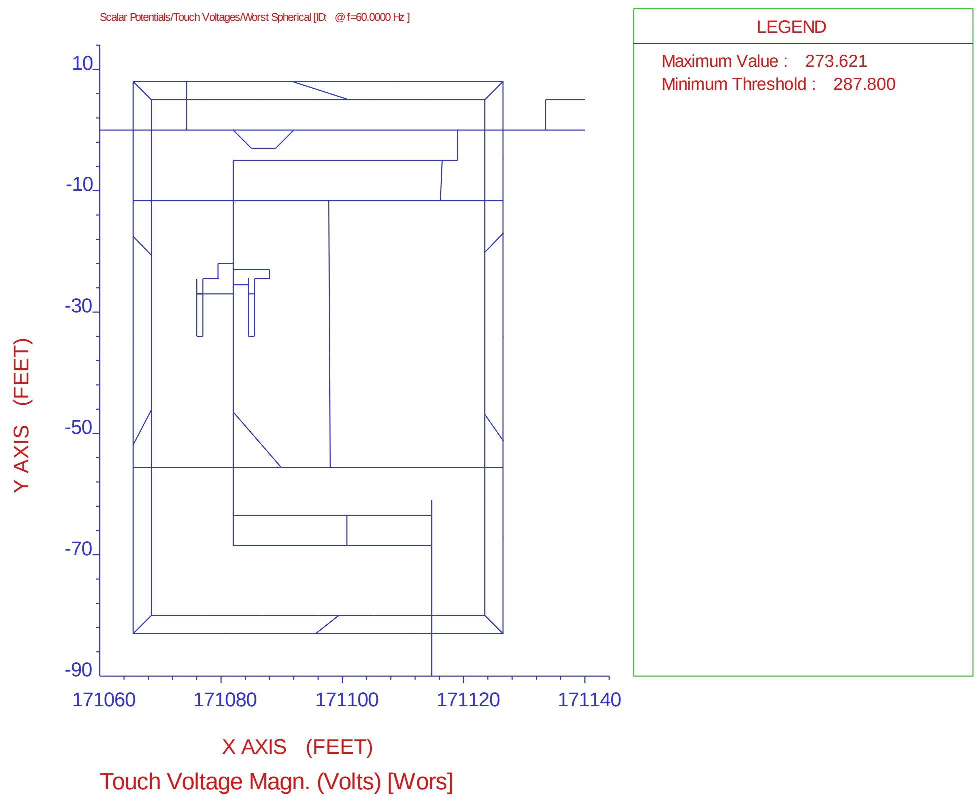
ARK Engineering & Technical Services, Inc.

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.

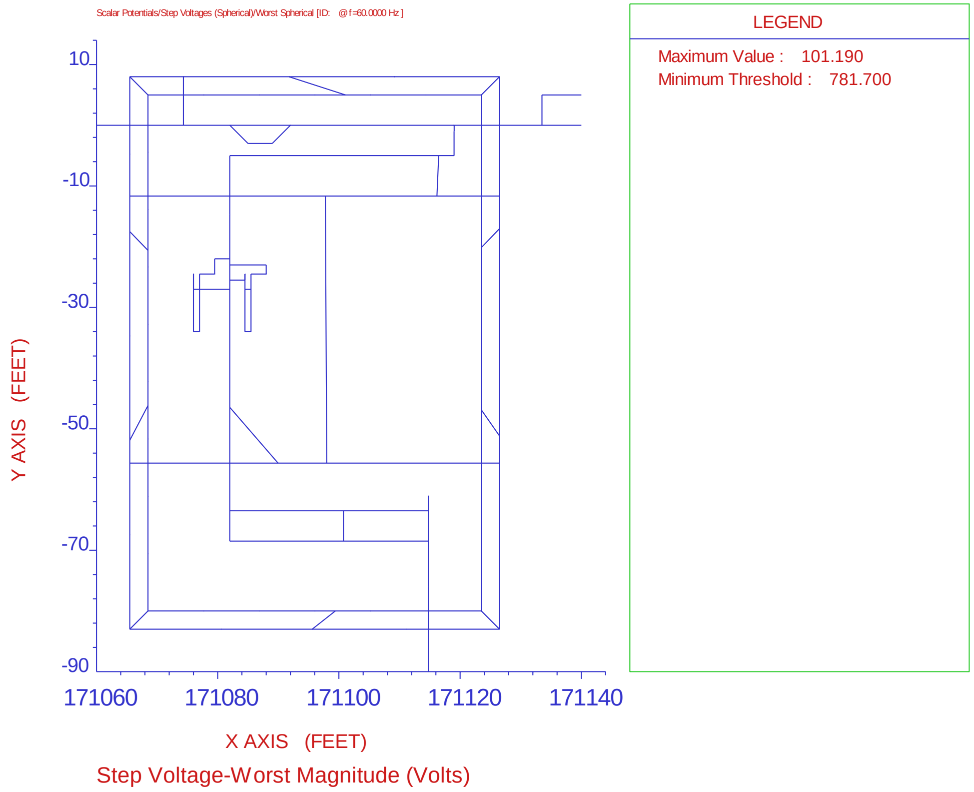


ARK Engineering & Technical Services, Inc.

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

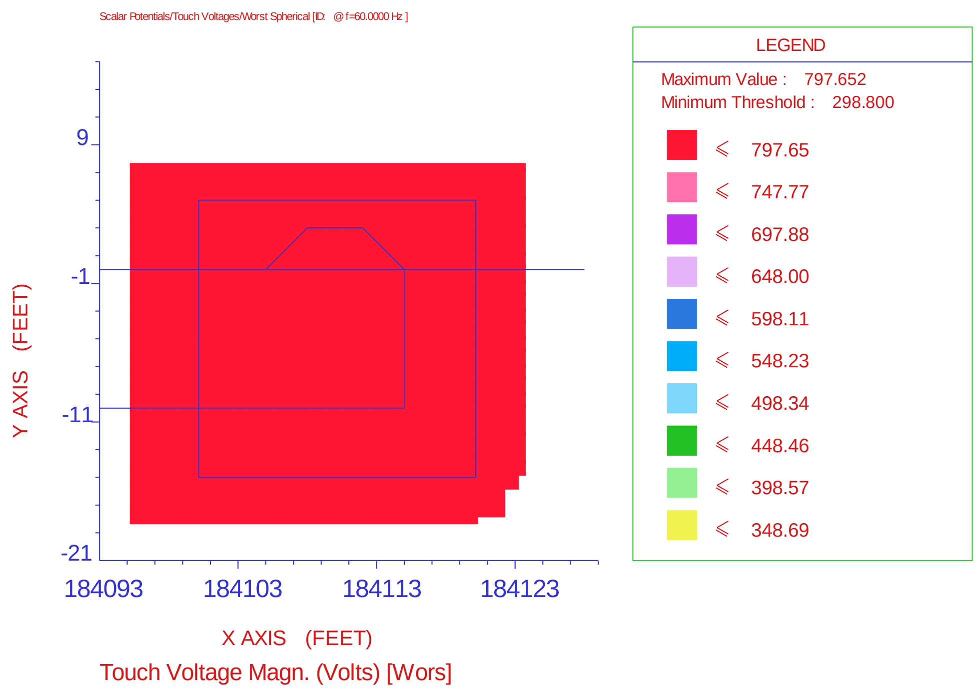


Coler & Colantonio - Vermont Gas Pipeline Project - 12" Proposed Pipeline
MLV-5/Plank Rd. M&R @ MP 32.54
Faulted at Velco 115 kV K43 Tower
Step Voltages – Safety Limit 781.7 Volts.
With Mitigation



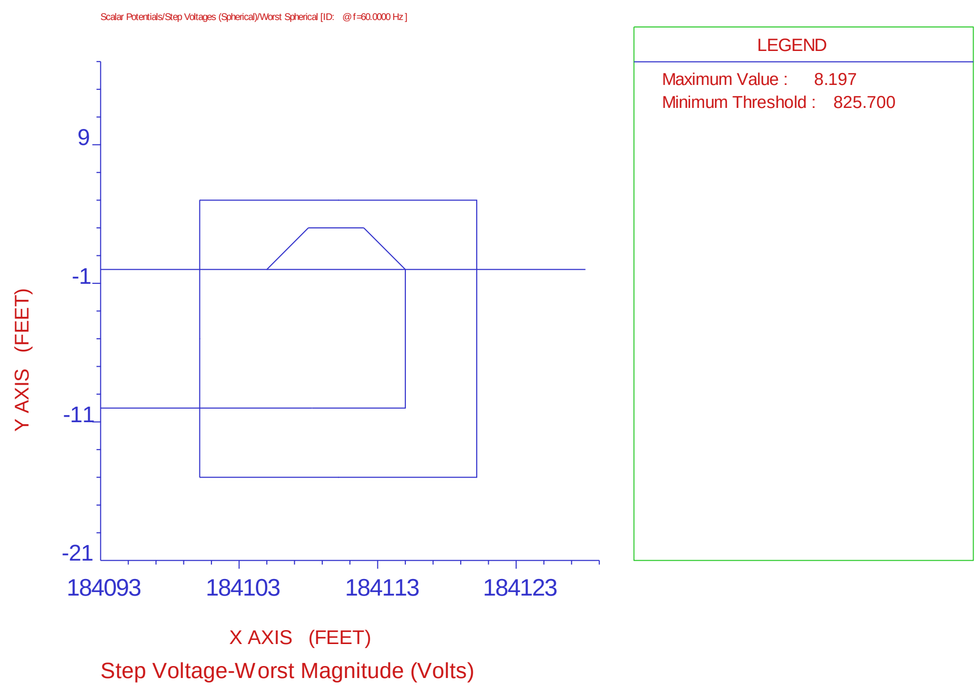
ARK
Engineering & Technical Services, Inc.

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.



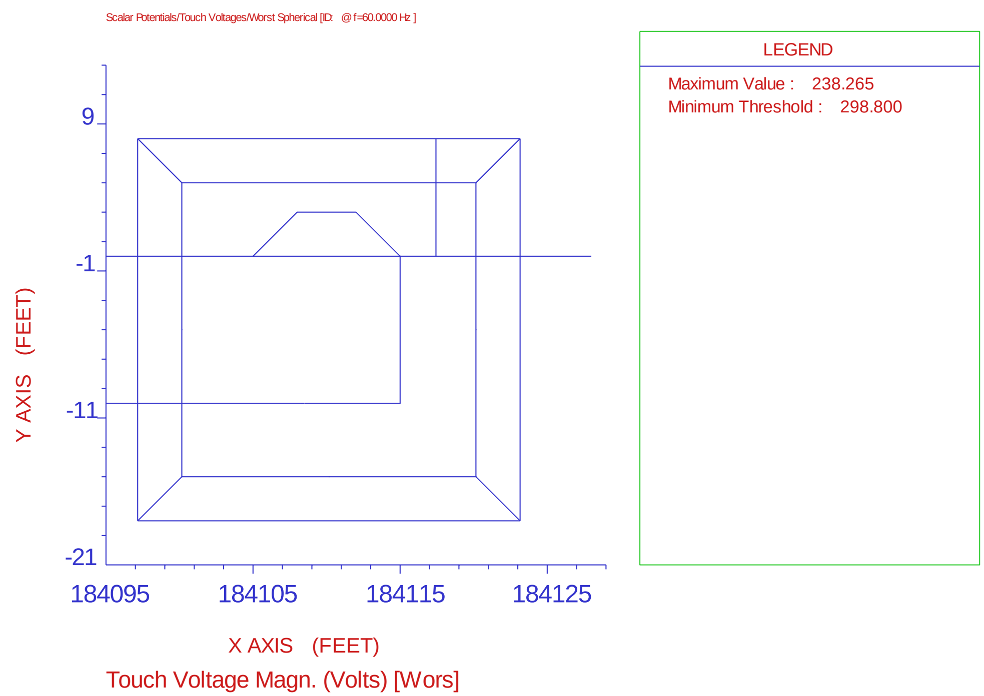
ARK Engineering & Technical Services, Inc.

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.



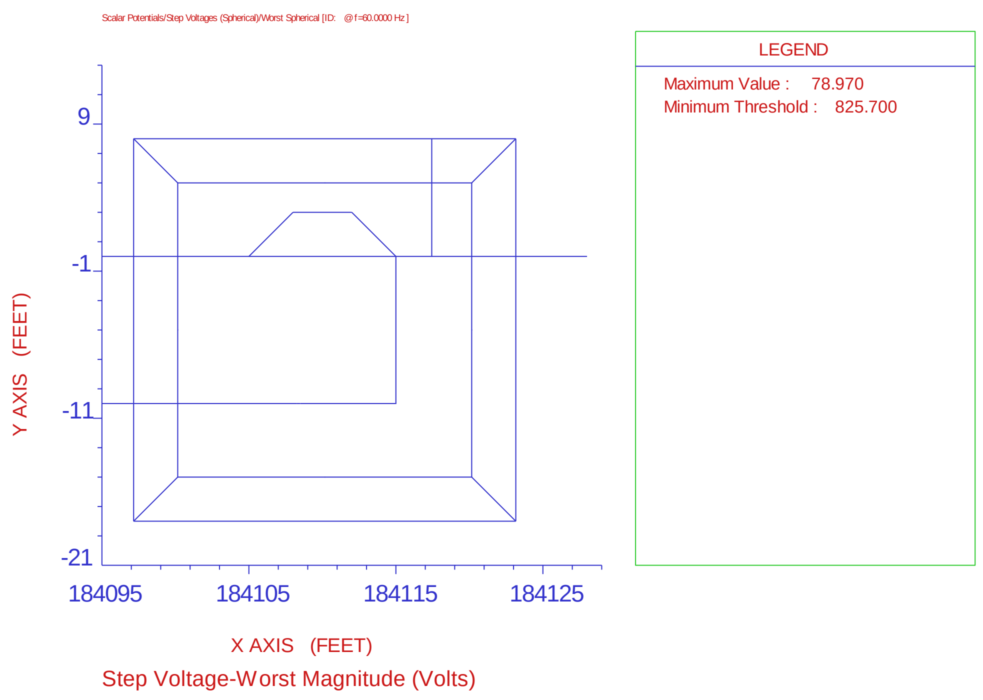
ARK Engineering & Technical Services, Inc.

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



ARK Engineering & Technical Services, Inc.

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



ARK ENGINEERING & TECHNICAL SERVICES, INC.

APPENDIX C –
POWER & PIPELINE COMPANY DATA

ARK Engineering

Line Data (General Electrical)

Circuit Name	Voltage (kV)	Origin Substation	Destination Substation	Projected Future Maximum Load Current (A) (Not conductor rating!)	Projected Future Emergency Load Current (A) (Not conductor)	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	500	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) (Rulling Span)	Minimum conductor hieght 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 sheilds 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	10810	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 VELCO facility	44.474460°	-73.088702°	Not a VELCO 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				

ARK Engineering & Technical Services, Inc.

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	7,968	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			
K21	1	North (Georgia)	3,825	77	42	65	4.15mi. from Essex
		Essex	5,700	78	8	25	23%
	2	North (Georgia)	2,775	77	42	65	3.38mi. from Essex
		Essex	12,450	77	8	25	19%
	3	North (Georgia)	2,700	77	42	65	2.70mi. from Essex
		Essex	13,950	77	8	25	15%
K22	4	North (Sandbar)	7,050	77	8	25	4.64mi. from Essex
		Essex	9,150	77	8	25	42%
	5	North (Sandbar)	6,300	77	8	25	3.88mi. from Essex
		Essex	10,050	77	8	25	35%
	6	North (Sandbar)	5,700	77	42	65	3.18mi. from Essex
		Essex	11,400	77	8	25	28%
K24 (Essex to Middlesex segment)	7	Essex	11,700	76	10	30	1.25mi. from Essex
		Middlesex	2,850	77	66	86	5%
	8	Essex	10,950	76	10	30	1.69mi. from Essex
		Middlesex	2,925	77	66	86	6%
	9	Essex	9,900	76	10	30	2.22mi. from Essex
		Middlesex	3,000	77	66	86	8%
K23 (Essex - Tafts Corner)	10	Essex	9,450	78	48	68	At Tafts bus
		Tafts Corner (Total)	16,875	75	10	20	
		Lime Kiln	1,800	81	92	112	
	11	Essex	10,200	78	23	43	0.61mi. from Tafts
		Tafts Corner	6,600	77	6	20	19%
		Lime Kiln	2,100	81	82	102	
K27	13	Tafts Corner	11,625	77	6	20	0.28mi. from Tafts
		Williston	5,250	79	24	44	14%
	14	Tafts Corner	11,250	77	6	20	0.54mi. from Tafts
		Williston	5,400	79	24	44	26%
	15	Tafts Corner	10,650	77	6	20	0.89mi. from Tafts
		Williston	5,475	79	24	44	43%
	16	Tafts Corner	10,500	77	6	20	0.98mi. from Tafts
		Williston	5,550	79	24	44	48%
	17	Tafts Corner	9,750	77	27	47	1.50mi. from Tafts
		Williston	5,775	79	6	20	73%
	18	Tafts Corner	9,150	77	27	47	1.98mi. from Tafts
		Williston	6,150	79	6	20	97%
K33	19	Queen City	3525	75	36	56	0.47mi. from Williston
		Williston	11250	75	6	20	7%
	20	Queen City	3375	75	36	56	At Williston bus
		Williston (Total)	15000	75	6	20	
K43	21	Williston (Total)	15000	77	6	20	At Williston bus
		New Haven	3150	80	54	74	
	22	Williston	10650	77	6	20	0.97mi. from Williston
		New Haven	3300	79	54	74	5%
	23	Williston	10125	77	6	20	1.54mi. from Williston
		New Haven	3375	78	54	74	7%
	24	Williston	9375	77	6	20	2.03mi. from Williston
		New Haven	3450	78	54	74	10%
	25	Williston	9,000	77	6	20	2.47mi. from Williston
		New Haven	3,525	78	54	74	12%
	26	Williston	8,700	77	6	20	2.78mi. from Williston
		New Haven	3,600	78	54	74	13%
	27	Williston	8,325	77	6	20	3.09mi. from Williston
		New Haven	3,675	78	54	74	15%
	28	Williston	7950	77	6	20	3.61mi. from Williston
		New Haven	3750	78	54	74	17%
	29	Williston	7200	77	6	20	4.59mi. from Williston
		New Haven	4050	78	54	74	22%
	30	Williston	6600	77	6	20	5.71mi. from Williston
		New Haven	4275	78	54	74	27%
	31	Williston	6000	77	6	20	6.72mi. from Williston
		New Haven	4500	78	54	74	32%
	32	Williston	5,475	78	6	20	7.83mi. from Williston
		New Haven	4,875	78	6	20	38%
	33	Williston	6,000	78	6	20	8.89mi. from Williston
		New Haven	5,250	78	6	20	43%
	34	Williston	4,800	78	6	20	9.87mi. from Williston
		New Haven	5,625	78	6	20	47%
	35	Williston	4,500	78	6	20	10.89mi. from Williston
		New Haven	6,150	78	6	20	52%
	36	Williston	4200	78	6	20	11.96mi. from Williston
		New Haven	6600	78	6	20	57%
	37	Williston	3900	78	6	20	13.08mi. from Williston
		New Haven	7425	78	6	20	63%
	38	Williston	3750	78	6	20	14.24mi. from Williston
		New Haven	8250	78	6	20	68%
	39	Williston	3600	78	6	20	14.78mi. from Williston
		New Haven	8850	78	6	20	71%
	40	Williston	3,450	78	6	20	15.26mi. from Williston
		New Haven	9,300	78	6	20	73%
	41	Williston	3,300	78	30	50	16.48mi. from Williston
		New Haven	10,800	78	6	20	79%
	42	Williston	3,000	78	30	50	17.62mi. from Williston
		New Haven	12,975	78	6	20	85%
	43	Williston	2,925	78	30	50	18.14mi. from Williston
		New Haven	13,500	78	6	20	87%
	44	Williston	2,775	79	30	50	18.71mi. from Williston
		New Haven	15,450	78	6	20	90%
	45	Williston	2,550	79	30	50	19.74mi. from Williston
		New Haven	19,200	78	6	20	95%
	46	Williston	2,400	79	30	50	20.45mi. from Williston
		New Haven	22,500	78	6	20	98%
	47	Williston	2,250	79	30	50	At New Haven bus
		New Haven (Total)	26,700	78	10	30	
K63	49	New Haven (Total)	26,700	74	10	30	At New Haven bus
		Middlebury	2,400	72	38	63	
	50	New Haven	21,450	74	6	20	0.63mi. from New Haven
		Middlebury	2,550	72	38	63	8%
	51	New Haven	18,825	74	6	20	1.13mi. from New Haven
		Middlebury	2,700	72	38	63	15%
	52	New Haven	16,950	74	6	20	1.60mi. from New Haven
		Middlebury	2,850	72	38	63	21%
	53	New Haven	13,800	74	6	20	2.61mi. from New Haven
		Middlebury	3,150	72	38	63	35%
	54	New Haven	11,700	74	6	20	3.64mi. from New Haven
		Middlebury	3,525	72	8	25	48%
	55	New Haven	10,800	74	6	20	4.24mi. from New Haven
		Middlebury	3,750	72	8	25	56%
	56	New Haven	10,050	74	30	50	4.83mi. from New Haven
		Middlebury	4,050	72	8	20	64%
K64	48	Vergennes	2,700	79	30	50	1.02mi. from New Haven
		New Haven	18,600	80	6	20	15%
	46	Vergennes	2,250	79	30	50	0.43mi. from New Haven
		New Haven	21,750	80	6	20	6%
	47	Vergennes	2,175	79	30	50	At New Haven bus
		New Haven (Total)	26,700	80	10	30	
K370	49	New Haven (Total)	11,400	75	10	30	At New Haven bus
		West Rutland	5,475	83	29	49	
	50	New Haven	7,500	75	5	20	0.63mi. from New Haven
		West Rutland	5,475	83	29	49	2%
	51	New Haven	7,425	75	5	20	1.13mi. from New Haven
		West Rutland	5,513	83	29	49	3%
	52	New Haven	7,275	80	5	20	1.60mi. from New Haven
		West Rutland	5,550	83	29	49	5%
	53	New Haven	7,200	80	5	20	2.61mi. from New Haven
		West Rutland	5,625	83	29	49	7%
	54	New Haven	7,050	84	5	20	3.64mi. from New Haven
		West Rutland	5,700	82	29	49	10%
	55	New Haven	6,900	84	5	20	4.24mi. from New Haven
		West Rutland	5,775	82	29	49	12%
	56	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.

ARK Engineering & Technical Services, Inc.

ARK Engineering

Line Data (General Electrical)

Not conductor rating!

Circuit Name	Voltage (kV)	Origin Substation	Destination Substation	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	7,968	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					

ARK Engineering & Technical Services, Inc.

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.

DATE	CH'K BY	DRAWN BY JM	CHECKED BY	DATE 6/77
REVISIONS		SCALE none	APPROVED BY DW	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.

DATE	CH'K BY	DRAWN BY JM	CHECKED BY	DATE 6/77
REVISIONS		SCALE none	APPROVED BY DW	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 2½" 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	Preformd	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~~

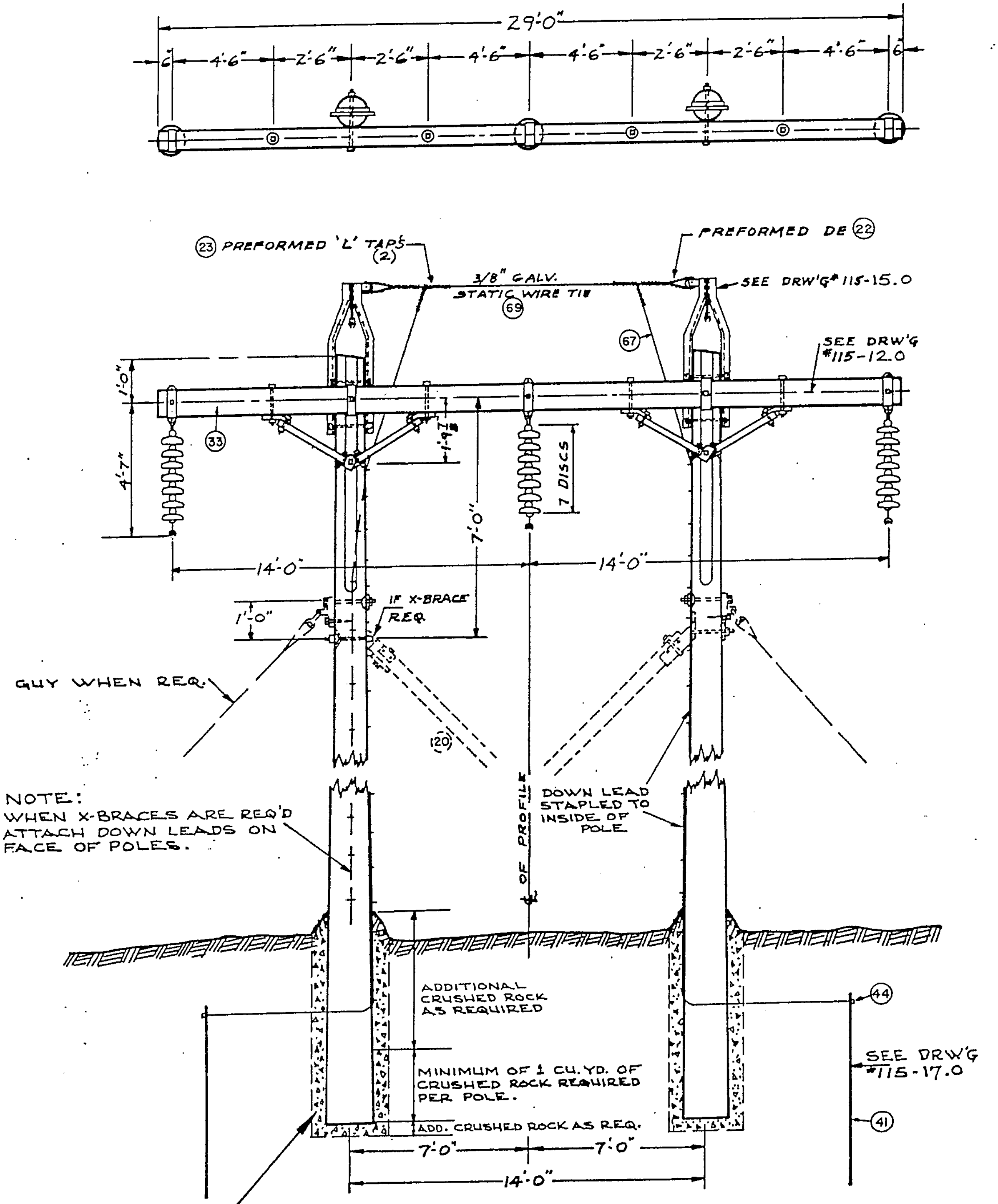
Rev. 2/77
Rev. 2/74

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
		When Required		
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 metalic (used if pole cut off in field)	Joslyn	J 2108
		Side Guys - When Required		
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.

REV 2/77
Rev. 2/74



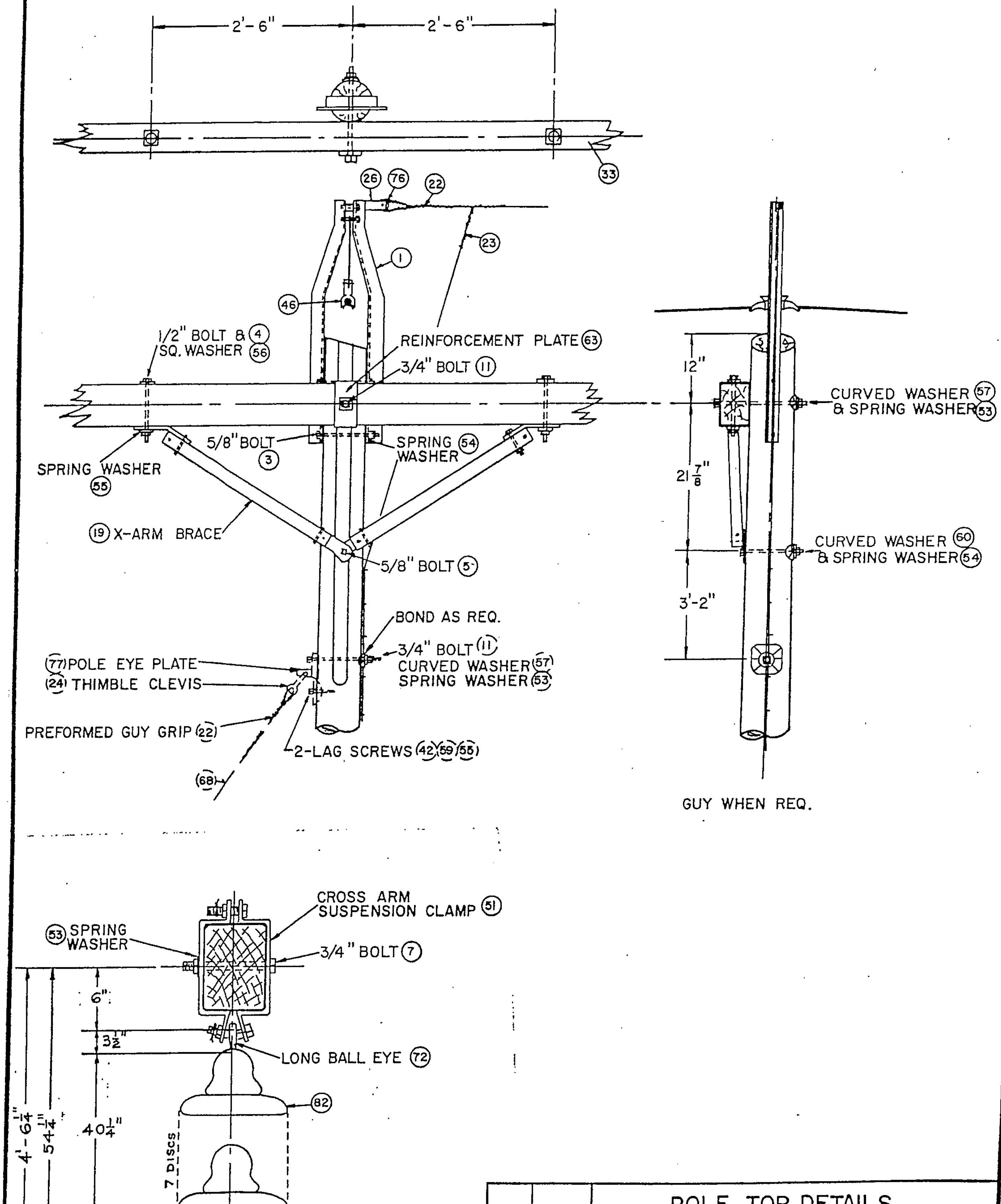
NOTE:
TYPICAL CRUSHED ROCK BACKFILL.

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.

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



		POLE TOP DETAILS TYPE "A" STRUCTURES 115KV CONSTRUCTION		
		VERMONT ELECTRIC POWER COMPANY, INC.		
3/1/77	JP	DRAWN BY JM	CHECKED BY	DATE 2/28/72
DATE	C'H'K BY	SCALE NONE	APPROVED BY	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	DN14G1
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
		When Required		
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 metalic(used if pole cut off in the field)	Joslyn	J 2108
		Side Guys - When Required		
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

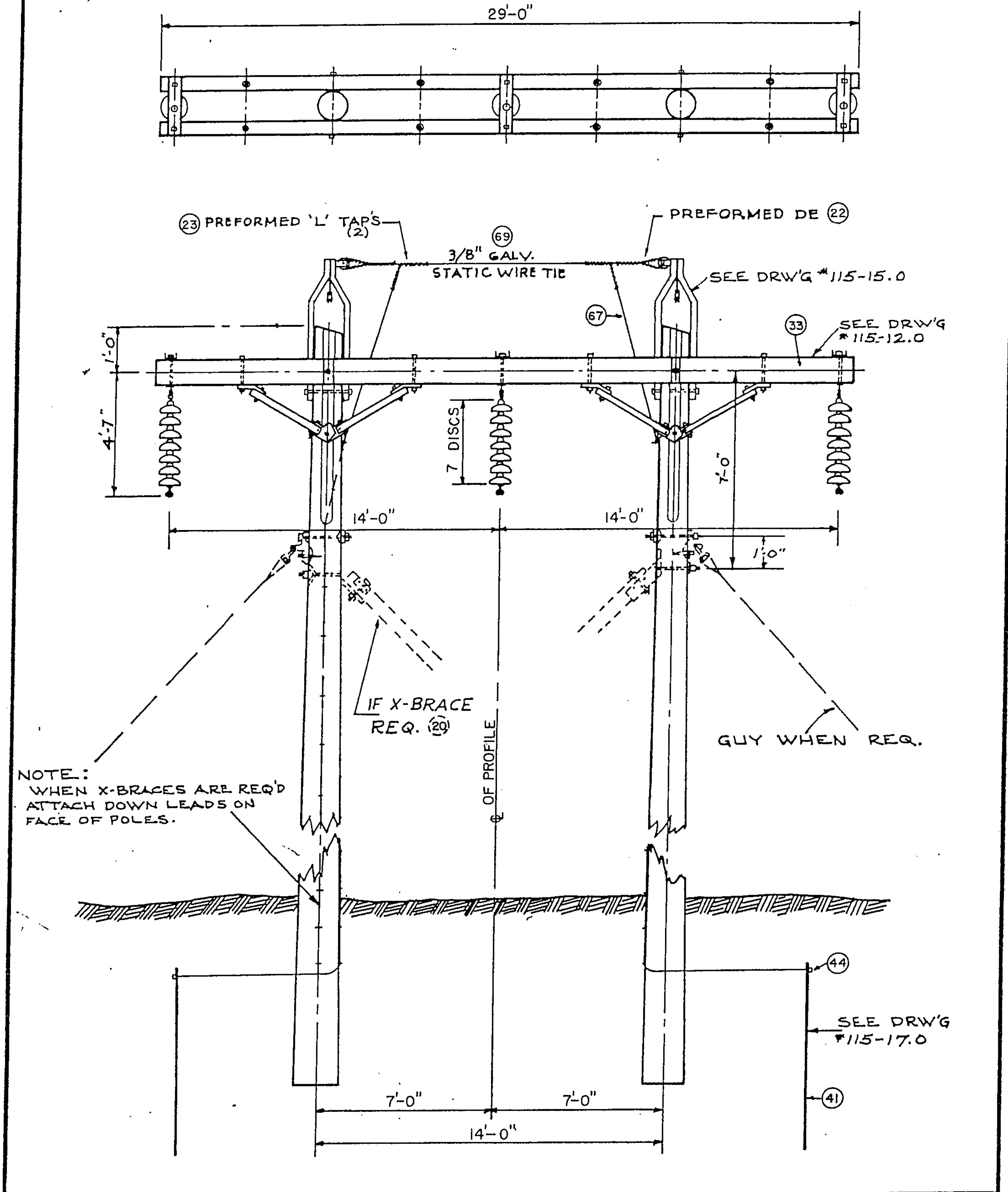
VERMONT ELECTRIC POWER COMPANY, INC.
MATERIAL FOR TYPE A-2 STRUCTURE
115 KV

Mark	Quant	Description	Manuf.	Cat. No.
68	135'	Cable, 3/8" EHS galv. steel		
77	2	Pole eye plate	Lapp MIF	304021 PX 88

Rev 2/77

4/72

FORM CV 198

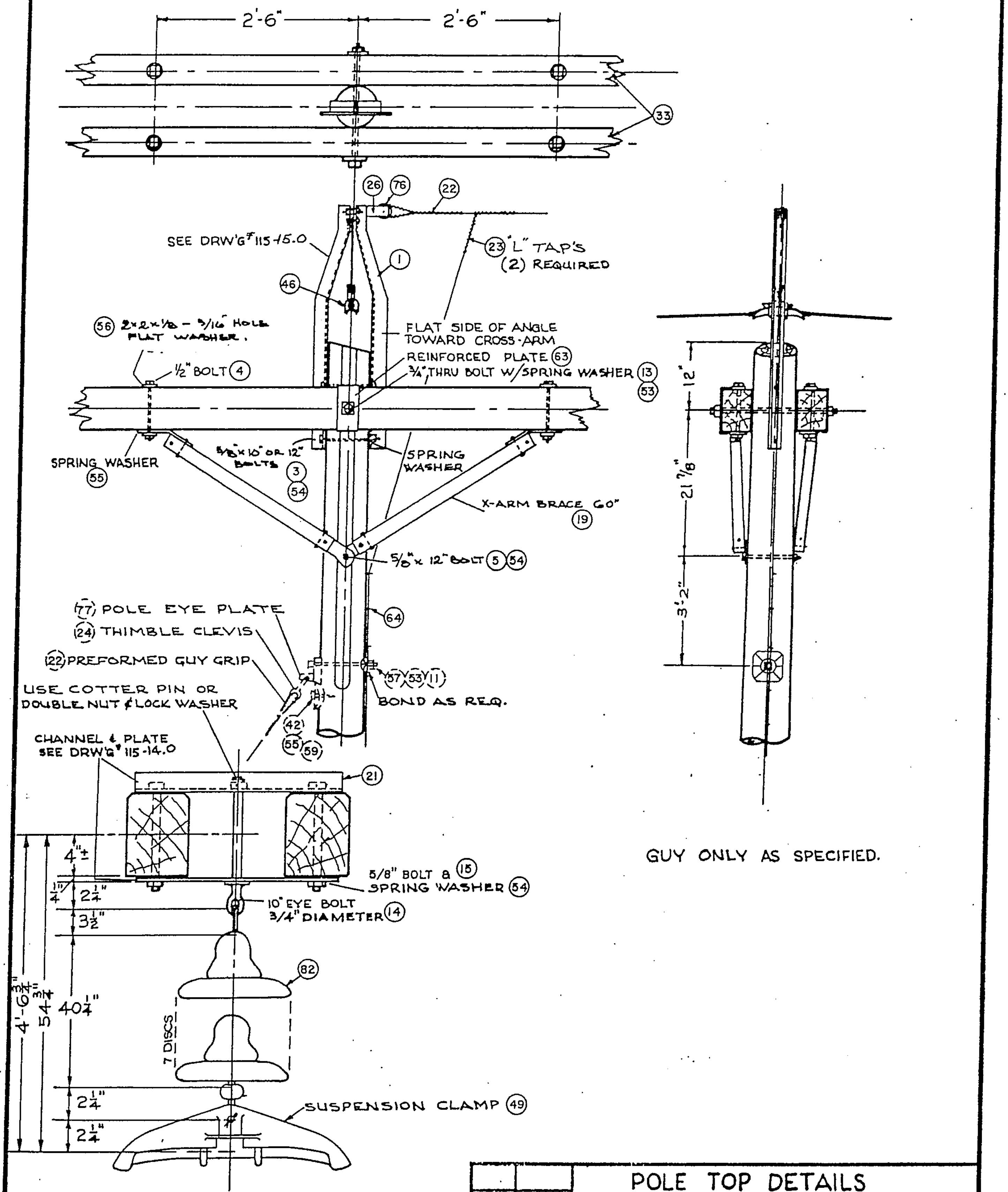


TYPE A-2
TANGENT STRUCTURE SPECIAL SPANS
115 KV CONSTRUCTION

VERMONT ELECTRIC POWER COMPANY, INC.

3/1/77		DRAWN BY JM	CHECKED BY	DATE 4/11/72
DATE	CH'K BY	SCALE NONE	APPROVED BY	DWG #115-2.0
REVISIONS				

FORM CY 198



GUY ONLY AS SPECIFIED.

TYPE A-2 DOUBLE ARM STRUCTURE INSULATOR ASSEMBLY

POLE TOP DETAILS TYPES A-2 STRUCTURES

115 KV. CONSTRUCTION

VERMONT ELECTRIC POWER COMPANY, INC.

DATE	CH'K BY	DRAWN BY	CHECKED BY	DATE
3/1/77	[illegible]	PDA		4-11-72

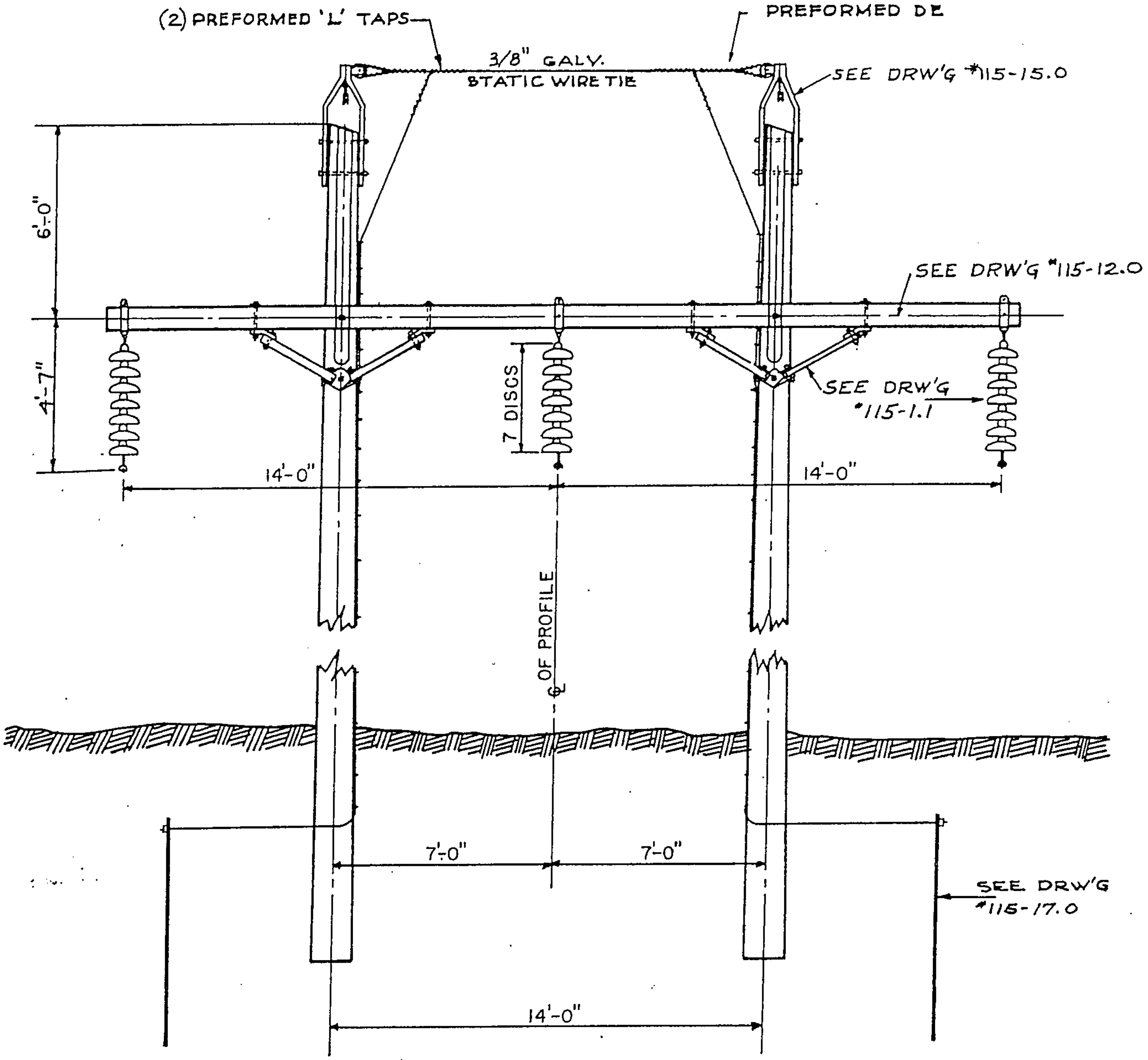
REVISIONS

SCALE: NONE

APPROVED BY

DWG #115-2.1

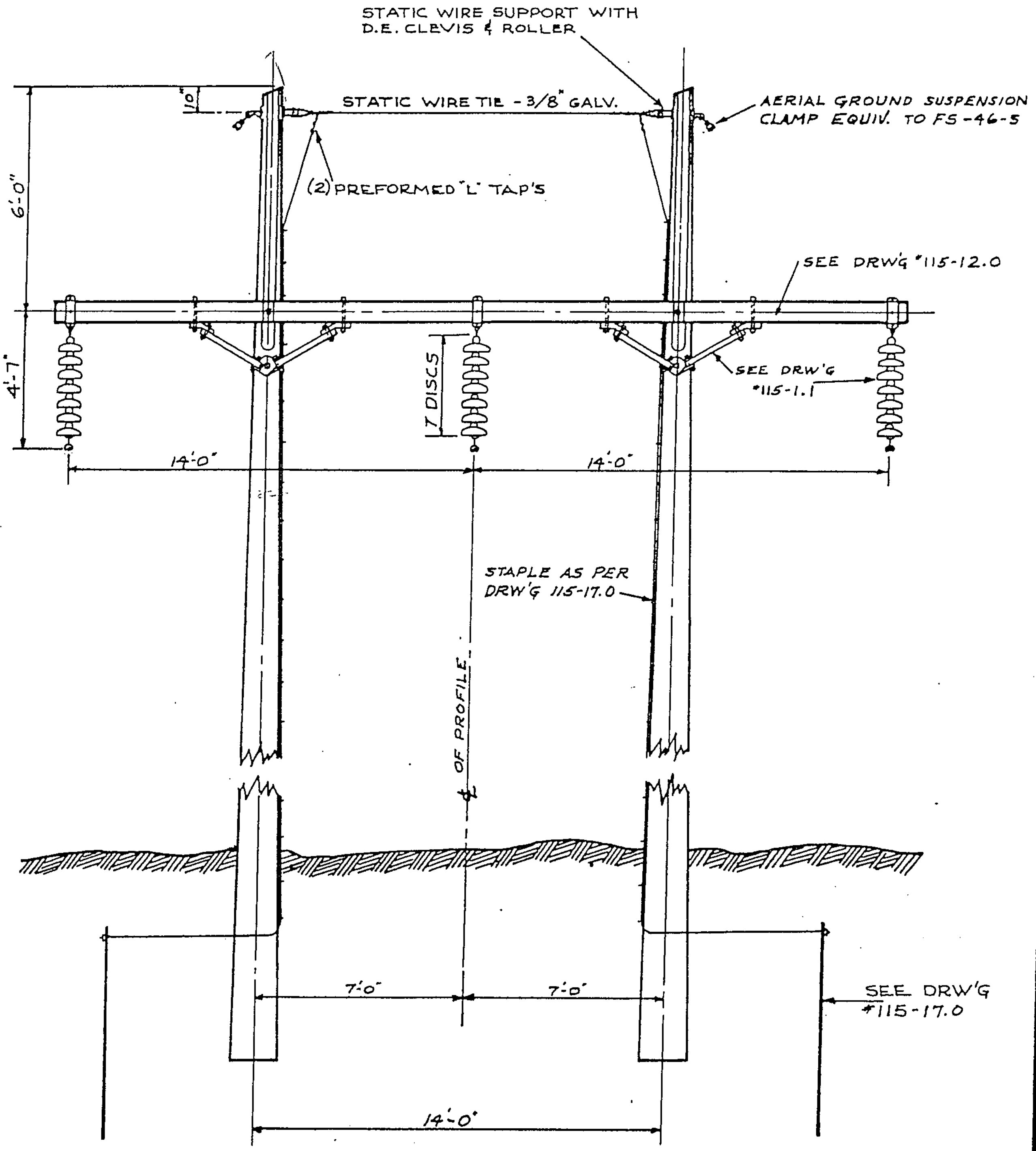
FORM CV 198



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

3/1/77		**TYPE A-3 & D-3** SPECIAL FRAMING 115 KV CONSTRUCTION
DATE	CH'K BY	VERMONT ELECTRIC POWER COMPANY, INC.
REVISIONS		DRAWN BY JM — CHECKED BY — DATE 4/17/72
		SCALE NONE — APPROVED BY — DWG #115-3.0

FORM CV 108



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

TYPE A-4 & D-4
SPECIAL FRAMING
115 KV. CONSTRUCTION

VERMONT ELECTRIC POWER COMPANY, INC.

DATE	CH'K BY
3/1/77	JP
2/13/74	

REVISIONS

DRAWN BY JM | CHECKED BY | DATE 4/17/72

SCALE NONE | APPROVED BY | DWG #115-4.0

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

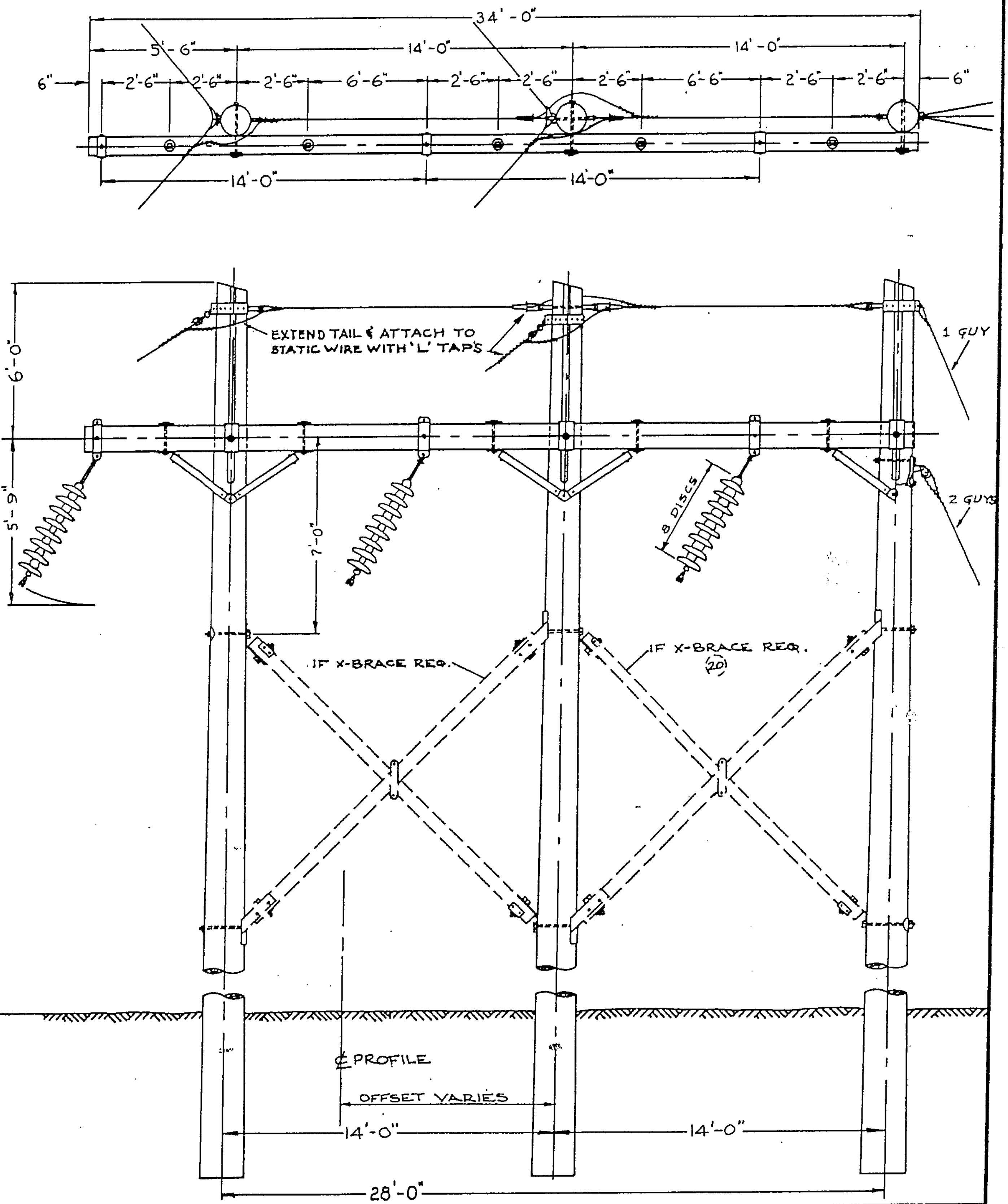
Mark	Quant	Description	Manuf.	Cat. No.
4	5	Bolts, brace 1/2" x 10"	Joslyn	J 8710
5	3	Bolts, machine 5/8" x 12" for crossarm brace	Joslyn	J 8812
6	6	Bolts, cone head	Joslyn	J 6277
7	3	Bolts, xarm clamps 3/4" x 8"	Joslyn	J 8908
9	1	Bolt, machine 3/4" x 10" pole top	Joslyn	J 8910
10	1	Bolt, machine 3/4" 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	2½Pr	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"		

Rev 6/77
Rev 2/77
Rev. 2/74

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
		When Required		
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 metalic (used if pole cut in field)	Joslyn	J 2108

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



-NOTES-

1. FOR ∠'s 0°-3° CONSIDER TYPE 'A'. (SEE DESIGN LIMITATIONS). GUYING DRW'G #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.

6/1/77	CROSSTIES PR	
3/1/77		
DATE	C'H'K BY	
REVISIONS		

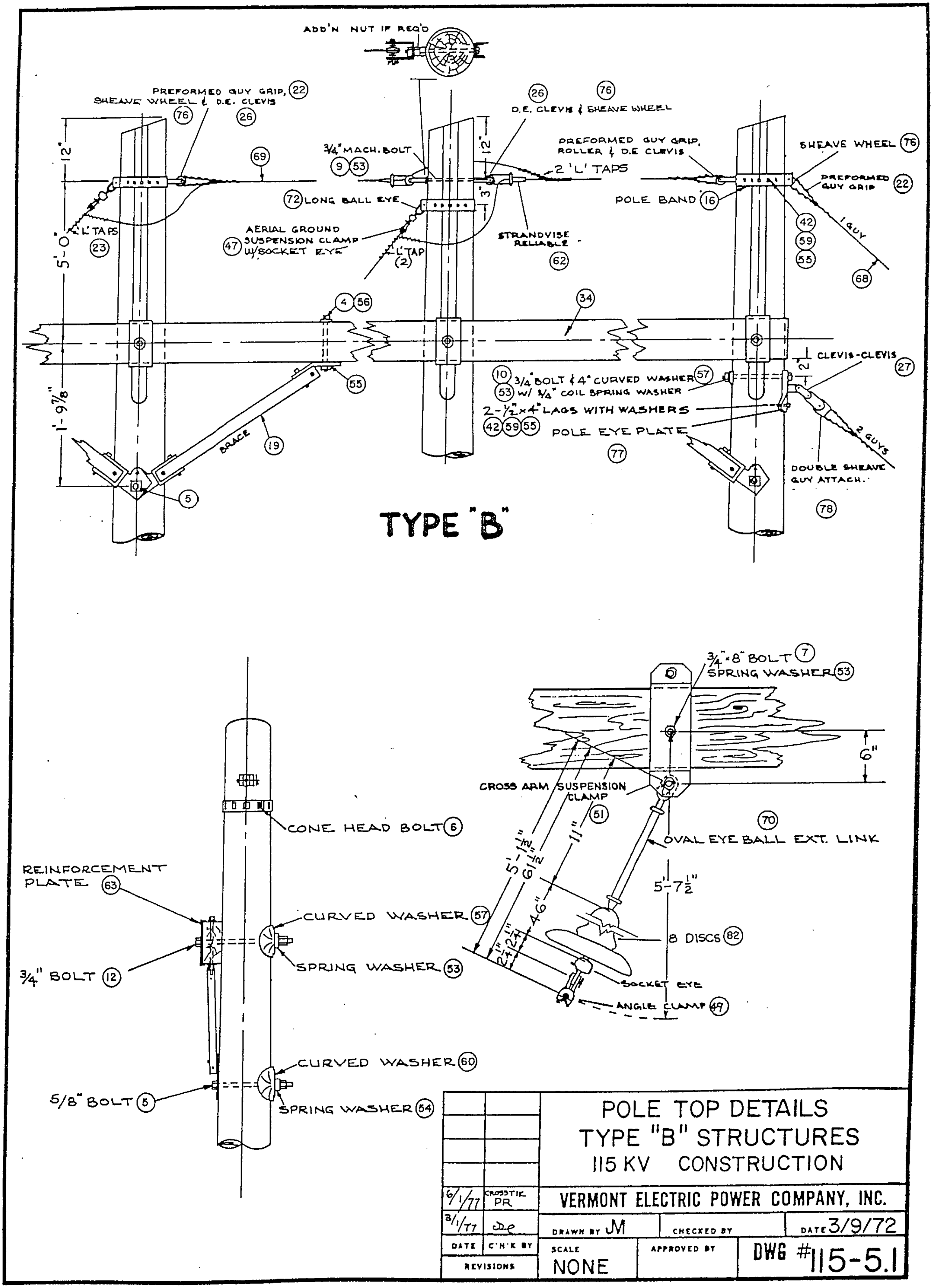
TYPE "B" STRUCTURE FOR ANGLES TO 10°

115 KV. CONSTRUCTION

VERMONT ELECTRIC POWER COMPANY, INC.

DRAWN BY P.D.A. CHECKED BY DATE 4-14-72

SCALE NONE APPROVED BY DWG #115-5.0



Boston Blue Print Co.-100-8-57-8½ x 11

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	DN14G1
45	1	Clamp, guy ground	Joslyn	J 1050

Rev 1/78
Rev 6/7-
rev 2/77

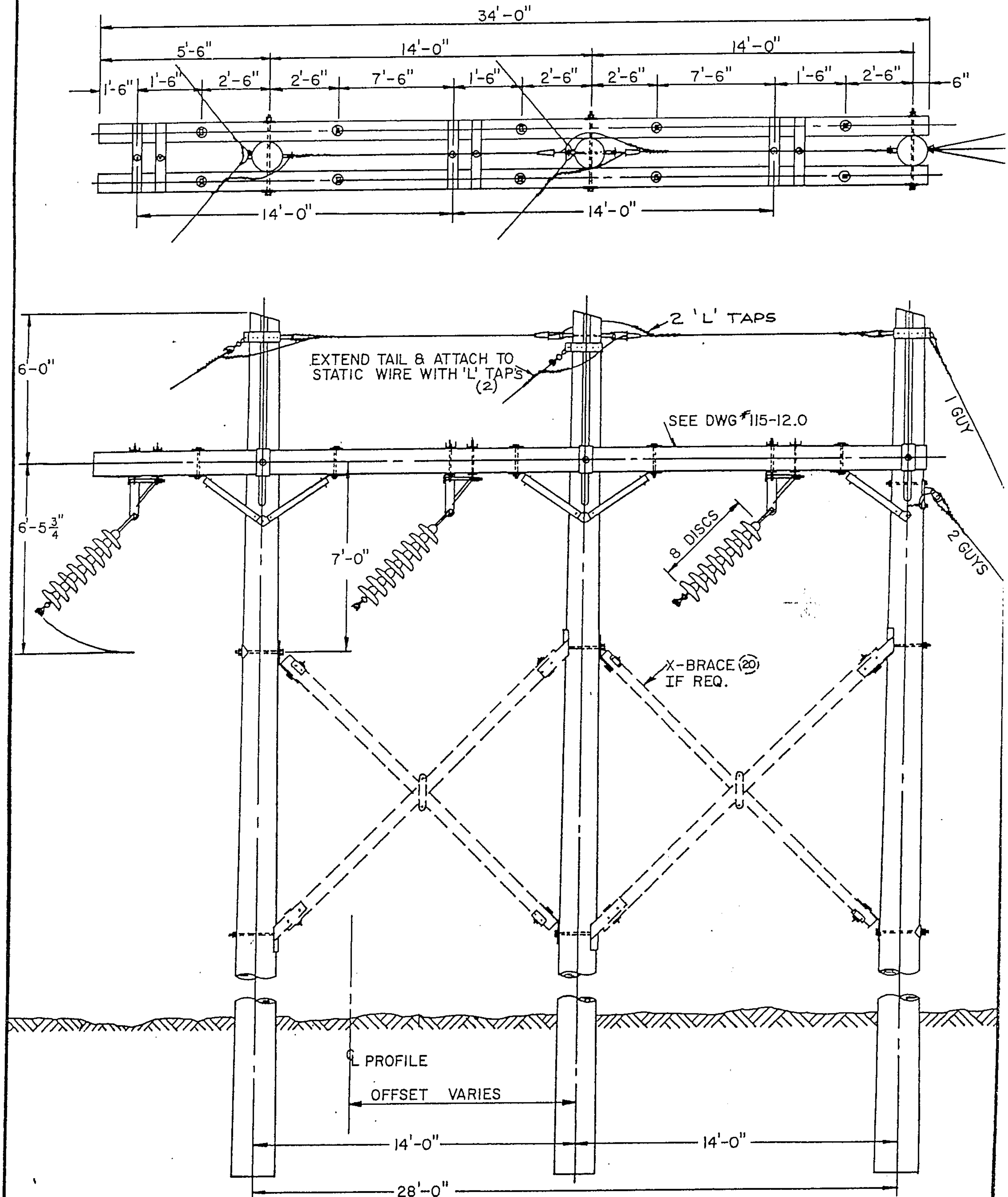
Rev. 2/74

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 cond)	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 metalic (used if pole cut in field)	Joslyn	J 2108

Rev. 1/78
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.

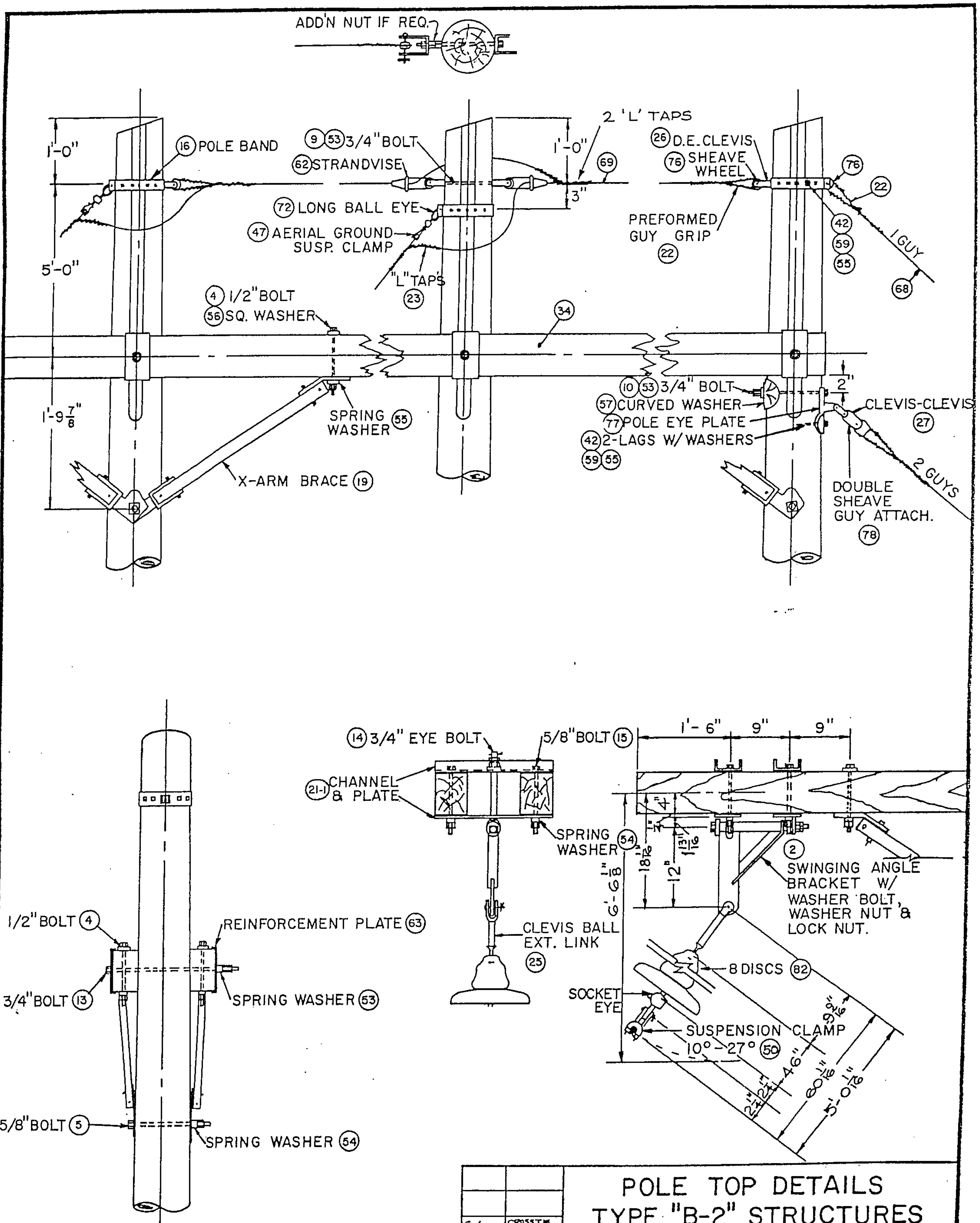
6/1/77	CROSSTIE PR
3/1/77	[illegible]
2/13/74	* BKT. #2 LOCATION
DATE	CH'K BY
REVISIONS	

TYPE "B-2" STRUCTURE FOR ANGLES 10° - 27° 115 KV CONSTRUCTION

VERMONT ELECTRIC POWER COMPANY, INC.

DRAWN BY JM | CHECKED BY | DATE 3/21/72

SCALE NONE | APPROVED BY | DWG #115-6.0



POLE TOP DETAILS
TYPE "B-2" STRUCTURES
115 KV CONSTRUCTION

DATE	C'H'K BY
6/1/77	CROSSTIE PR
3/1/77	DC
2/25/74	CHANNEL & PLATES
2/13/74	BKT. #2 LOCATION

REVISIONS

VERMONT ELECTRIC POWER COMPANY, INC.

DRAWN BY JM	CHECKED BY	DATE 3-15-72
SCALE NONE	APPROVED BY	DWG # 115-6.1

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	DN14G1
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"		

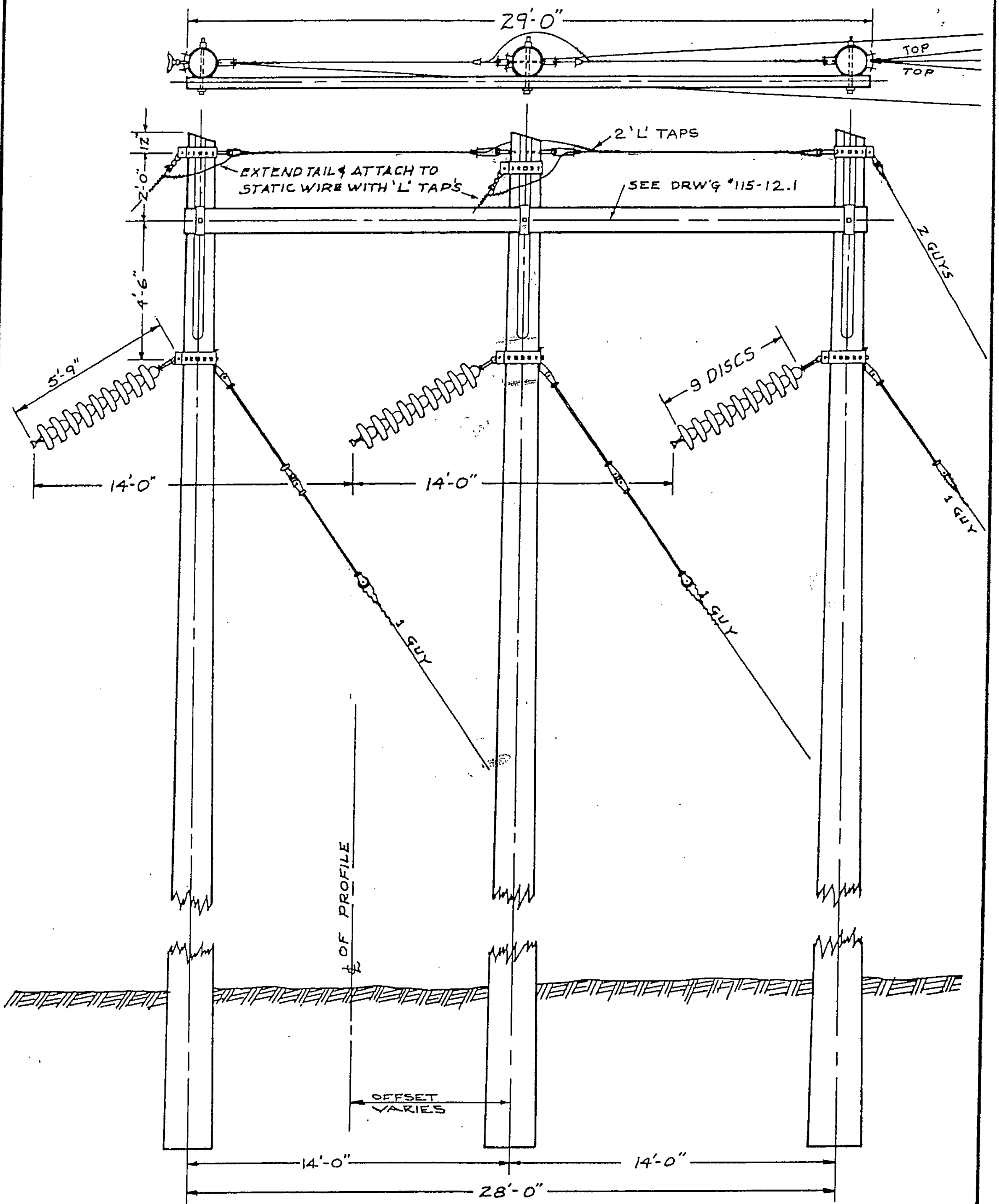
Rev 6/77
Rev 2/77

Rev. 2/74

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	Joslyn	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-metalic (used if pole cut off in field)	Joslyn	J 2108

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



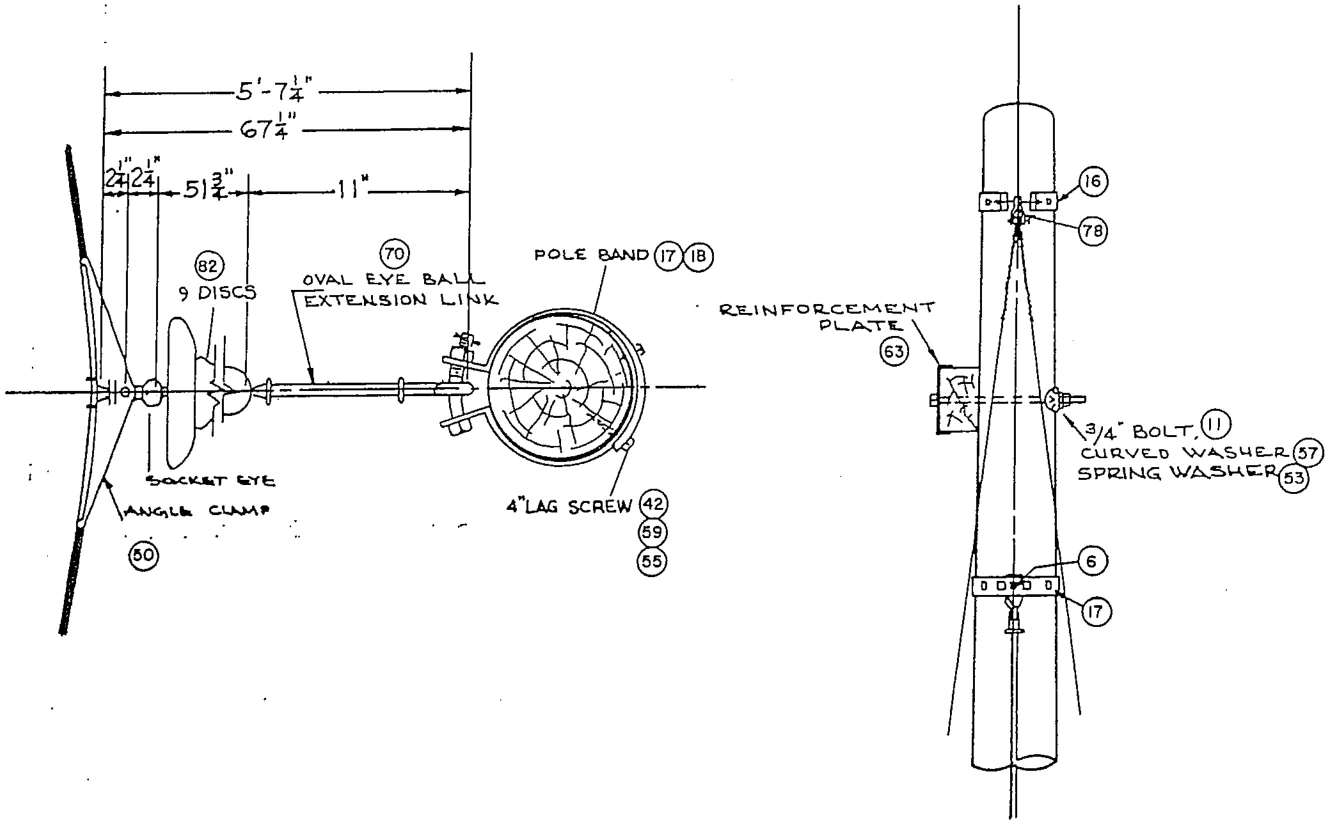
NOTE:
1. POLE BANDS TO BE TIGHT AND LAGGED WITH 2 LAGS, ROUND WASHERS & SPRING WASHERS.
2. CONE HEAD BOLTS NOT UNDER TENSION TO BE SECURED WITH LOCKNUT.

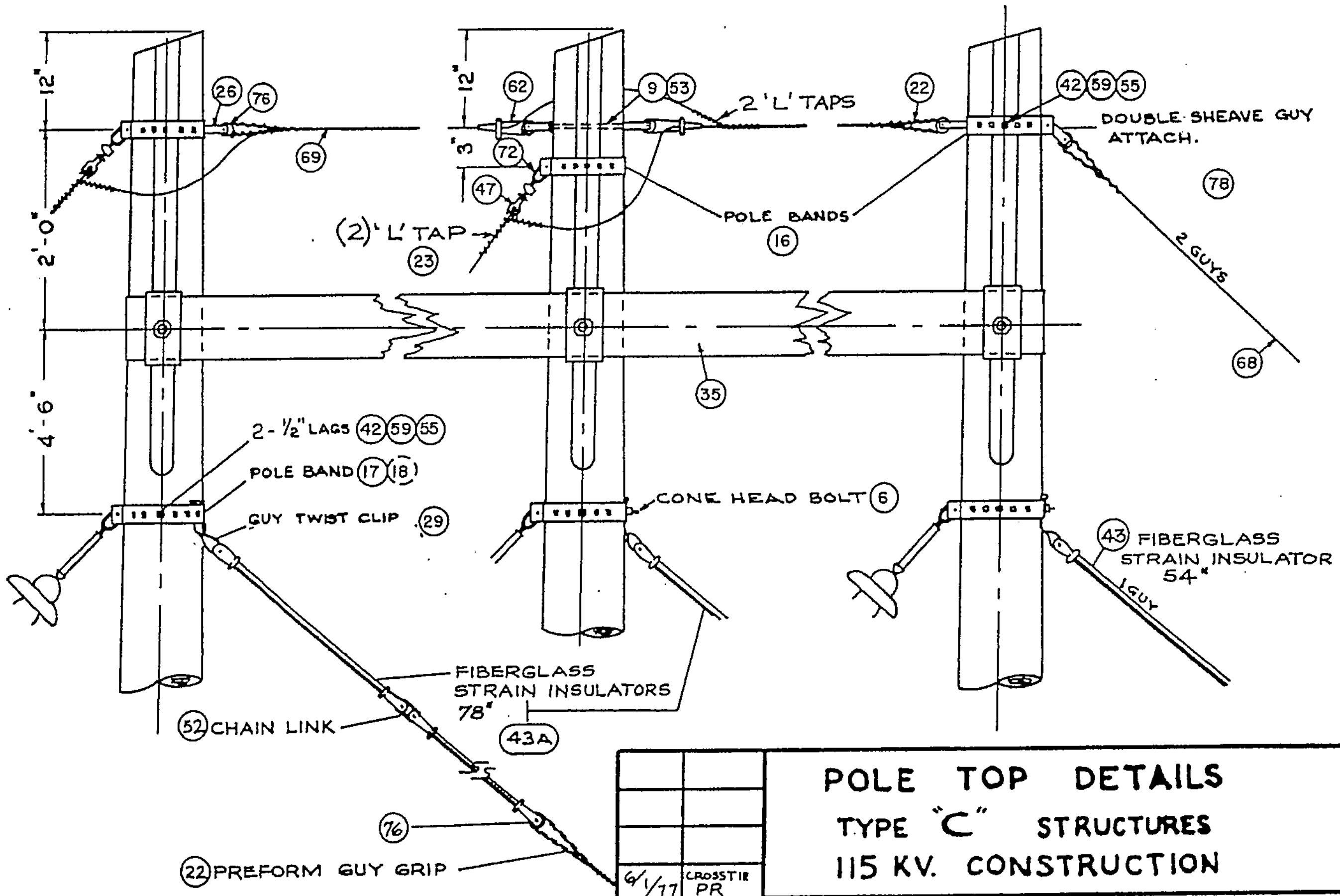
8/1/77	CROSS TIE PR	
8/1/77	JP	
DATE	2/13/74	

TYPE-C STRUCTURE
ANGLES 27° TO 50°
115 KV CONSTRUCTION

VERMONT ELECTRIC POWER COMPANY, INC.

DRAWN BY JM		DATE 4/7/72
SCALE NONE		DWG # 115-7.0





		POLE TOP DETAILS TYPE "C" STRUCTURES 115 KV. CONSTRUCTION
6/1/77	CROSSTIE PR	
3/1/77	2e	VERMONT ELECTRIC POWER COMPANY, INC.
2/13/74	FIBER-GLASS INSULATOR	DRAWN BY P.D.A. CHECKED BY DATE 4/7/72
DATE	CH'K BY	SCALE NONE APPROVED BY DWG #115-71

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 2½" 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"		

Rev 2/77
Rev. 2/74

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
		When Required		
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
		Line Guys - When Required		
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

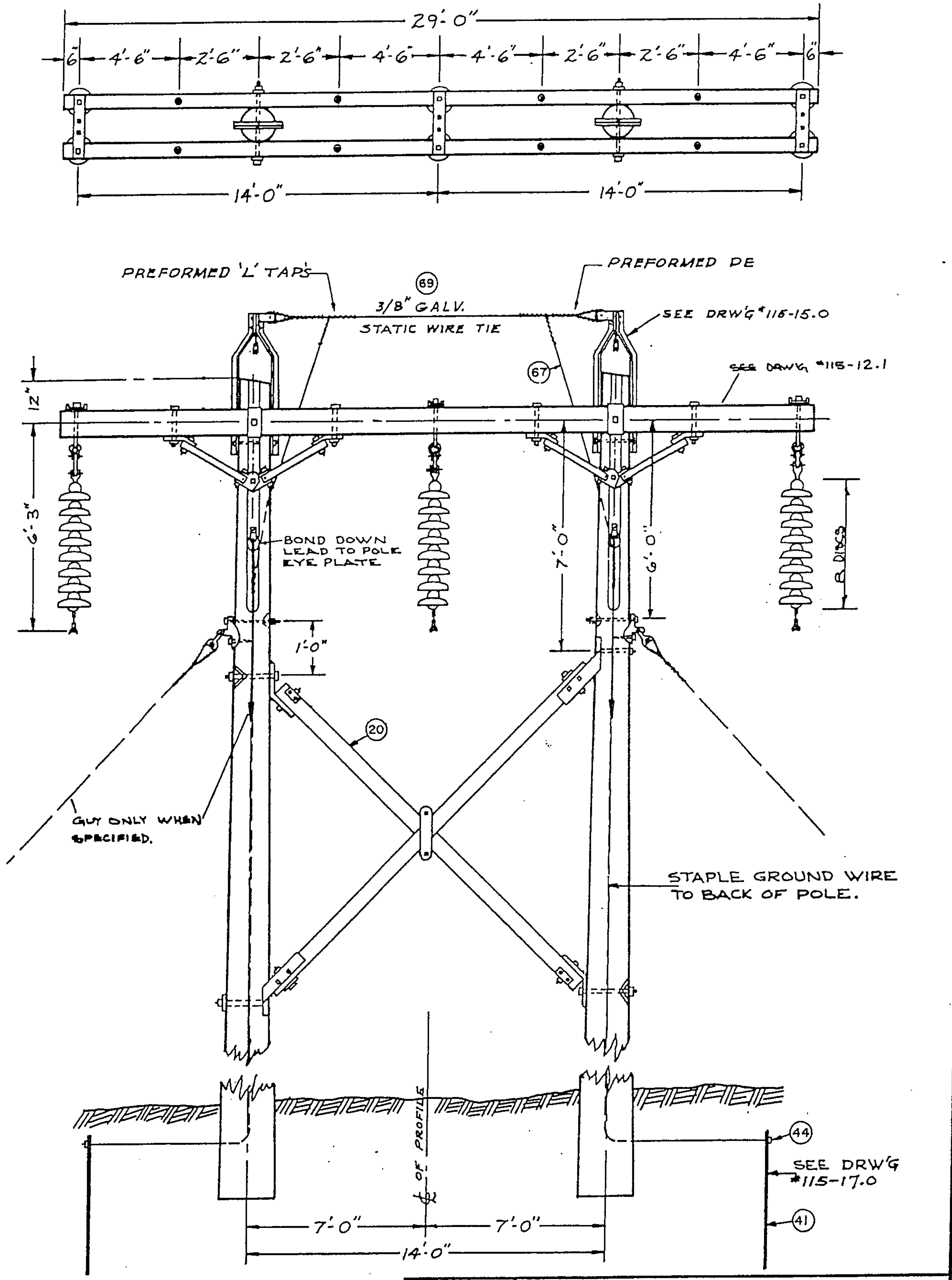
Rev 1/78
Rev 2/77
Rev. 2/74

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
		Side Guys - When Required Refer to Side Guy Materials for Type "A"		

Rev 2/77

4/72



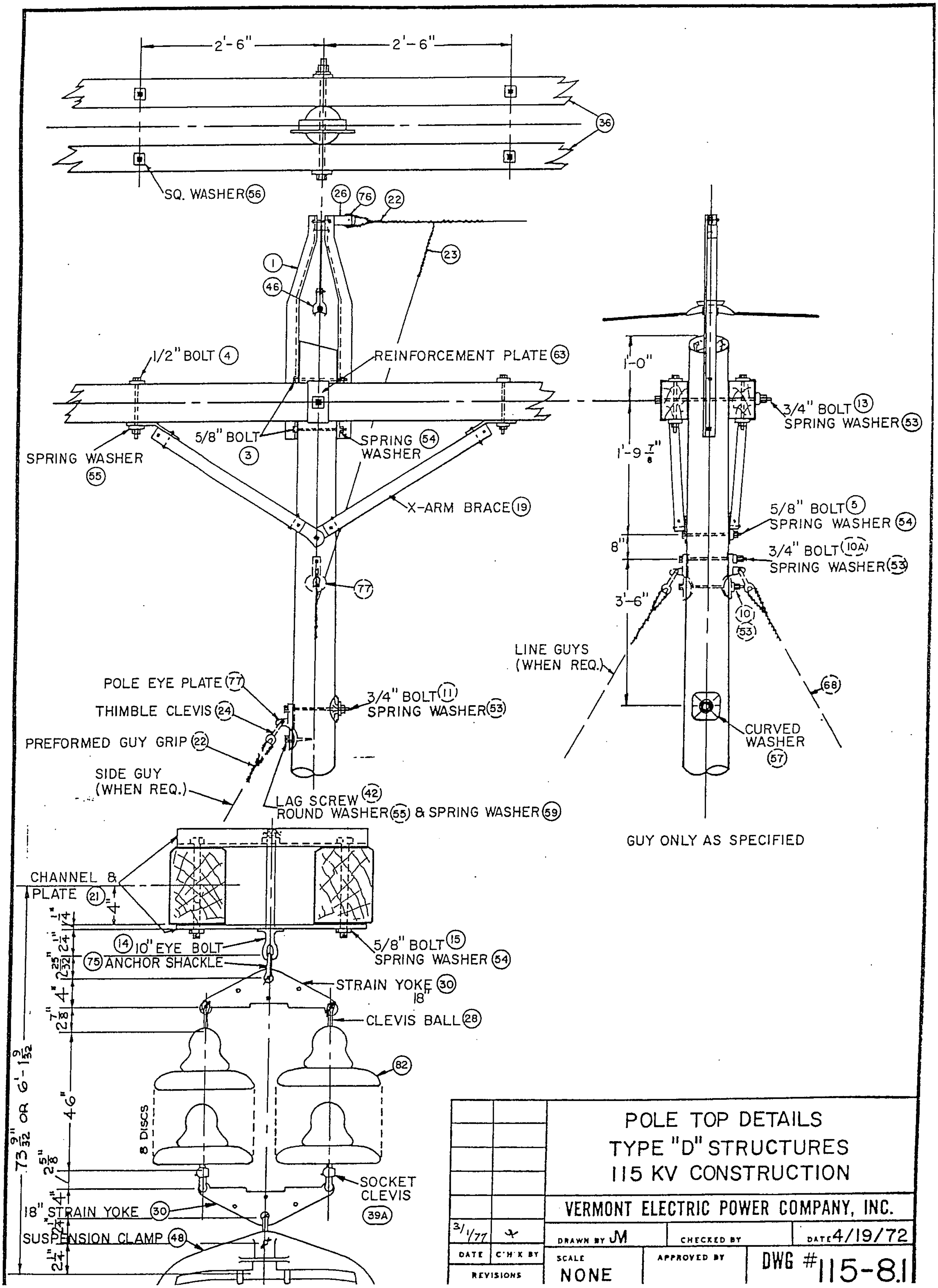
TYPE – D

HWY & RAILROAD X-INGS
115 KV CONSTRUCTION

VERMONT ELECTRIC POWER COMPANY, INC.

3/1/77 — DRAWN BY JM — DATE 4/19/72

DATE — REVISIONS — SCALE NONE — DWG# 115-8.0



POLE TOP DETAILS
TYPE "D" STRUCTURES
115 KV CONSTRUCTION

VERMONT ELECTRIC POWER COMPANY, INC.

3/1/77	[illegible]	DRAWN BY JM	CHECKED BY	DATE 4/19/72
DATE	CH'K BY	SCALE NONE	APPROVED BY	DWG # 115-8.1
REVISIONS				

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	GSI-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

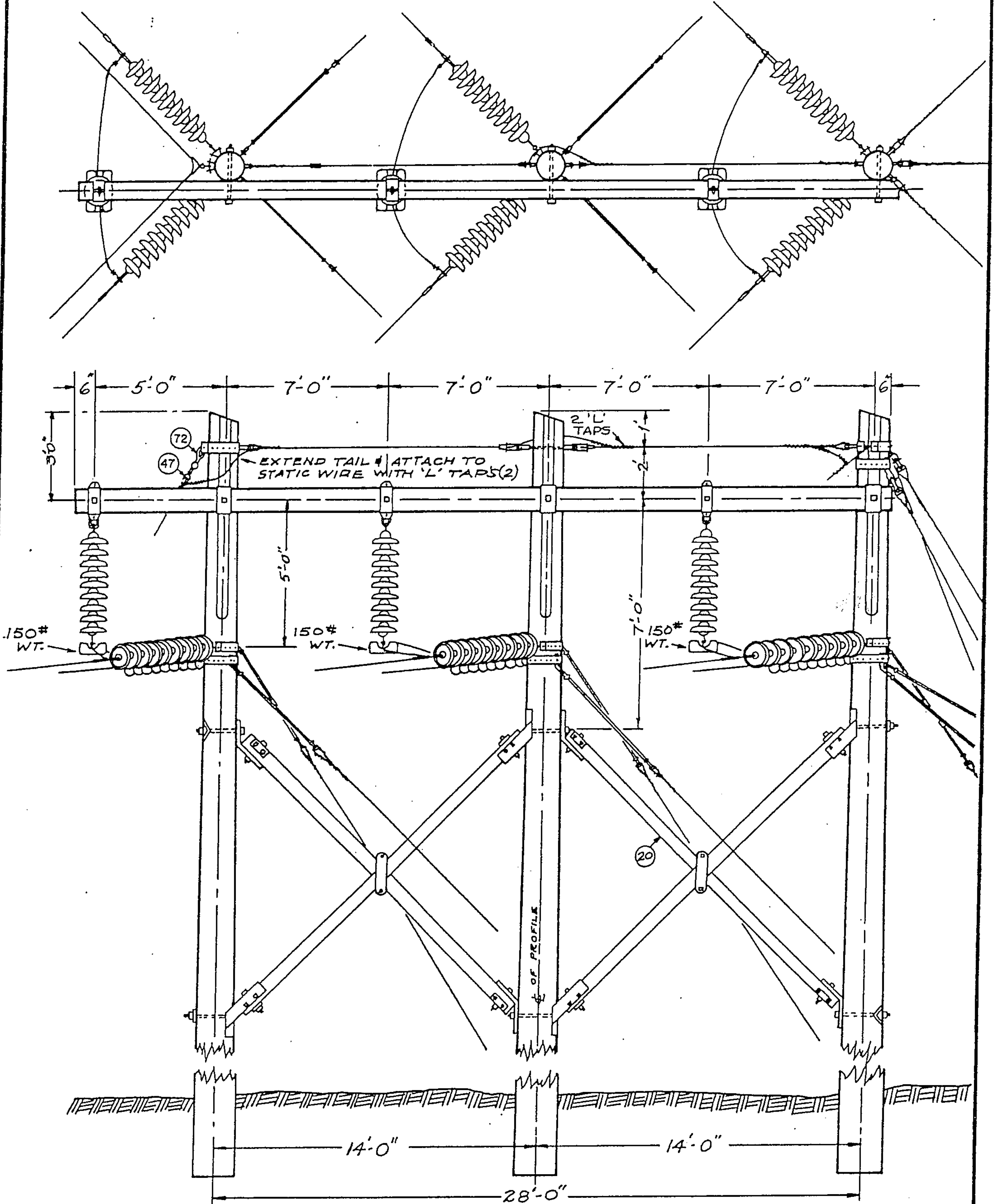
Rev 6/77
Rev 2/77

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	Strandvise 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
		When Required		
79		Pole roof, non-metalic (used if pole cut in field)	Joslyn	J 2108
		S.W. DE guys under 50°		
40	2	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

Rev. 1/78
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

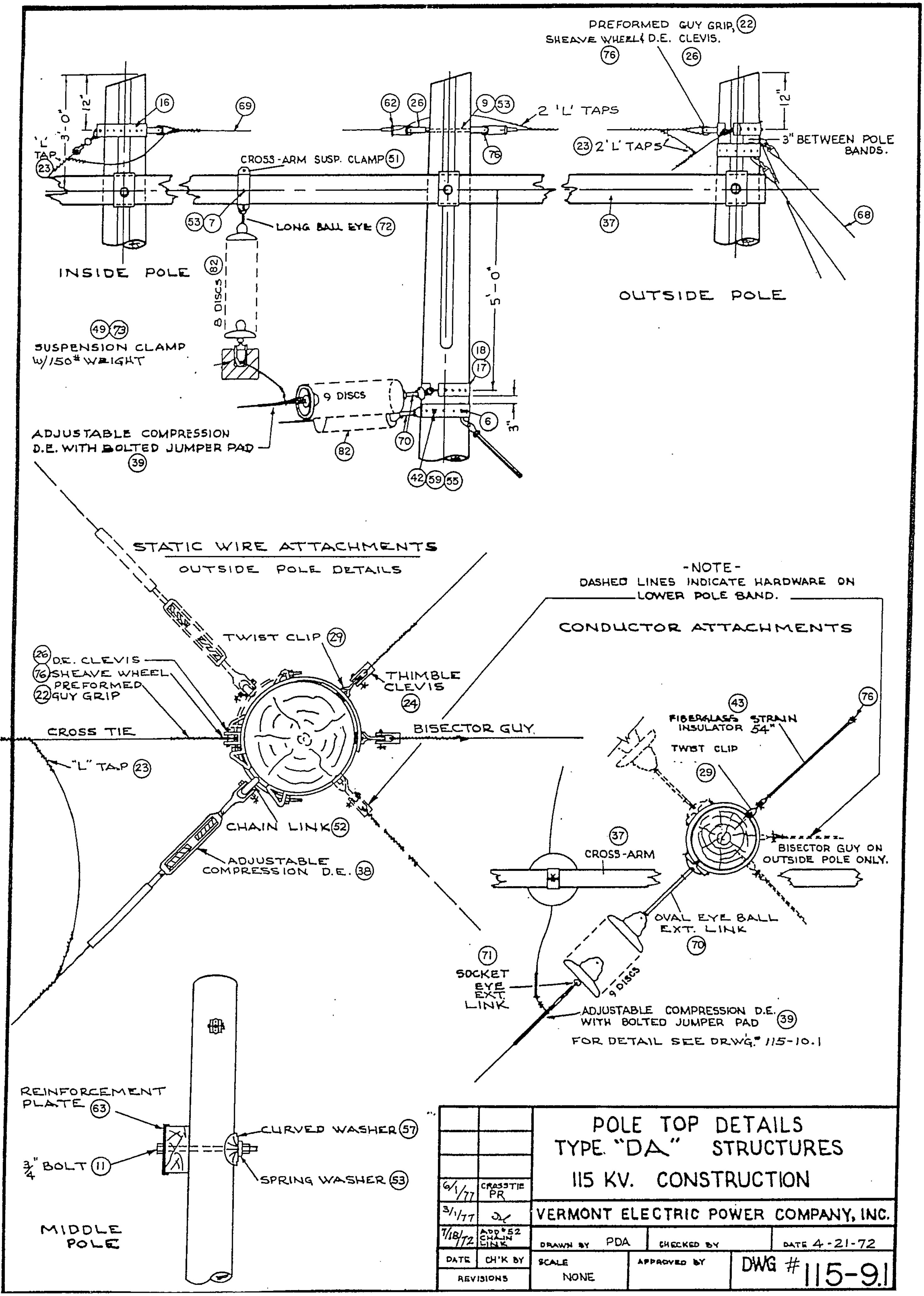
DATE	CHK'D BY	
9/1/77	CROSSTIE PR	
3/1/77	[illegible]	
REVISIONS		

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

VERMONT ELECTRIC POWER COMPANY, INC.

DRAWN BY	CHECKED BY	DATE
JM		4/20/72

SCALE	APPROVED BY	DWG #
NONE		115-9.0


PREFORMED GUY GRIP (22)
SHEAVE WHEEL & D.E. CLEVIS.
(76) (26)
(16) (69)
(62) (26) (9) (53) 2 'L' TAPS
12"
3'-0"
'L' TAP (23)
(76)
(23) 2 'L' TAPS
3" BETWEEN POLE BANDS.
CROSS-ARM SUSP. CLAMP (51)
(53) (7) LONG BALL EYE (72)
(37)
(68)
INSIDE POLE
OUTSIDE POLE
8 DISCS (82)
5'-0"
(49) (73)
SUSPENSION CLAMP W/150# WEIGHT
(18) (17)
9 DISCS
(6)
3"
ADJUSTABLE COMPRESSION D.E. WITH BOLTED JUMPER PAD (39)
(82) (70)
(42) (59) (55)
STATIC WIRE ATTACHMENTS
OUTSIDE POLE DETAILS
-NOTE-
DASHED LINES INDICATE HARDWARE ON LOWER POLE BAND.
CONDUCTOR ATTACHMENTS
TWIST CLIP (29)
THIMBLE CLEVIS (24)
(26) D.E. CLEVIS
(76) SHEAVE WHEEL
(22) PREFORMED GUY GRIP
CROSS TIE
BISECTOR GUY
"L" TAP (23)
CHAIN LINK (52)
ADJUSTABLE COMPRESSION D.E. (38)
(43)
FIBERGLASS STRAIN INSULATOR 54"
(76)
TWIST CLIP (29)
(37) CROSS-ARM
BISECTOR GUY ON OUTSIDE POLE ONLY.
OVAL EYE BALL EXT. LINK (70)
(71) SOCKET EYE EXT. LINK
9 DISCS
ADJUSTABLE COMPRESSION D.E. WITH BOLTED JUMPER PAD (39)
FOR DETAIL SEE DRWG.# 115-10.1
REINFORCEMENT PLATE (63)
¾" BOLT (11)
CURVED WASHER (57)
SPRING WASHER (53)
MIDDLE POLE
POLE TOP DETAILS
TYPE "DA" STRUCTURES
115 KV. CONSTRUCTION
VERMONT ELECTRIC POWER COMPANY, INC.
6/1/77 CROSSTIE PR
3/1/77
7/18/72 ADD #52 CHAIN LINK
DATE CH'K BY
REVISIONS
DRAWN BY PDA
CHECKED BY
DATE 4-21-72
SCALE NONE
APPROVED BY
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"		

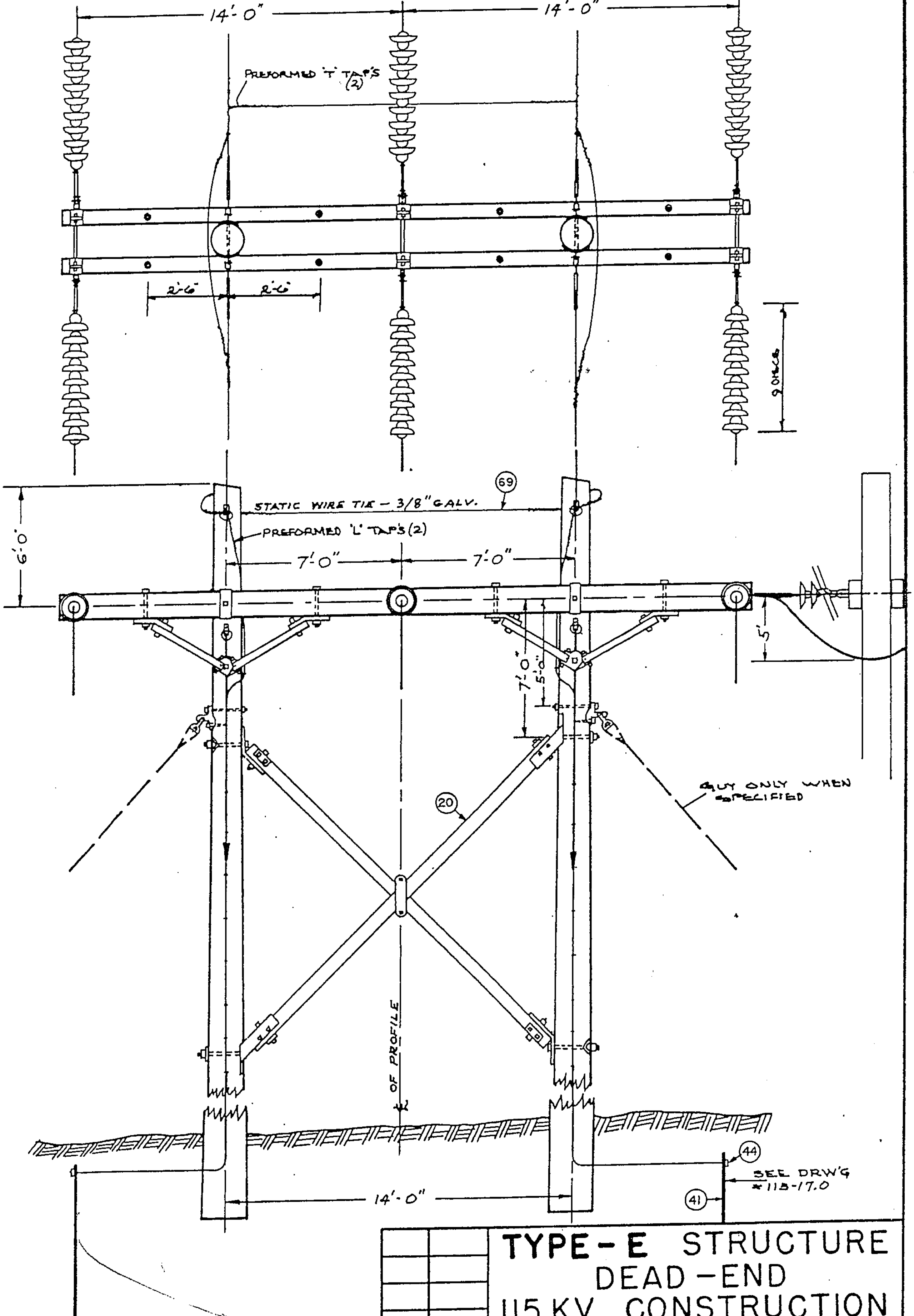
Rev 2/77

Rev. 2/74

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
		When Required		
79		Pole roof, non-metalic (used if pole cut in field)	Joslyn	J 2108
		Side Guys - When Required Refer to Side Guy Material for Type "A"		

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

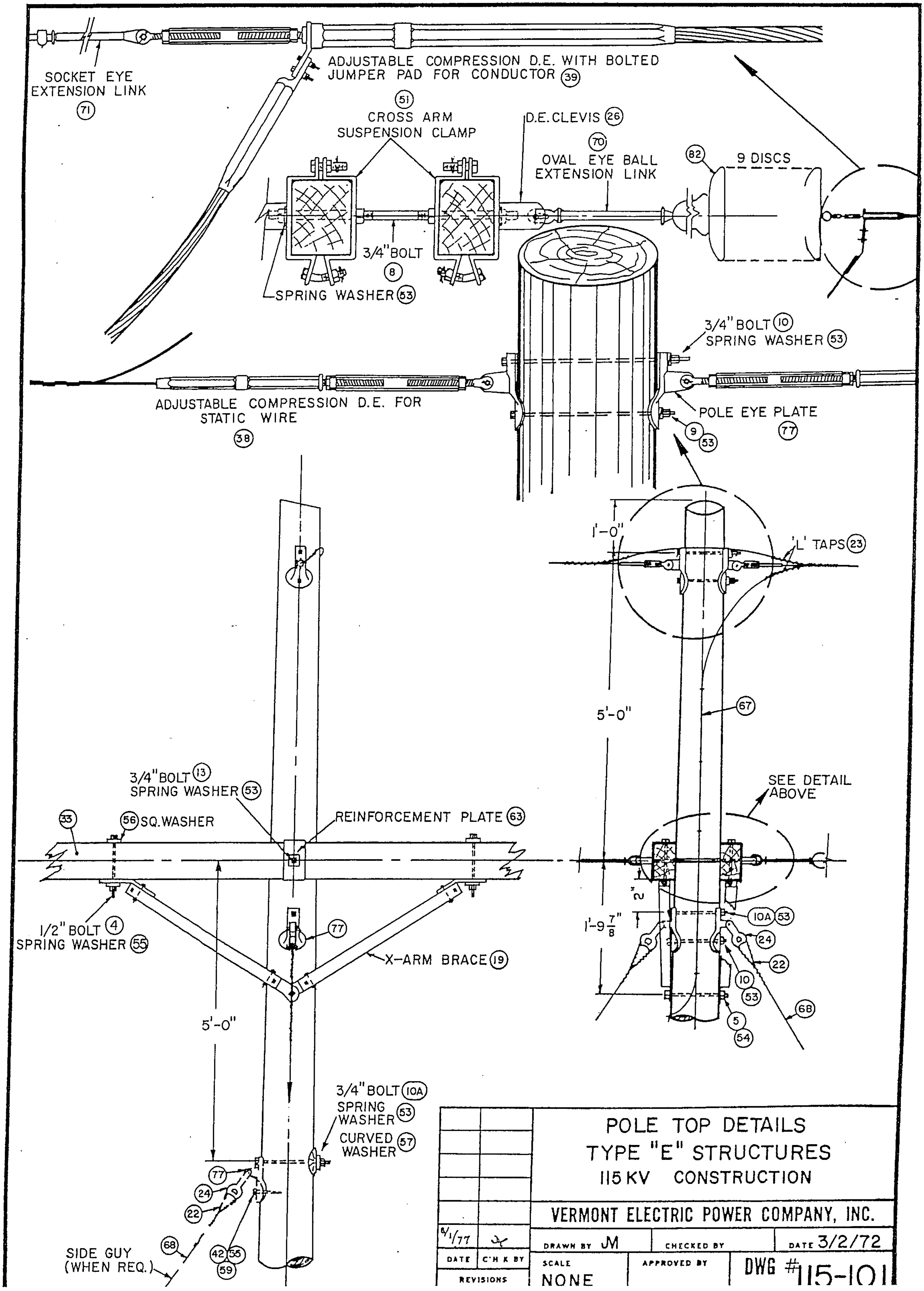


TYPE-E STRUCTURE
DEAD-END
115 KV CONSTRUCTION

VERMONT ELECTRIC POWER COMPANY, INC.

3/1/77	DRAWN BY LM	CHECKED BY	DATE 3/3/72
DATE	SCALE NONE	APPROVED BY	DWG # 115-10.0
REVISIONS			

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.



		POLE TOP DETAILS TYPE "E" STRUCTURES 115 KV CONSTRUCTION		
		VERMONT ELECTRIC POWER COMPANY, INC.		
8/1/77		DRAWN BY JM	CHECKED BY	DATE 3/2/72
DATE	CH'K BY	SCALE NONE	APPROVED BY	DWG # 115-101
REVISIONS				

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

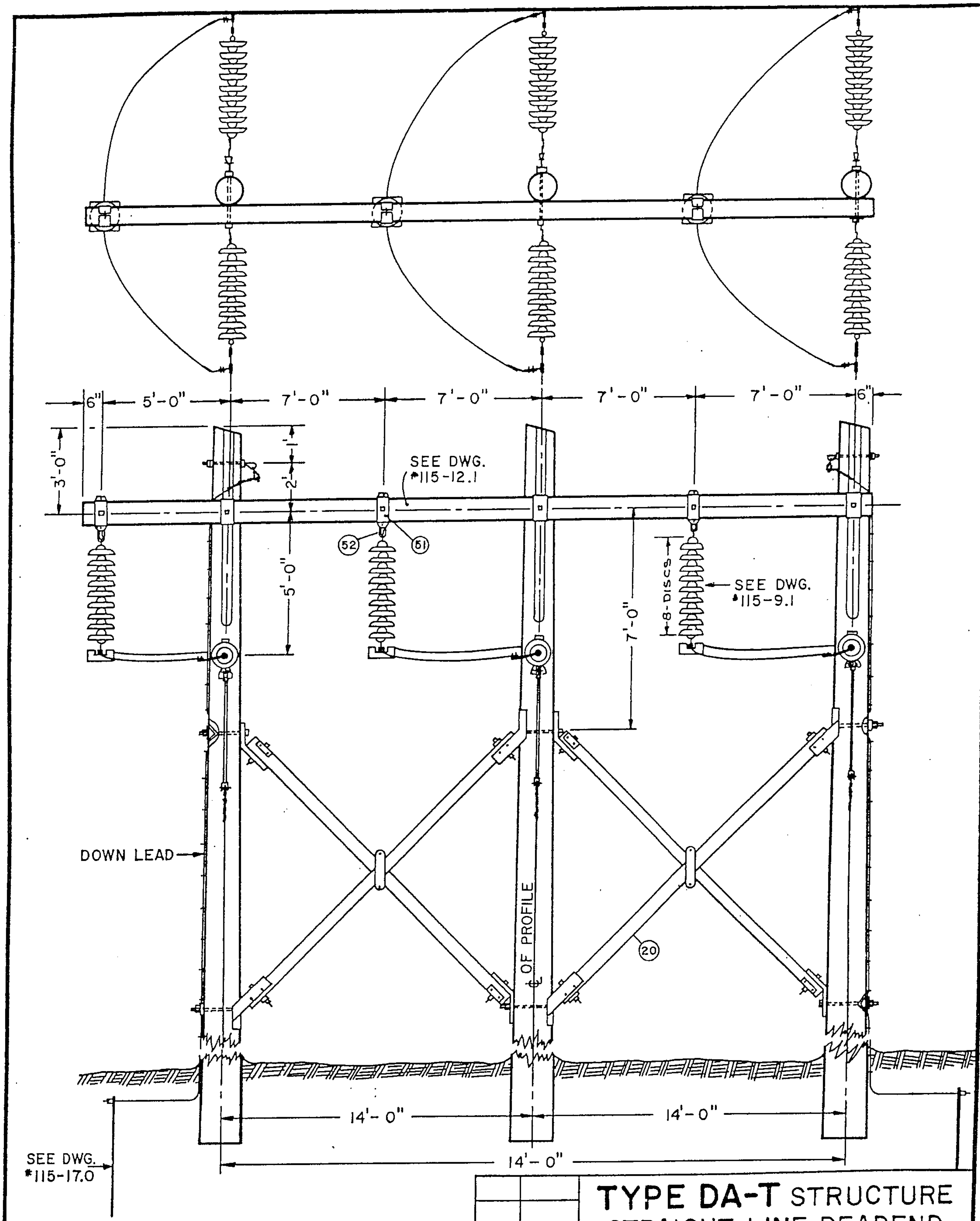
7	3	Bolts, Xarm clamp 3/4"	Joslyn	J 6277
11	3	Bolts, thru 3/4" x 16"	Joslyn	J 8916
13A	6	Bolts, thru 7/8" x 16" 14" 12"	Joslyn	J 9064
14A	2	Static wire support	Hughes	2854
20	2	Xbrace w/mounting hardware	Hughes	1042X
22A	12	Preformed guy grips deadend 1/2"	Preformed	BG 2-115
23	4	Preformed 'L' tap	Preformed	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	P144-B
57	3	Washer, curved 4" x 4" x 1/4" w/13/16" hole	MIF	P144
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
		When Required		
79		Pole Roof - non-metalic (used if pole cut in field)	Joslyn	J 2108

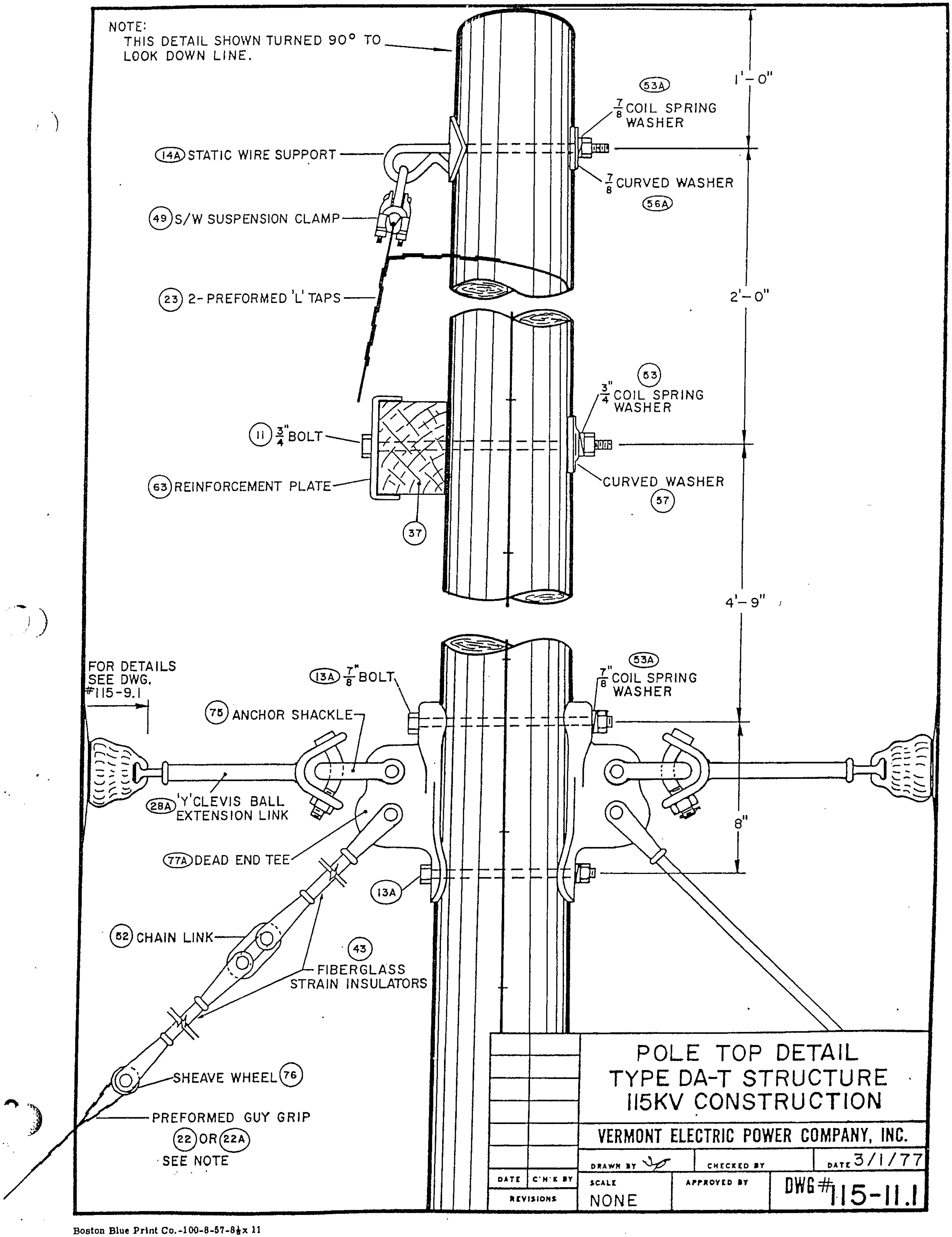


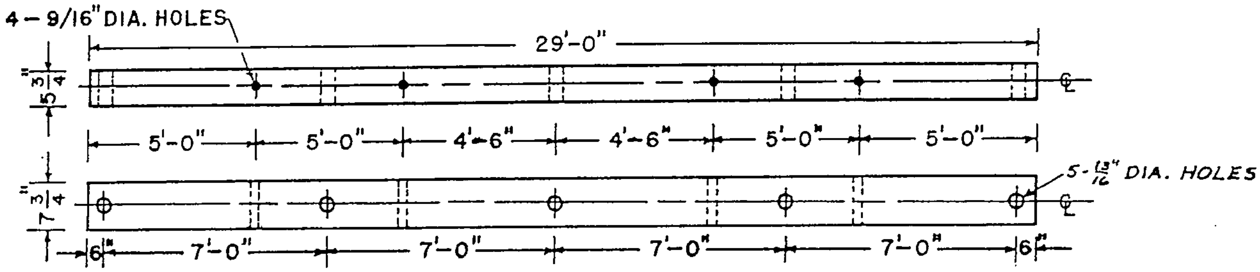
TYPE DA-T STRUCTURE
STRAIGHT LINE DEADEND
115KV CONSTRUCTION

VERMONT ELECTRIC POWER COMPANY, INC.

DRAWN BY	CHECKED BY	DATE 3/1/77
SCALE NONE	APPROVED BY	DWG #115-11.0

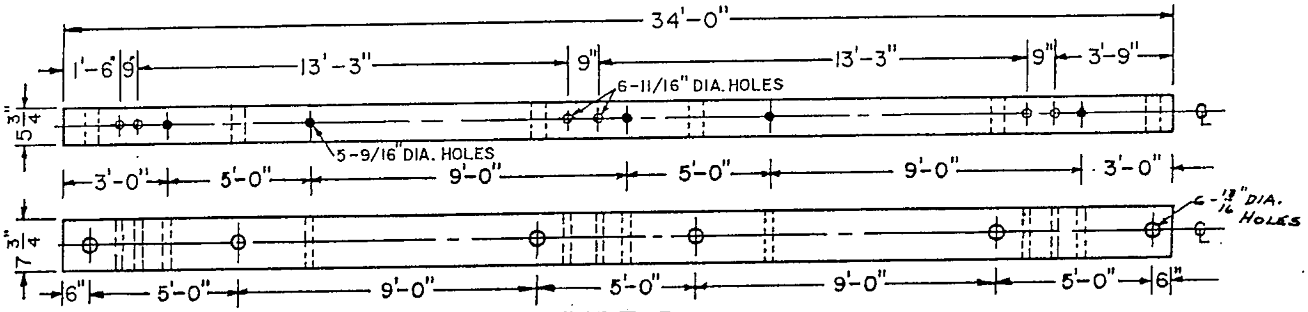
DATE	C'H'K BY
REVISIONS	


NOTE:
THIS DETAIL SHOWN TURNED 90° TO LOOK DOWN LINE.
1'-0"
2'-0"
4'-9"
8"
53A
7/8 COIL SPRING WASHER
14A STATIC WIRE SUPPORT
7/8 CURVED WASHER
56A
49 S/W SUSPENSION CLAMP
23 2-PREFORMED 'L' TAPS
53
3/4" COIL SPRING WASHER
11 3/4" BOLT
63 REINFORCEMENT PLATE
CURVED WASHER
57
37
FOR DETAILS SEE DWG. #115-9.1
13A 7/8" BOLT
53A
7/8" COIL SPRING WASHER
75 ANCHOR SHACKLE
28A 'Y' CLEVIS BALL EXTENSION LINK
77A DEAD END TEE
13A
52 CHAIN LINK
43
FIBERGLASS STRAIN INSULATORS
SHEAVE WHEEL 76
PREFORMED GUY GRIP
22 OR 22A
SEE NOTE
POLE TOP DETAIL
TYPE DA-T STRUCTURE
115KV CONSTRUCTION
VERMONT ELECTRIC POWER COMPANY, INC.
DRAWN BY
CHECKED BY
DATE 3/1/77
DATE
C'H'K BY
REVISIONS
SCALE
NONE
APPROVED BY
DWG # 115-11.1



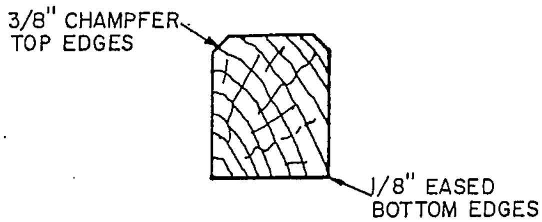
TYPE A (A & E STRUCTURE)

(33)



TYPE B (B & B-2 STRUCTURE)

(34)



DETAIL OF CROSSARMS A & B

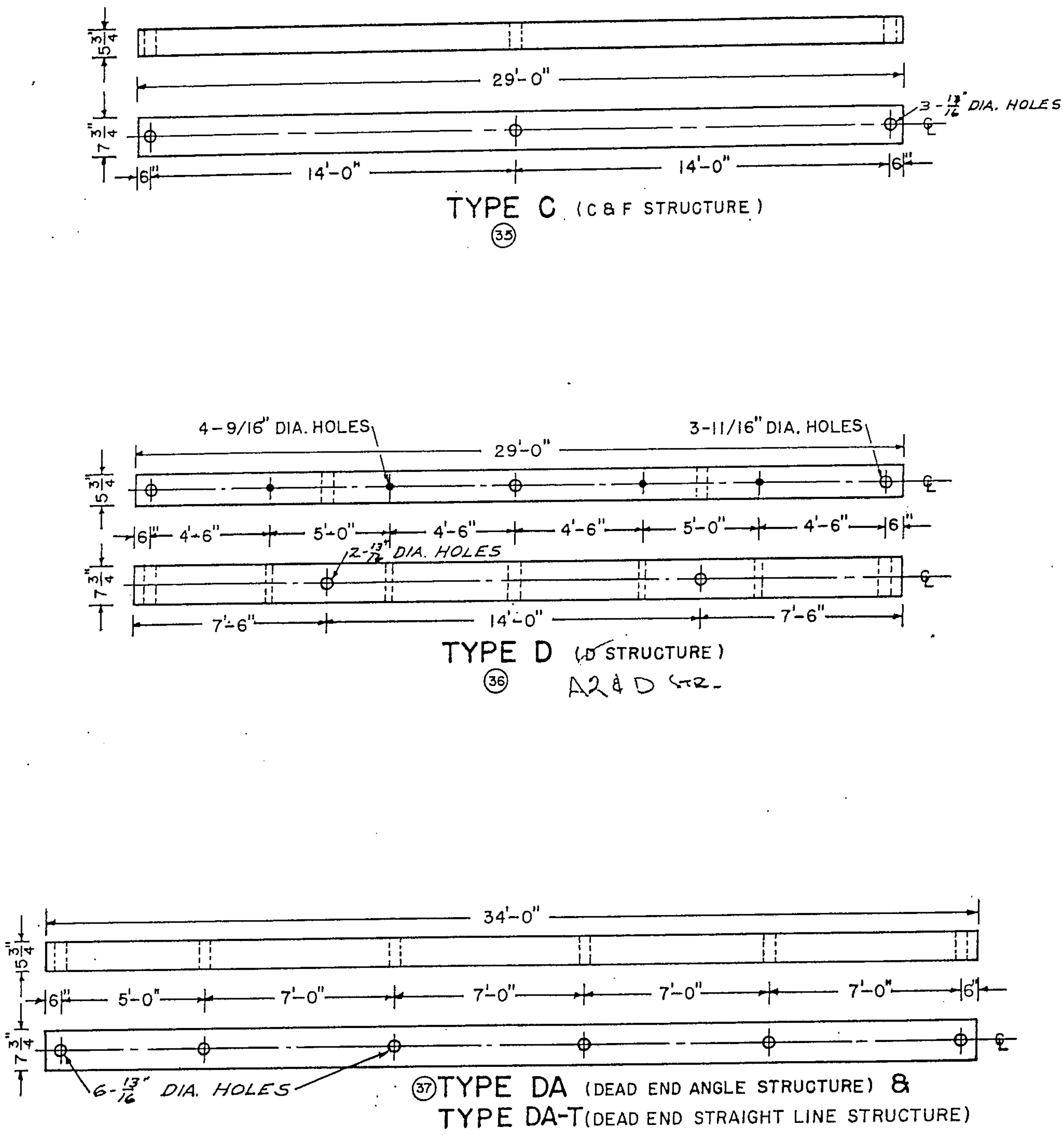
VERMONT ELECTRIC POWER COMPANY, INC.

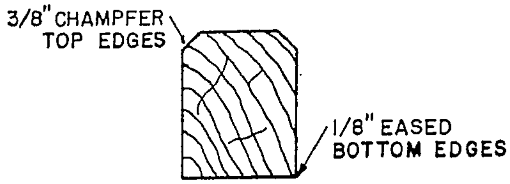
DATE	CH'K BY
3/13/74	TYPE "B-2"

REVISIONS

DRAWN BY JM | CHECKED BY | DATE 4/19/72

SCALE NONE | APPROVED BY | DWG # 115-12.0



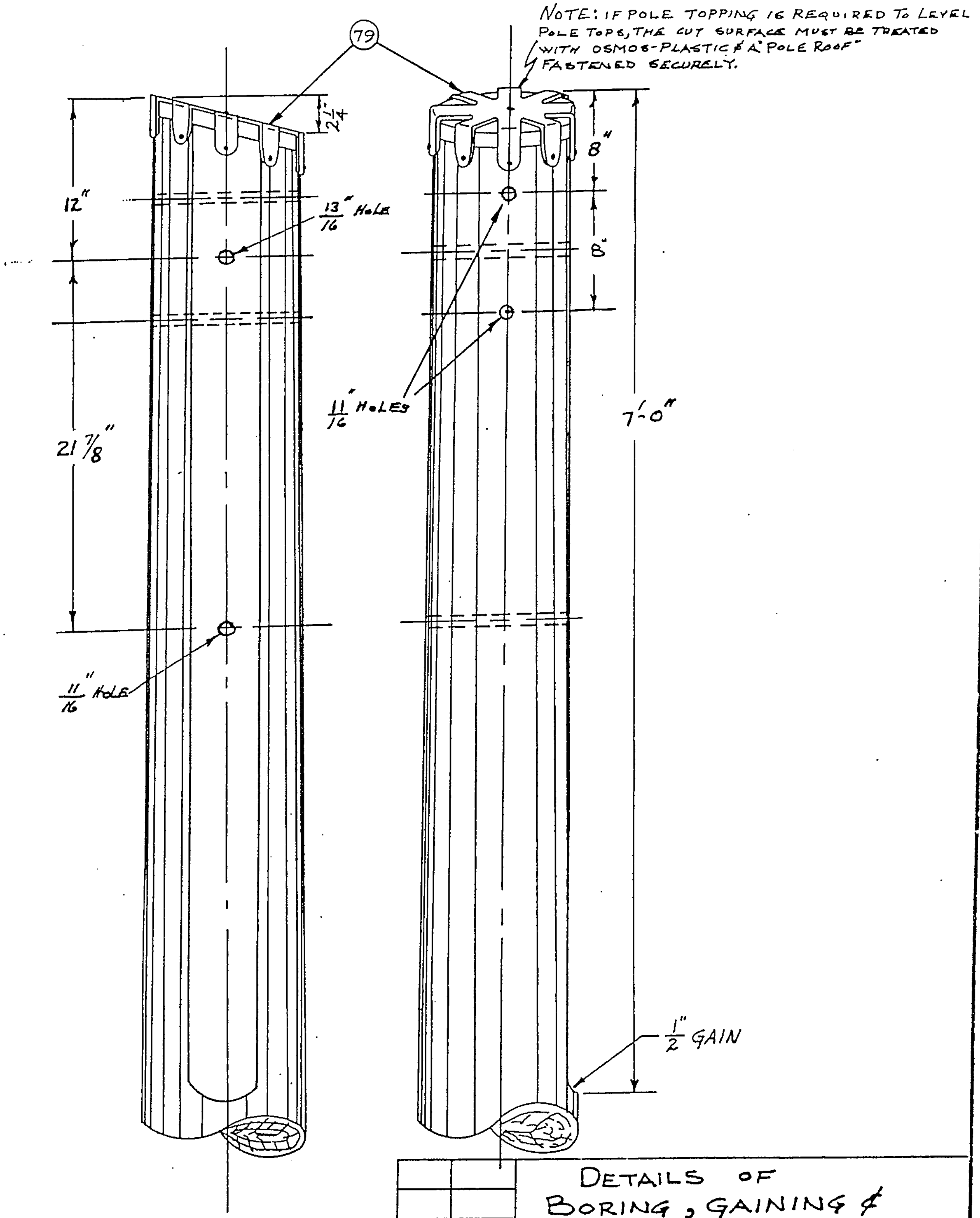


DETAIL OF CROSSARMS C, D, DA

VERMONT ELECTRIC POWER COMPANY, INC.

3/1/77		DRAWN BY JM	CHECKED BY	DATE 4/18/72
DATE	C'H'K BY	SCALE NONE	APPROVED BY	DWG #115-12.1
REVISIONS				

FORM CV 198



		DETAILS OF BORING, GAINING & POLE ROOF		
		VERMONT ELECTRIC POWER COMPANY, INC.		
		DRAWN BY R.G.	CHECKED BY	DATE 4-6-72
DATE	C'H'K BY	SCALE None	APPROVED BY	DWG # 115-13.0
REVISIONS				

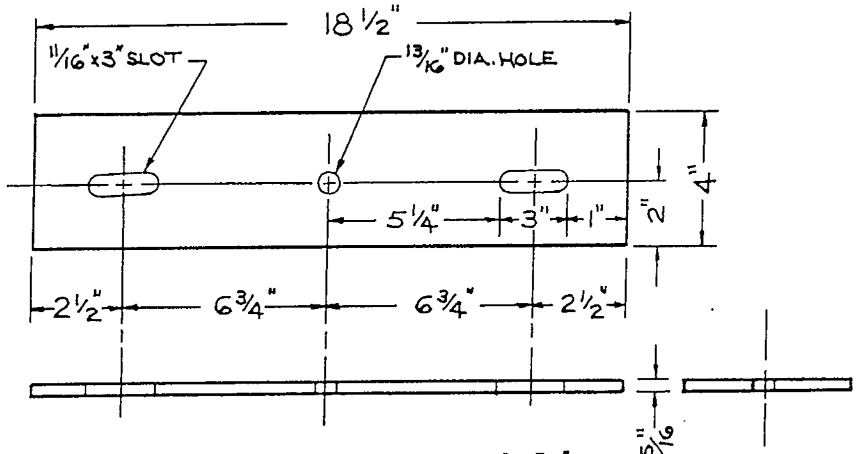
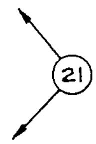
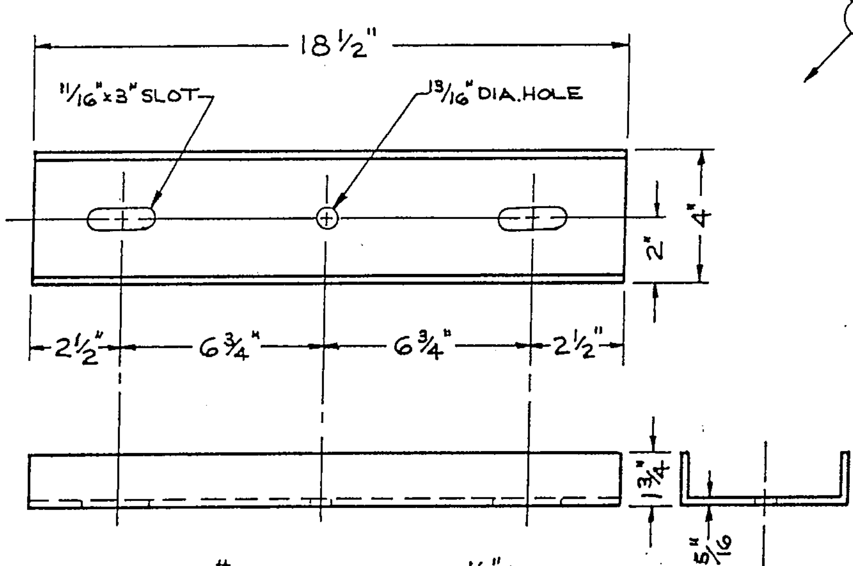


PLATE 18 1/2" x 4" x 5/16"





4" – 7.25# CHANNEL 18 1/2" Lg.

- NOTE -
PLATE & CHANNEL
HOT DIP GALVANIZED

PLATE & CHANNEL DETAIL
115 KV CONSTRUCTION

VERMONT ELECTRIC POWER COMPANY, INC.

DRAWN BY DG	CHECKED BY	DATE 3-1-77
SCALE NONE	APPROVED BY	DWG #115-14.0

DATE	C'H'K BY
REVISIONS	

FORM CV 198

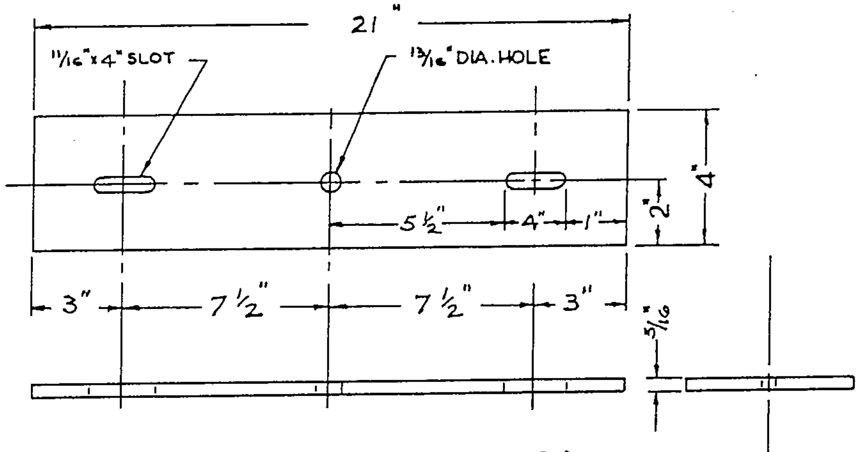
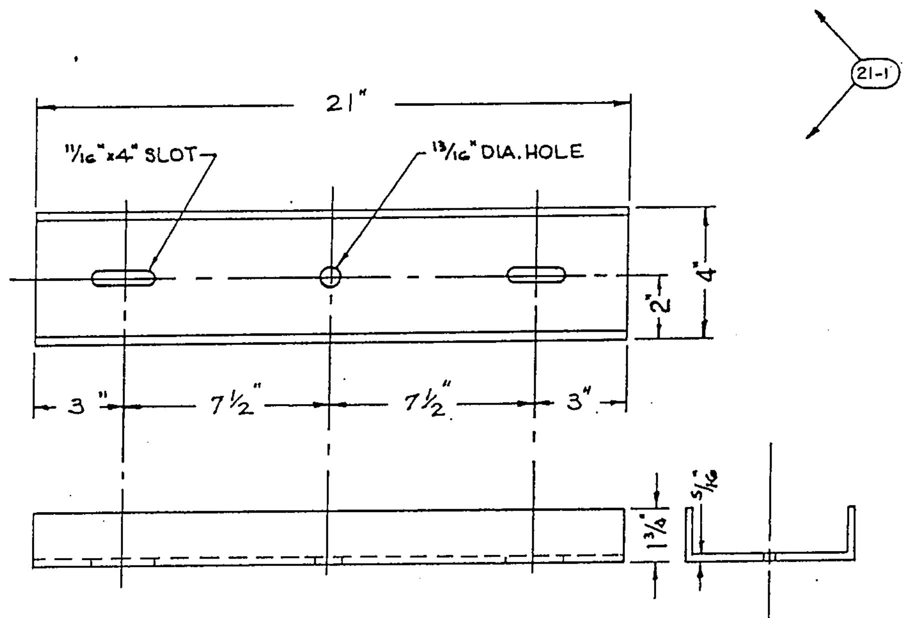


PLATE 21"x4"x5/16"

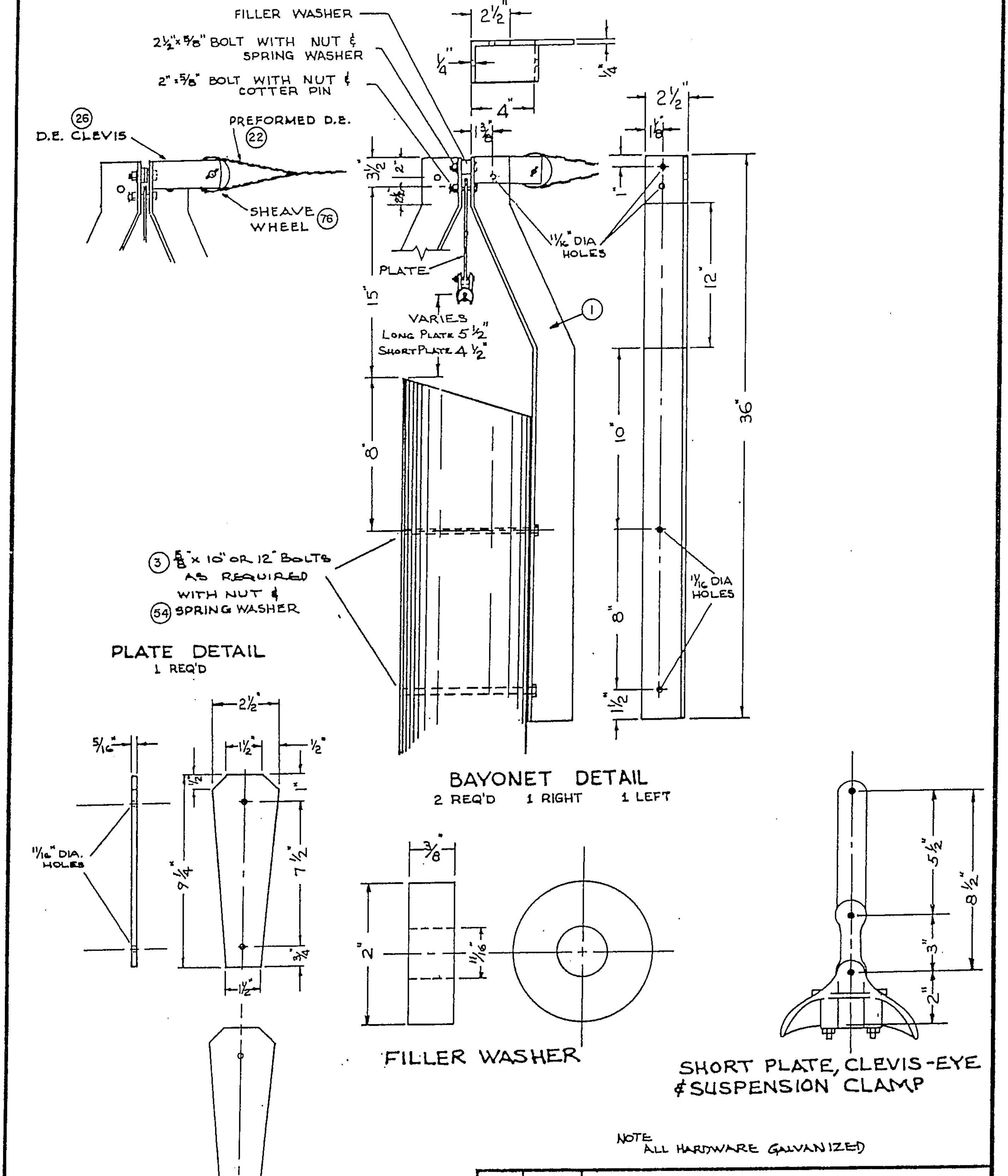


4" – 7.25# CHANNEL 21" LG.

- NOTE -
PLATE & CHANNEL
HOT DIP GALVANIZED

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

FORM CV 190



NOTE
ALL HARDWARE GALVANIZED

BAYONET DETAIL
115 KV. CONSTRUCTION

VERMONT ELECTRIC POWER COMPANY, INC.

DRAWN BY PDA	CHECKED BY		DATE 4-7-72
SCALE NONE	APPROVED BY		DWG #115-15.0

DATE	CH'K BY
3/1/77	

REVISIONS

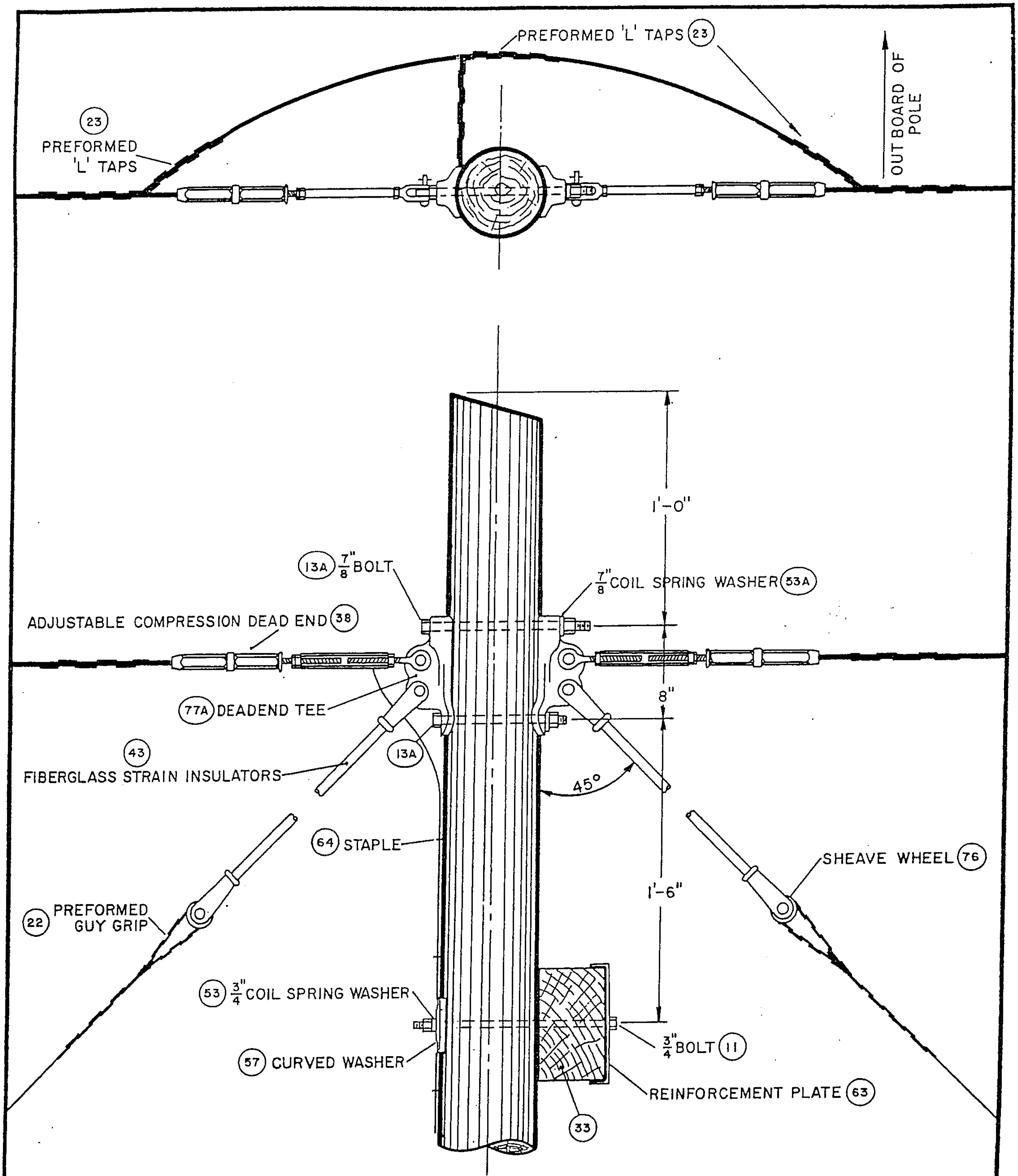
VERMONT ELECTRIC POWER COMPANY, INC.
Material for Special Type A Structure
w/Shield Wire Deadended

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
		When Required		
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

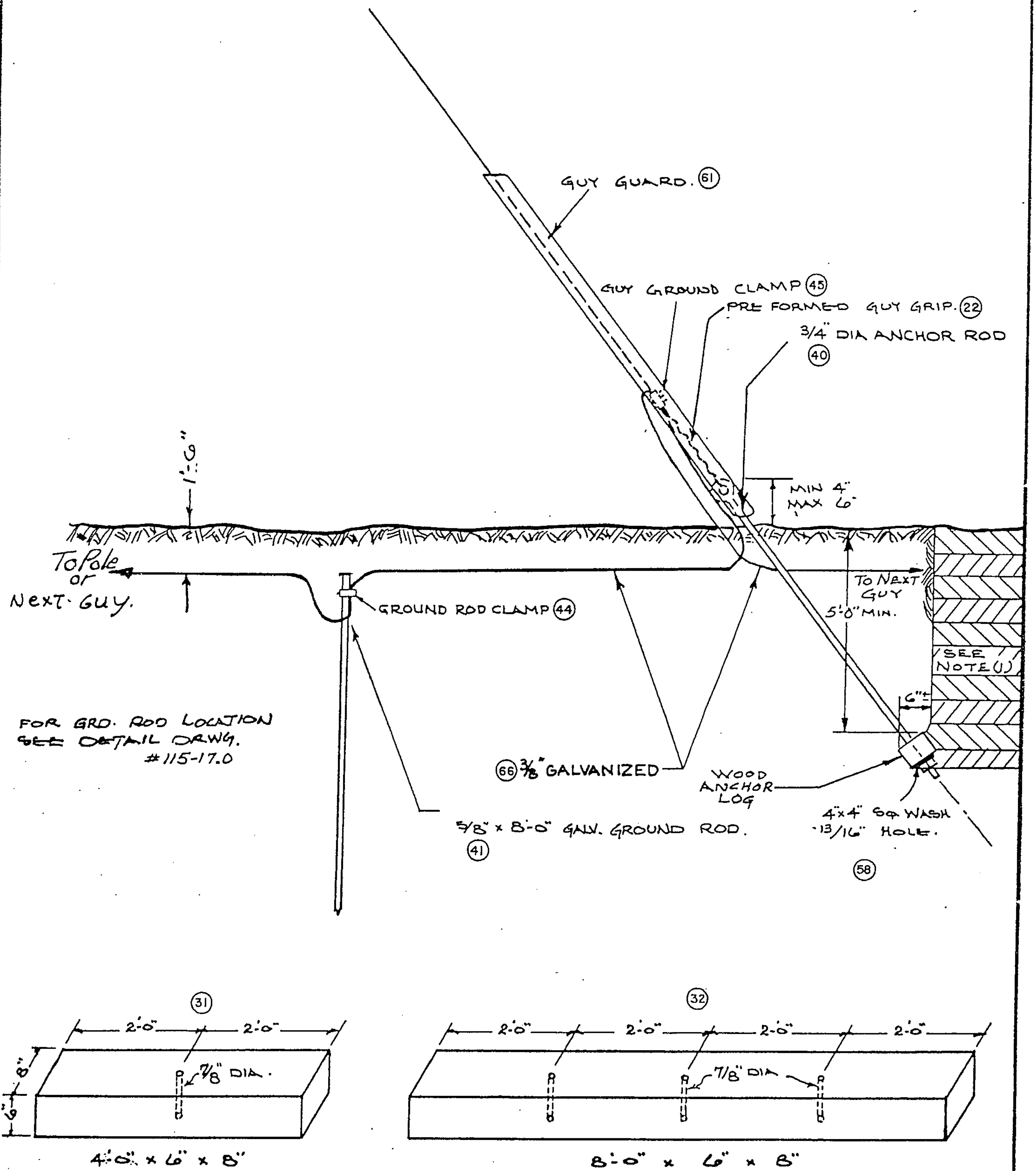
6/77
REv 1/78



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

		POLE TOP DETAIL 115 KV TYPE "A" STRUCTURE WITH SHIELD WIRE DEAD END
		VERMONT ELECTRIC POWER COMPANY, INC.
		DRAWN BY JG / CHECKED BY / DATE 3/1/77
DATE	C'H'K BY	SCALE NONE / APPROVED BY / DWG # 115-15.1
REVISIONS		

Boston Blue Print Co.-100-8-57-8½ x 11



WOOD ANCHOR LOGS

NOTE:

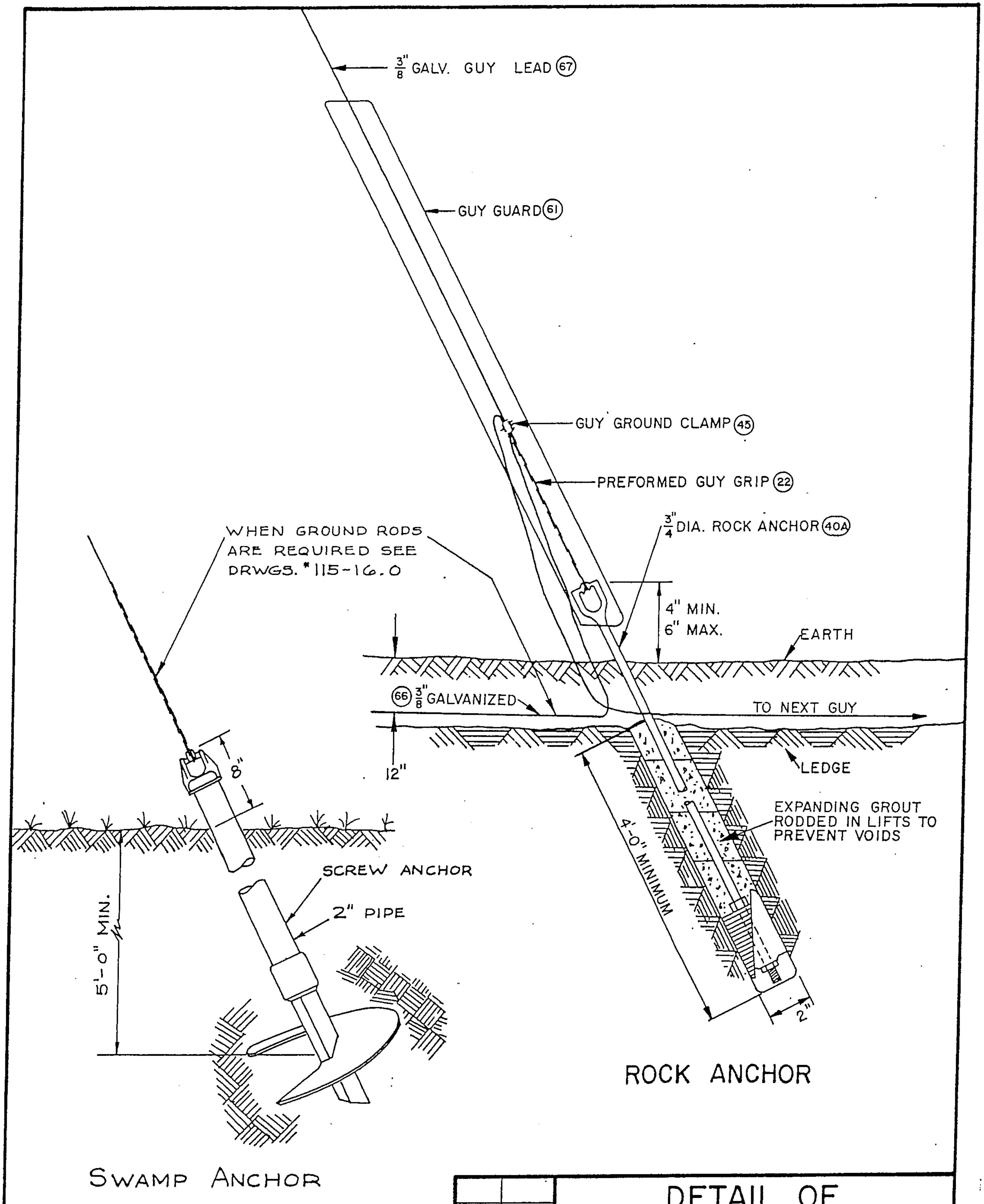
1. SET ANCHOR LOG FIRMLY AGAINST UNDER CUT, SOIL AND COMPACT IN 8" LIFTS TO 90% SURROUNDING EARTH.
2. WHEN BACKFILLING ANCHOR HOLES, 1000 LB. TENSION SHALL BE MAINTAINED ON THE ANCHOR ROD DURING THE BACKFILLING OPERATION.
3. WHEREVER POSSIBLE, THE GROUND WIRE SHALL BE MADE CONTINUOUS THRU JOINTS.

DATE	C'H'K BY
REVISIONS	

DETAIL OF GUY GROUNDING AND ANCHORS

VERMONT ELECTRIC POWER COMPANY, INC.

DRAWN BY R.G.	CHECKED BY	DATE 4-7-72
SCALE NONE	APPROVED BY	DWG #115-16.0



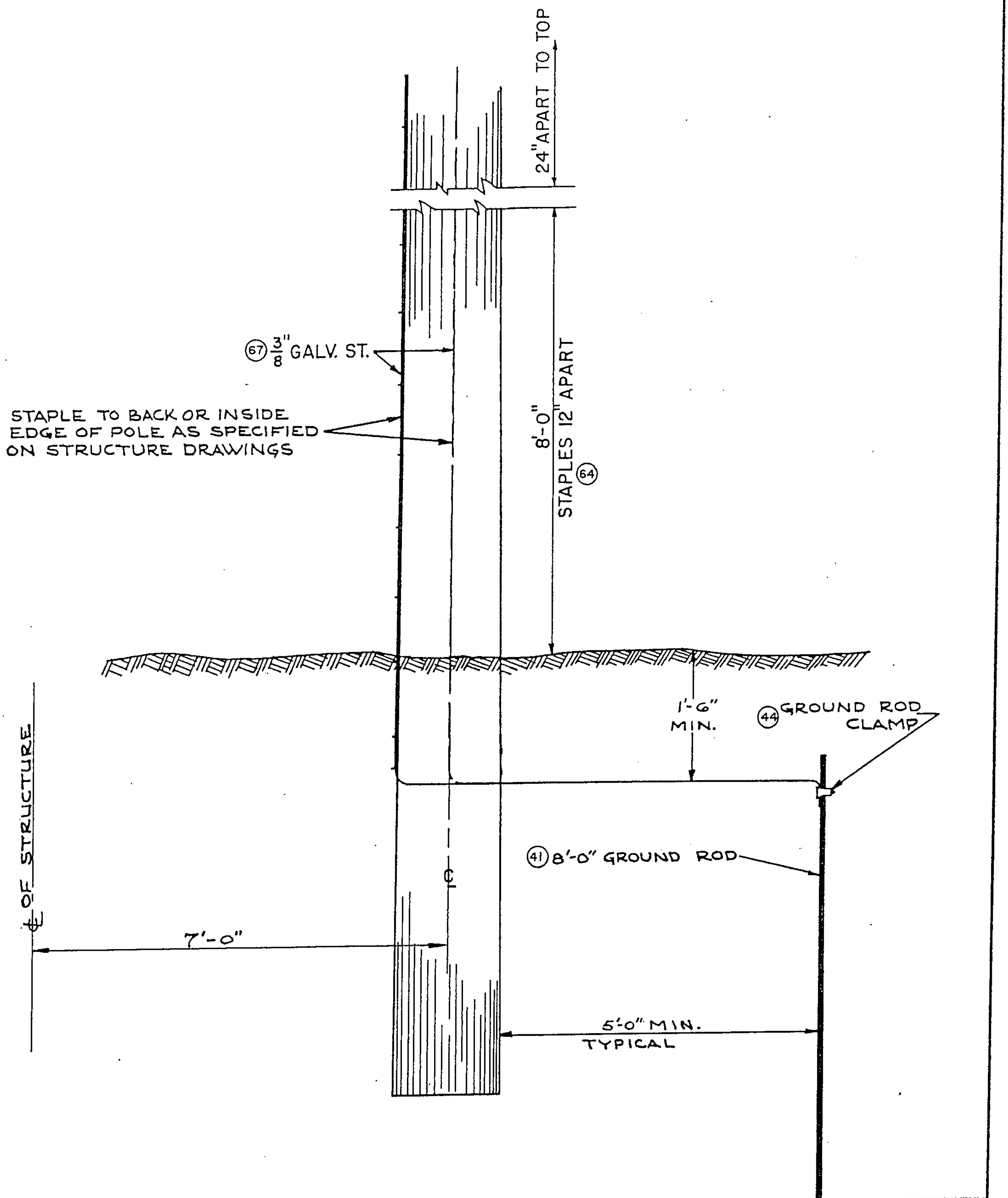
SWAMP ANCHORS TO BE INSTALLED BY HAND & USED FOR STRUCTURE STABILIZATION ONLY.

DETAIL OF ROCK AND SWAMP ANCHOR

VERMONT ELECTRIC POWER COMPANY, INC

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

DATE	CH'K BY
REVISIONS	

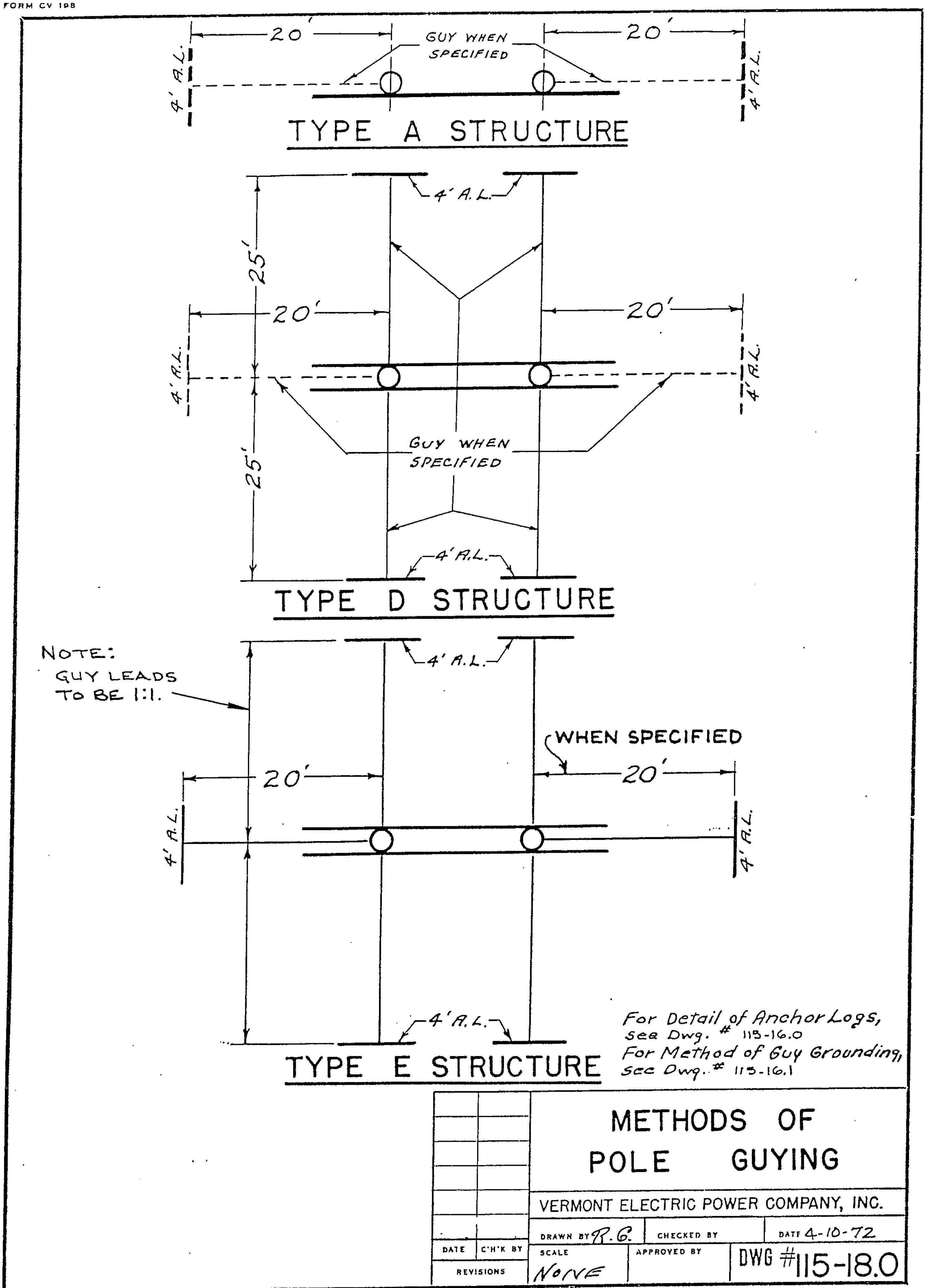


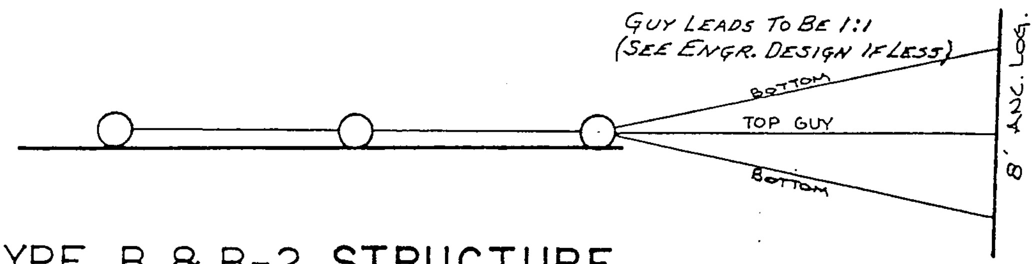
GROUND ROD DETAIL

VERMONT ELECTRIC POWER COMPANY, INC.

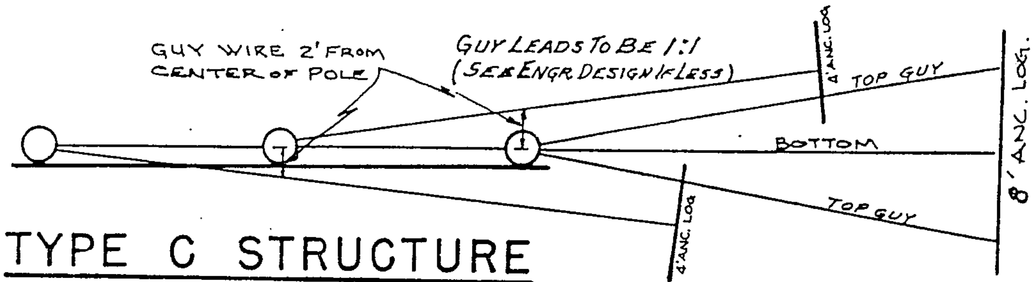
DRAWN BY JM	CHECKED BY	DATE 4/8/72	
SCALE NONE	APPROVED BY	DWG #115-170	

DATE	CH'K BY
REVISIONS	

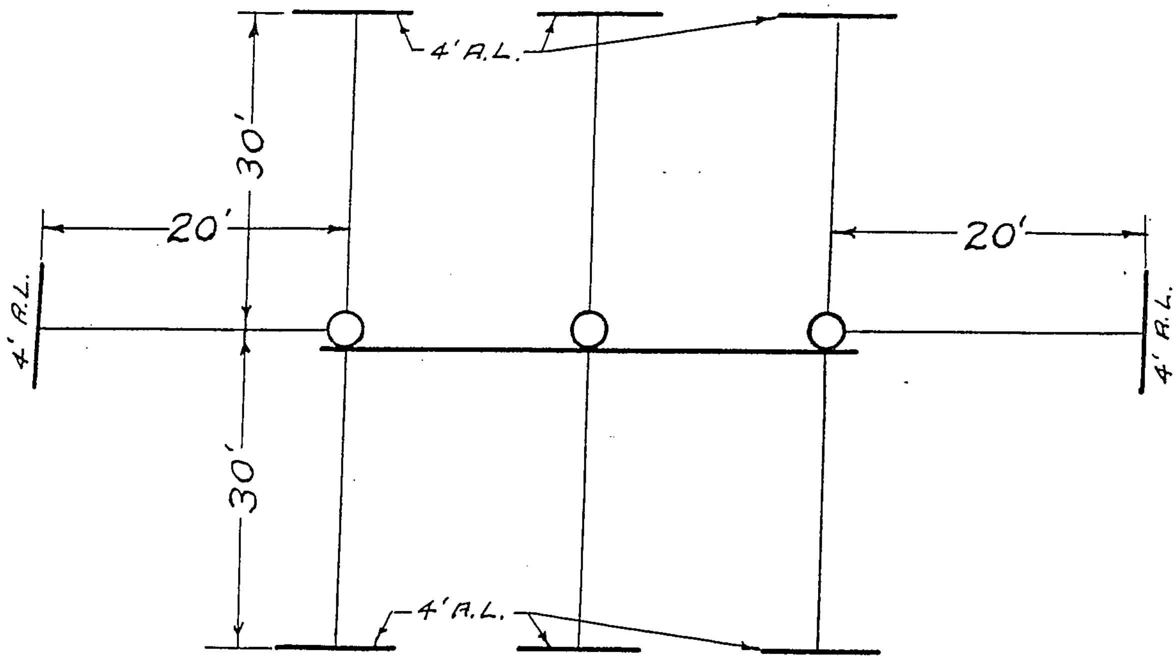

20'
20'
GUY WHEN SPECIFIED
4' A.L.
4' A.L.
TYPE A STRUCTURE
4' A.L.
25'
20'
20'
4' A.L.
4' A.L.
GUY WHEN SPECIFIED
25'
4' A.L.
TYPE D STRUCTURE
NOTE: GUY LEADS TO BE 1:1.
4' A.L.
WHEN SPECIFIED
20'
20'
4' A.L.
4' A.L.
4' A.L.
TYPE E STRUCTURE
For Detail of Anchor Logs, see Dwg. # 115-16.0
For Method of Guy Grounding, see Dwg. # 115-16.1
METHODS OF POLE GUYING
VERMONT ELECTRIC POWER COMPANY, INC.
DRAWN BY R.G.
CHECKED BY
DATE 4-10-72
DATE
C'H'K BY
REVISIONS
SCALE NONE
APPROVED BY
DWG #115-18.0



TYPE B & B-2 STRUCTURE
0°-27°



TYPE C STRUCTURE
27°-50°



TYPE F STRUCTURE

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

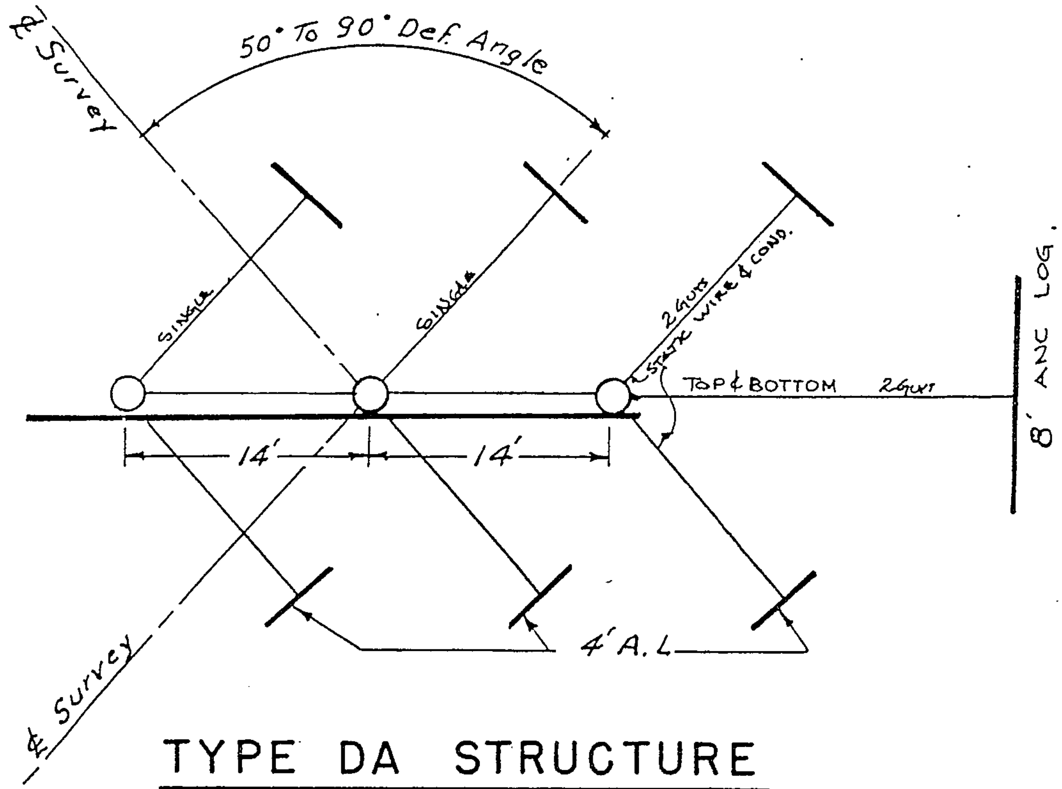
METHODS OF POLE GUYING

VERMONT ELECTRIC POWER COMPANY, INC.

DRAWN BY	R.G.
CHECKED BY	
DATE	4-10-72
SCALE	NONE
APPROVED BY	
DWG #	115-18.1

DATE | C'H'K BY
REVISIONS

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

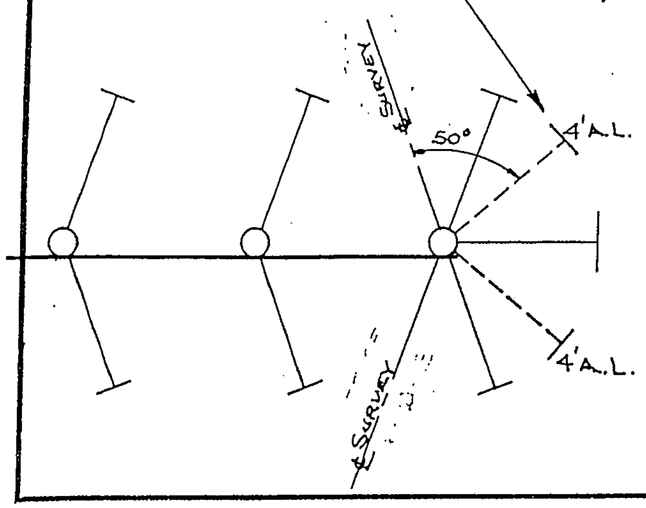


TYPE DA STRUCTURE

50°-UP

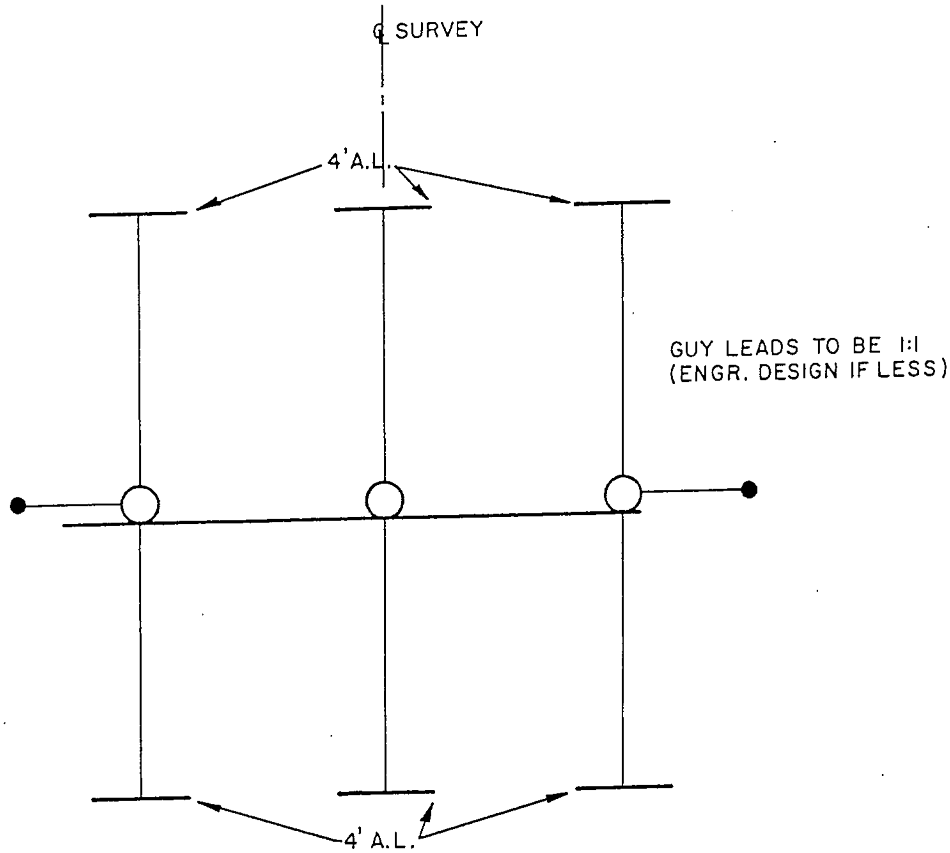
FOR LINE ANGLES LESS THAN 50°, SHIELD WIRE DE. GUYS WILL GO TO ADDITIONAL 4' ANCHOR LOGS AT 50° DEFLECTION ANGLE FROM OUTSIDE PHASE.

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



METHODS OF POLE GUYING	
VERMONT ELECTRIC POWER COMPANY, INC.	
REVISIONS: DATE 3/1/77, C'H'K BY Jg	
DRAWN BY R.G.	CHECKED BY
DATE 4-10-72	APPROVED BY
SCALE None.	DWG # 115-18.2

BOSTON BLUE PRINT CO. 814C - 200 - 3-53

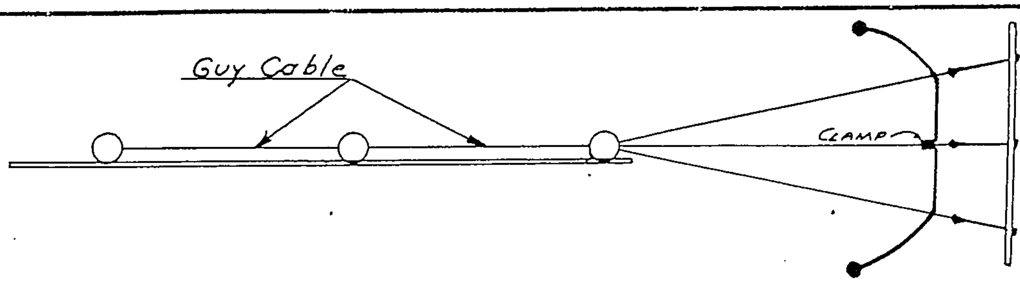


TYPE DA-T STRUCTURE

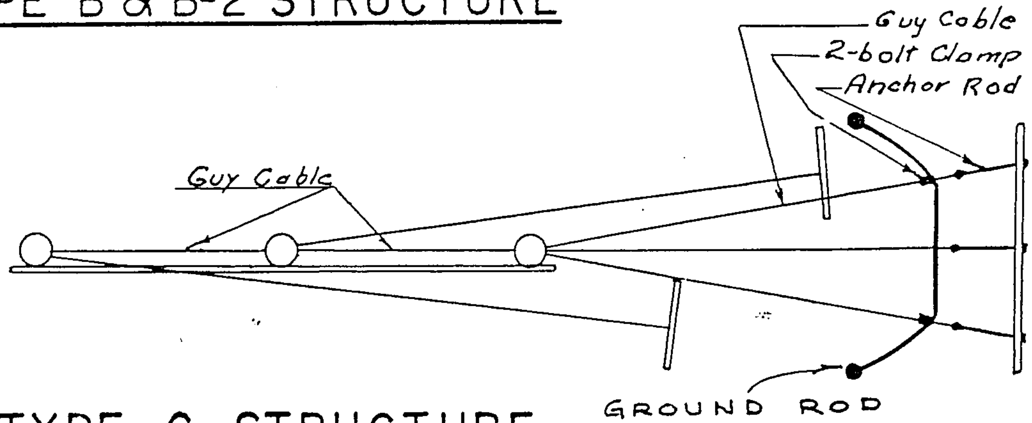
FOR LONG SPAN AND/OR DIFFERENTIAL CONDUCTOR TENSIONS

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

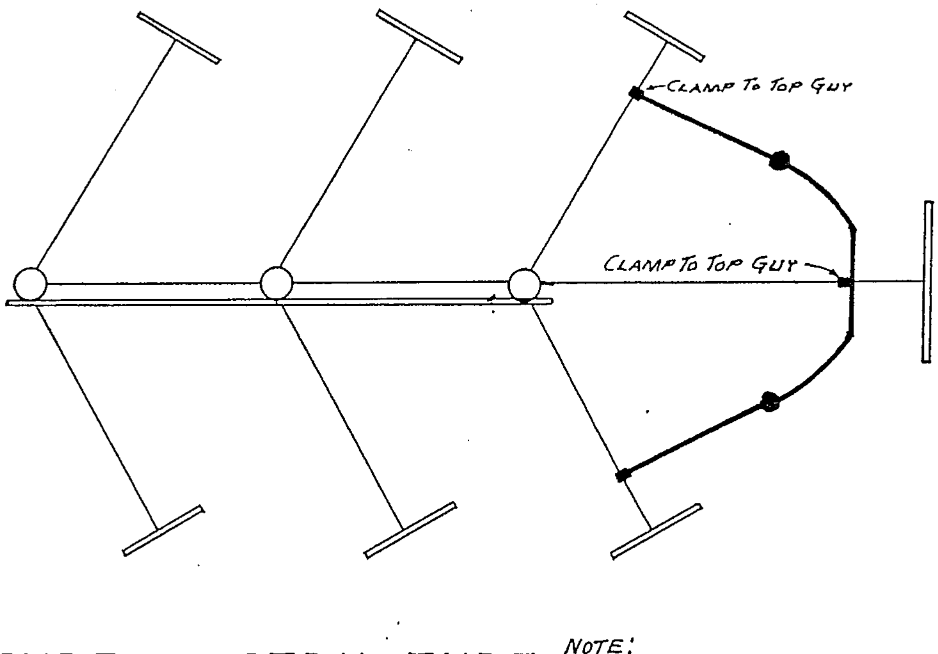
DATE	C'H'K BY	METHODS OF POLE GUYING		
REVISIONS		VERMONT ELECTRIC POWER COMPANY, INC.		
		DRAWN BY [signature]	CHECKED BY	DATE 3/1/77
		SCALE NONE	APPROVED BY	DWG #115-18.3



TYPE B & B-2 STRUCTURE



TYPE C STRUCTURE



TYPE DA STRUCTURE

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

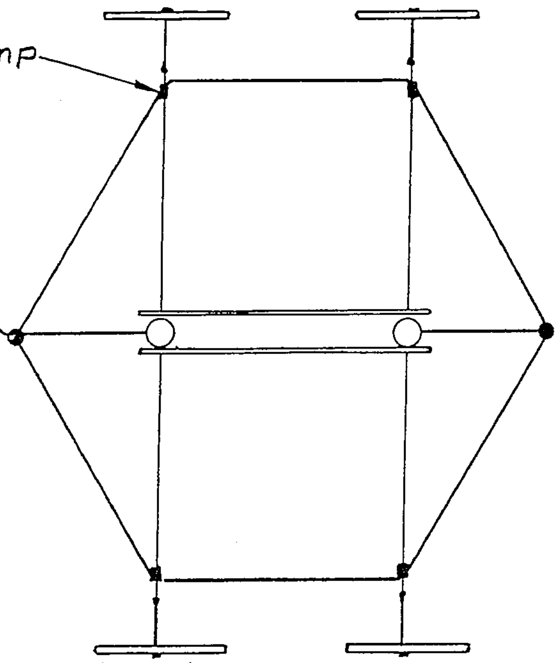
For Pole Ground Detail, see Dwg. 115-16.0
For Method of Guying, see Dwg. 115-18.1 & 115-18.2

METHODS OF POLE & GUY GROUNDING
3-POLE STRUCTURE

VERMONT ELECTRIC POWER COMPANY, INC.

DRAWN BY R.G.	CHECKED BY	DATE 4-11-72
SCALE NONE	APPROVED BY	DWG # 115-19.0

DATE	C'H'K BY
REVISIONS	

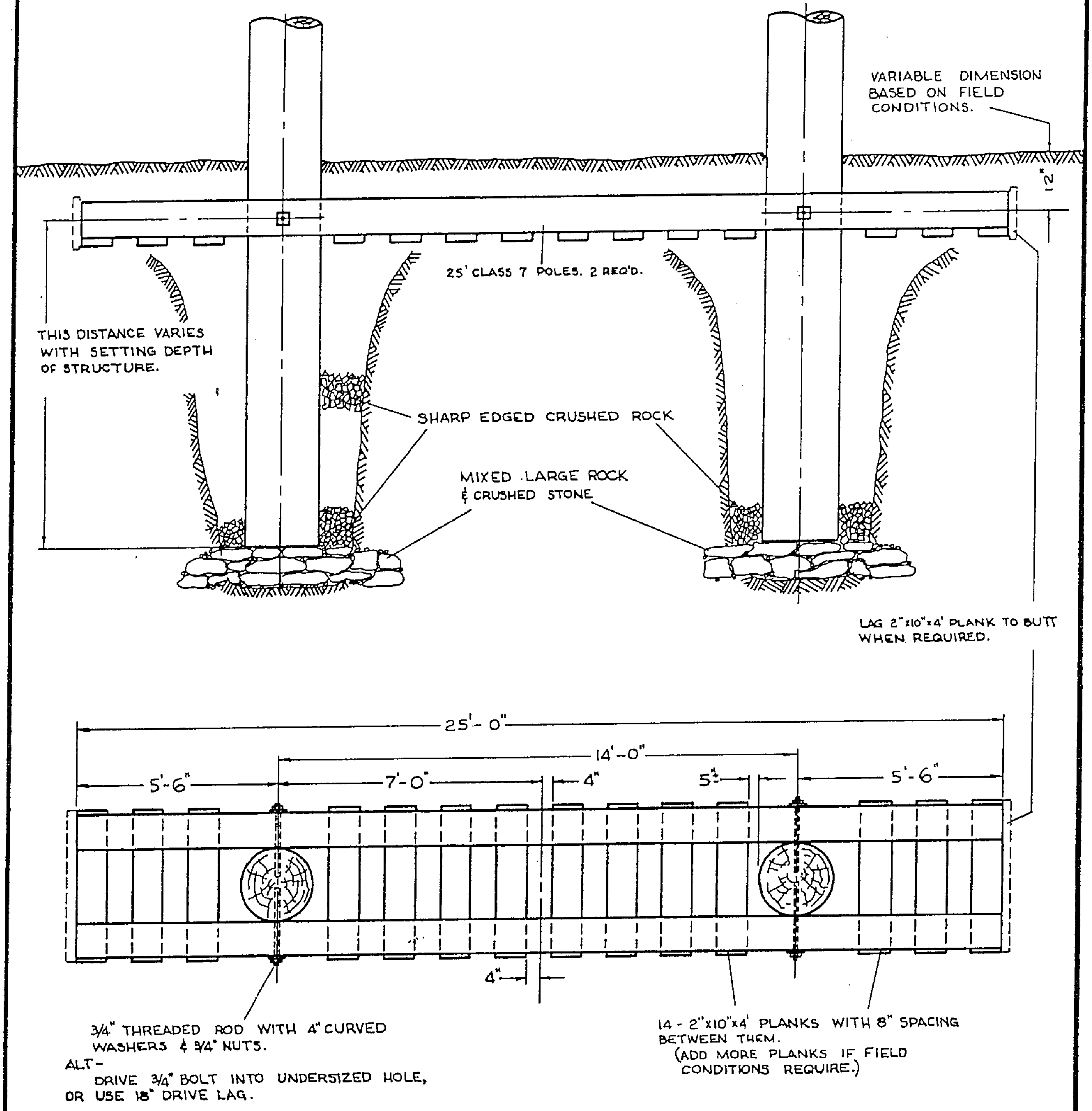


TYPE D&E STRUCTURE

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'H'K BY	SCALE NONE	APPROVED BY	DWG # 115-19.1
REVISIONS				

FORM CV 188



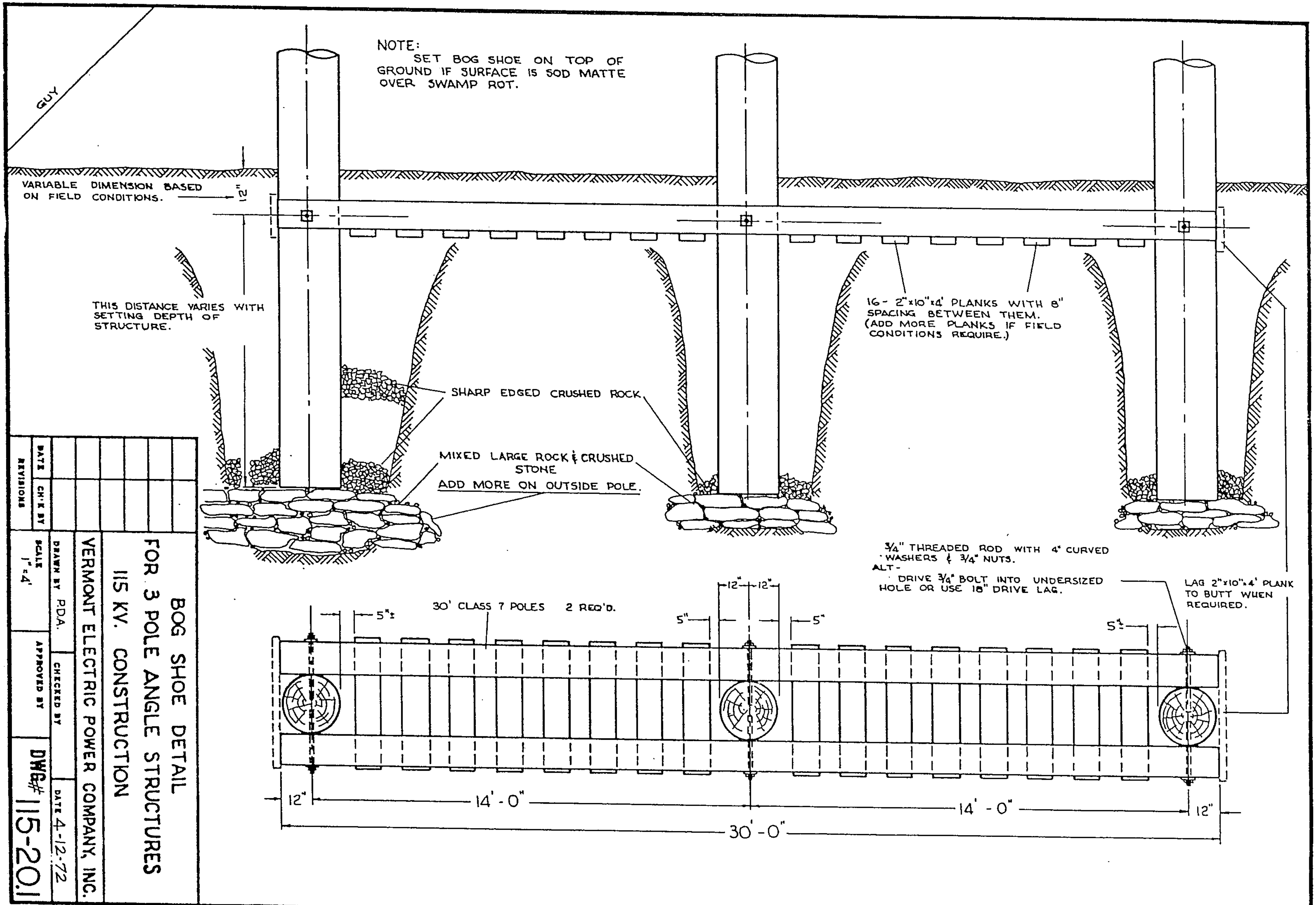
NOTE:
SET BOG SHOE ON TOP OF GROUND IF SURFACE IS SOD MATTE OVER SWAMP ROT.

BOG SHOE DETAIL
TANGENT "A" STRUCTURE
115 KV. CONSTRUCTION

VERMONT ELECTRIC POWER COMPANY, INC.

DRAWN BY PDA	CHECKED BY	DATE 4-12-72
SCALE 1"=4'	APPROVED BY	DWG# 115-20.0

DATE	CH'K BY
REVISIONS	

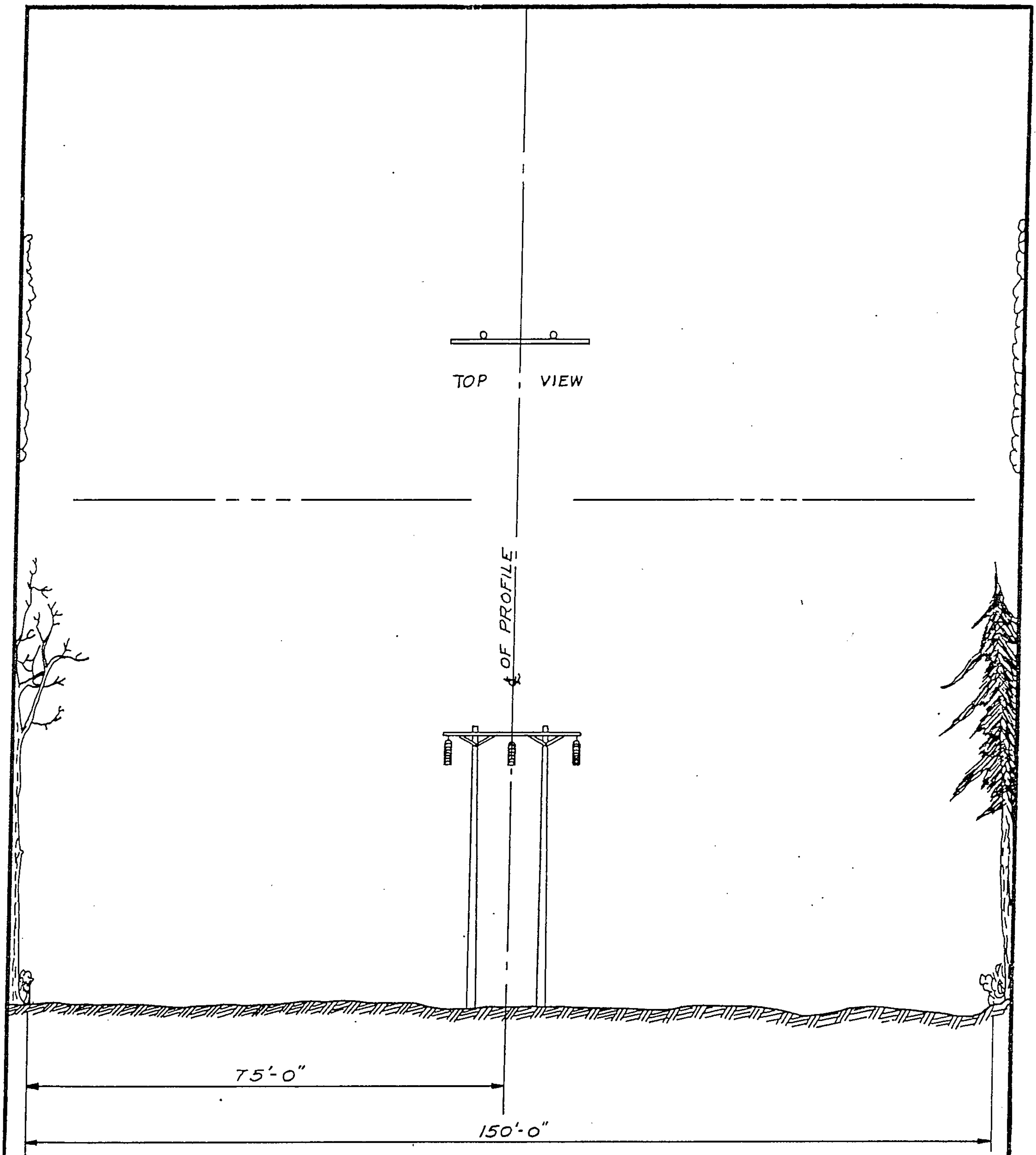


BOG SHOE DETAIL
FOR 3 POLE ANGLE STRUCTURES
115 KV. CONSTRUCTION

VERMONT ELECTRIC POWER COMPANY, INC.

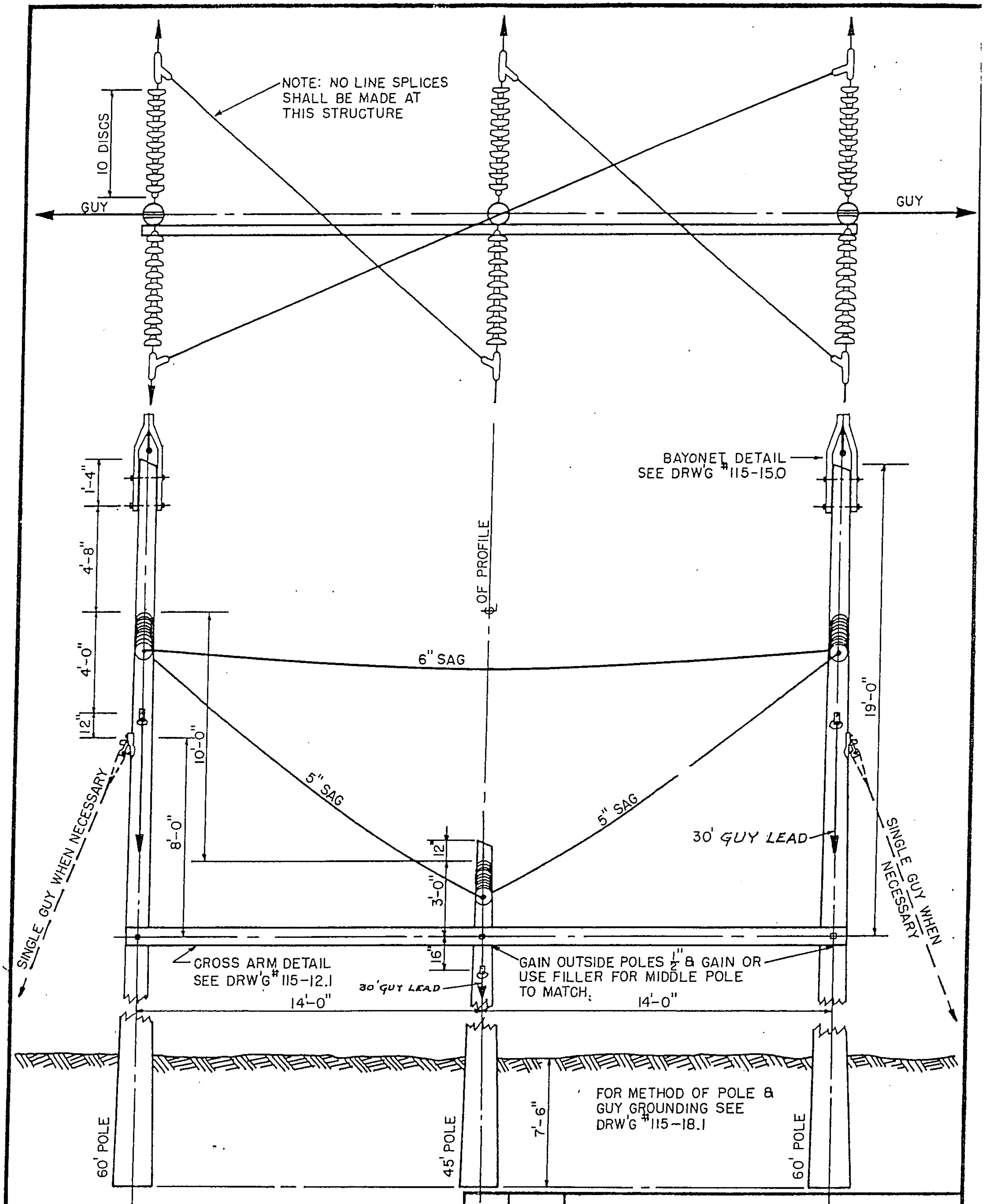
DRAWN BY P.D.A.	CHECKED BY	DATE 4-12-72
SCALE 1" = 4'	APPROVED BY	DWG# 115-20.1

DATE	CH'K BY
REVISIONS	



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

DATE | CH'K BY | REVISIONS



NOTE:
FOR STRUCTURAL DETAILS SEE DRW'G 115-11.2

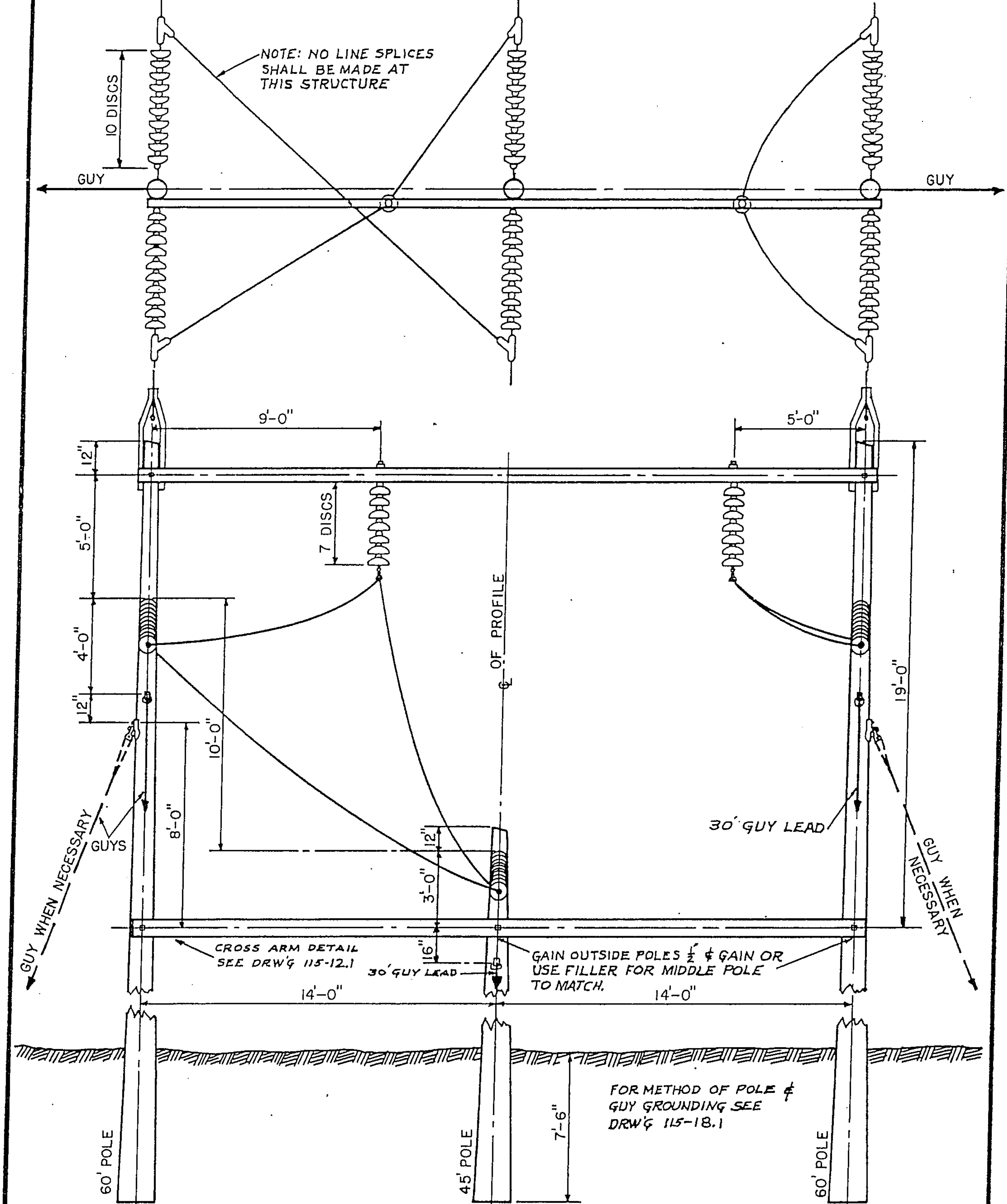
3/1/77	JC	
DATE	CH'K BY	
REVISIONS		

TYPE F STRUCTURE
TRANSPOSITION
115 KV CONSTRUCTION

VERMONT ELECTRIC POWER COMPANY, INC.

DRAWN BY JM	CHECKED BY	DATE 4/22/72
SCALE NONE	APPROVED BY	DWG # 115-22.0

FORM CV 199

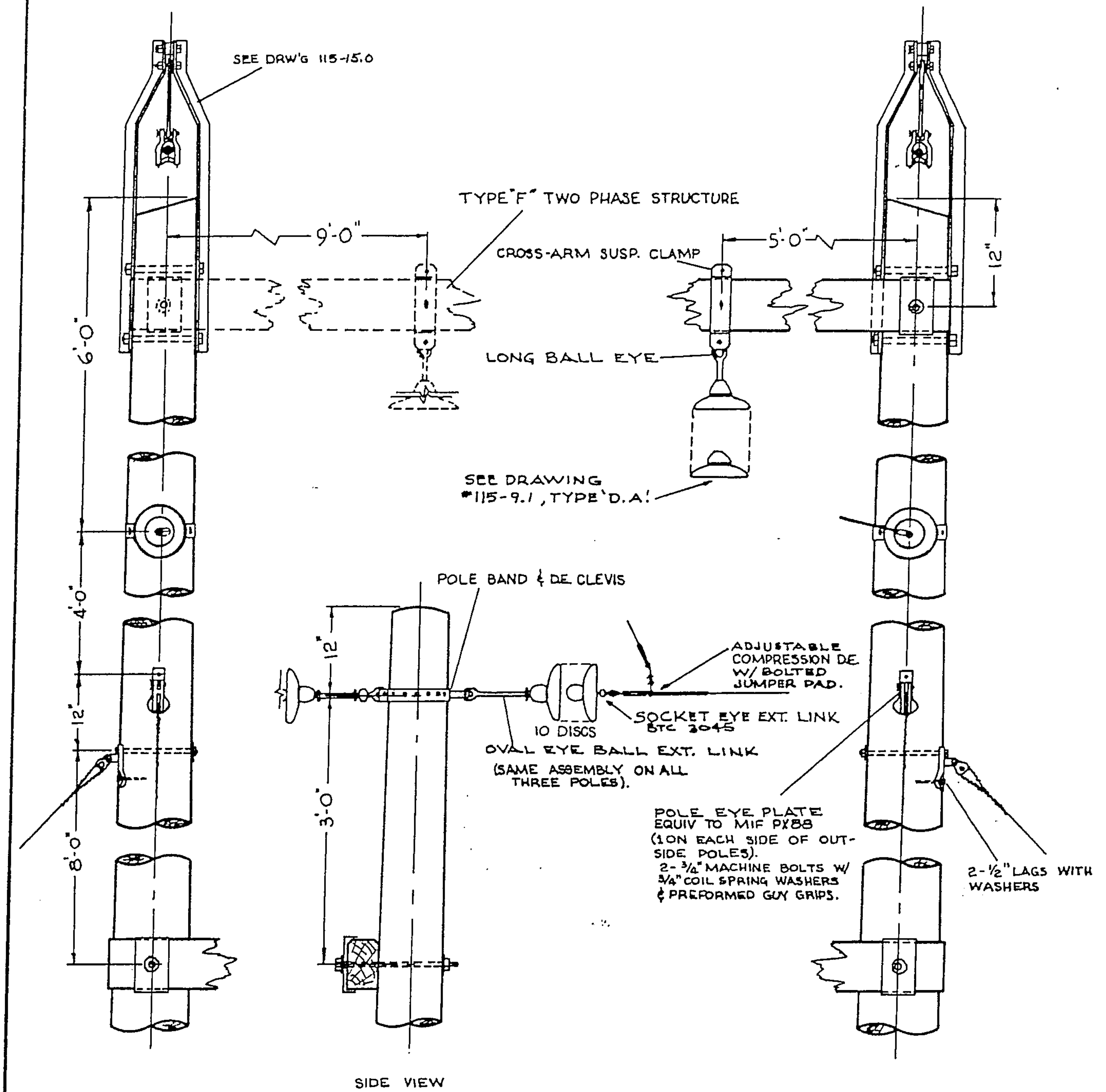


NOTE: FOR STRUCTURAL DETAILS
SEE DRW'G. 115-11.2

TYPE F SPECIAL
TWO PHASE TRANSPOSITION 115KV CONSTRUCTION

VERMONT ELECTRIC POWER COMPANY, INC.

3/1/77		DRAWN BY JM	CHECKED BY	DATE 4/22/72
DATE	CH'K BY	SCALE NONE	APPROVED BY	DWG # 115-22.1
REVISIONS				



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	[initials]	DRAWN BY PDA	CHECKED BY		DATE 4/22/72
DATE	CH'K BY	SCALE NONE	APPROVED BY		DWG # 115-22.2
REVISIONS					

VELCO

West Rutland-New Haven

Burns & McDonnell Project No. 40240

345KV STRUCTURE DRAWING INDEX

DRAWING NO.	TITLE
345-0.0	345KV CONSTRUCTION INDEX TO DRAWINGS
345-1.0	TANGENT SUSPENSION STRUCTURE TYPE 'A'
345-1.1	TANGENT SUSPENSION POLE TOP DETAILS TYPE 'A'
345-1.2	TANGENT SUSPENSION BILL OF MATERIALS TYPE 'A'
345-1.3	SHIELD WIRE DEAD END ATTACHMENT TYPE 'A' STRUCTURE
345-1.4	OPTICAL WIRE DEAD END ATTACHMENT TYPE 'A' STRUCTURE
345-3.0	SUSPENSION ANGLE STRUCTURE TYPE 'SA2' (12° TO 22°)
345-3.1	SUSPENSION ANGLE POLE TOP DETAILS TYPE 'SA2' (12° TO 22°)
345-3.2	SUSPENSION ANGLE BILL OF MATERIALS TYPE 'SA2' (12° TO 22°)
345-4.0	SUSPENSION ANGLE STRUCTURE TYPE 'SA3' (22° TO 35°)
345-4.1	SUSPENSION ANGLE POLE TOP DETAILS TYPE 'SA3' (22° TO 35°)
345-4.2	SUSPENSION ANGLE BILL OF MATERIALS TYPE 'SA3' (22° TO 35°)
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'

DRAWING NO.	TITLE
345-5.3	STRAIGHT LINE DEAD END POLE TOP DETAILS-TIMBER CONNECTIONS TYPE 'DE1'
345-5.4	STRAIGHT LINE DEAD END POLE TOP DETAILS-COND. & GUY ATTACH. TYPE 'DE1'
345-5.5	STRAIGHT LINE DEAD END BILL OF MATERIALS TYPE 'DE1'
345-6.0	ANGLE DEAD END STRUCTURE TYPE 'DE2' (35° TO 55°)
345-6.1	ANGLE DEAD END POLE TOP DETAILS TYPE 'DE2' (35° TO 55°)
345-6.2	ANGLE DEAD END POLE TOP DETAILS-COND. & GUY ATTACH. TYPE 'DE2' (35° TO 55°)
345-6.3	ANGLE DEAD END BILL OF MATERIALS TYPE 'DE2' (35° TO 55°)
345-7.0	ANGLE DEAD END STRUCTURE TYPE 'DE3' (55° TO 75°)
345-7.1	ANGLE DEAD END POLE TOP DETAILS TYPE 'DE3' (55° TO 75°)
345-7.2	ANGLE DEAD END POLE TOP DETAILS-COND. & GUY ATTACH. TYPE 'DE3' (55° TO 75°)
345-7.3	ANGLE DEAD END BILL OF MATERIALS TYPE 'DE3' (55° TO 75°)

DRAWING NO.	TITLE
345-9.0	CROSSARM DETAILS
345-9.1	CROSSARM DETAILS
345-10.0	ANCHOR AND GUY GROUNDING DETAILS
345-10.1	ROCK ANCHOR DETAILS
345-10.2	METHOD OF POLE GUYING
345-11.0	2-POLE GROUNDING DETAILS TYPE A, B & C
345-11.1	METHOD OF POLE AND GUY GROUNDING
345-13.0	FOUNDATIONS AND BOG SHOE PLATFORM FOR 2 POLE STRUCTURE
345-14.0	BOG SHOE PLATFORM FOR 3 POLE STRUCTURE 29'-0" & 29'-6" POLE SPACING
345-14.1	BOG SHOE PLATFORM FOR 3 POLE STRUCTURE 29'-0" & 29'-6" POLE SPACING
345-DG	345KV STRUCTURE POLE DRILLING GUIDE TYPE "A"
345-SIGN	AERIAL PATROL AND STRUCTURE NUMBER SIGNS

Burns & McDonnell SINCE 1898

CONFORMED TO CONSTRUCTION RECORDS

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

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

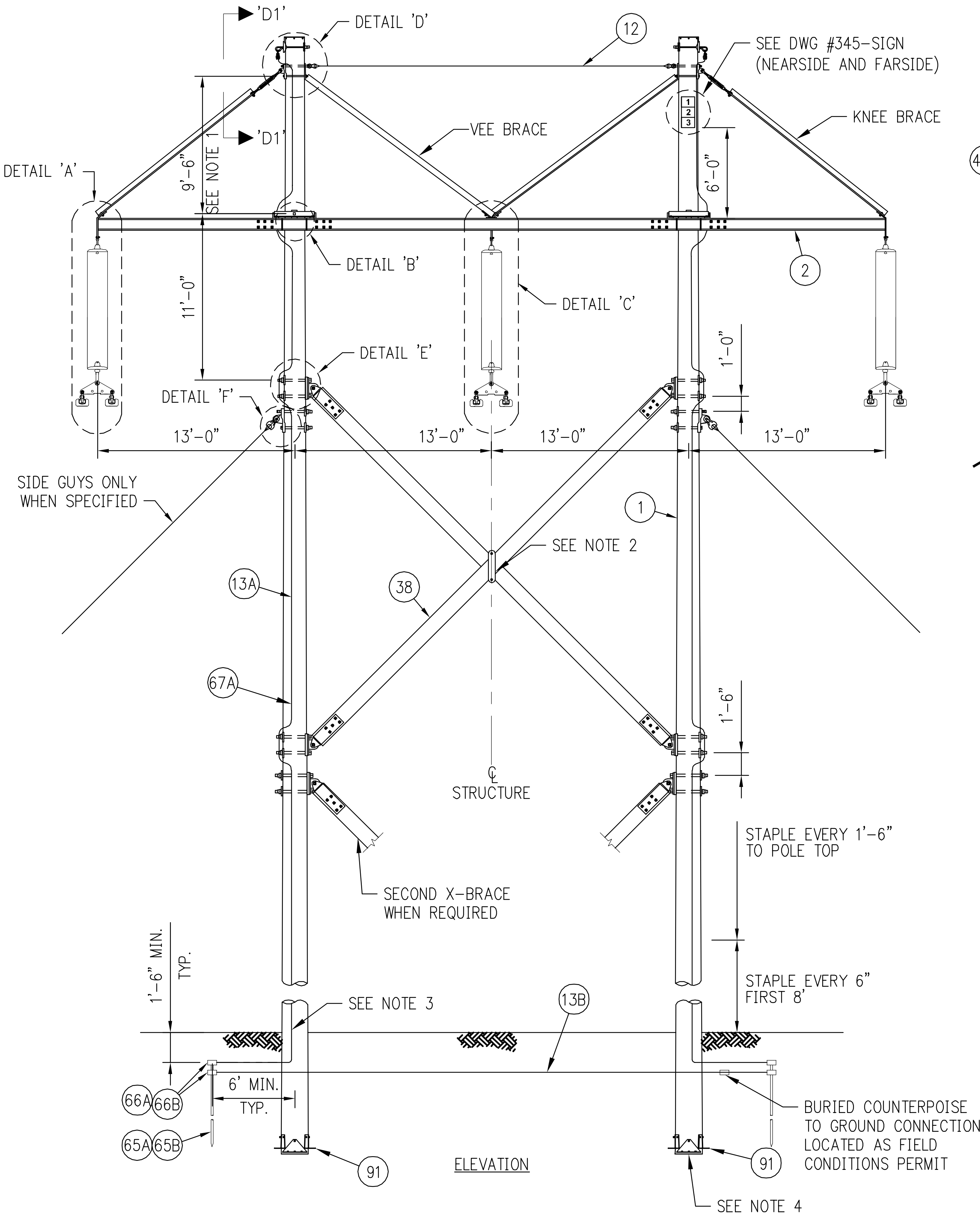
VELCO — VERMONT ELECTRIC POWER CO., INC.
RUTLAND, VERMONT

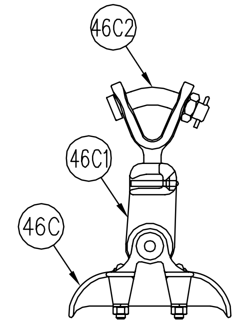
WEST RUTLAND – NEW HAVEN 345KV

345KV CONSTRUCTION INDEX TO DRAWINGS

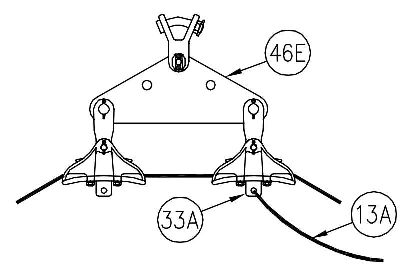
SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	
DATE: 11/05	CHECKED BY: KAW		DATE
DRAWING NUMBER: PLOT: 1=1	345-0.0		1 REV.

FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-00.0.dwg 09-20-2005 16:27 6

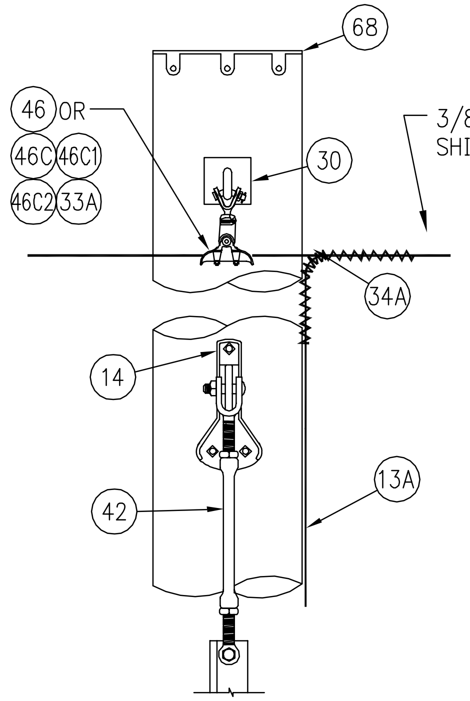




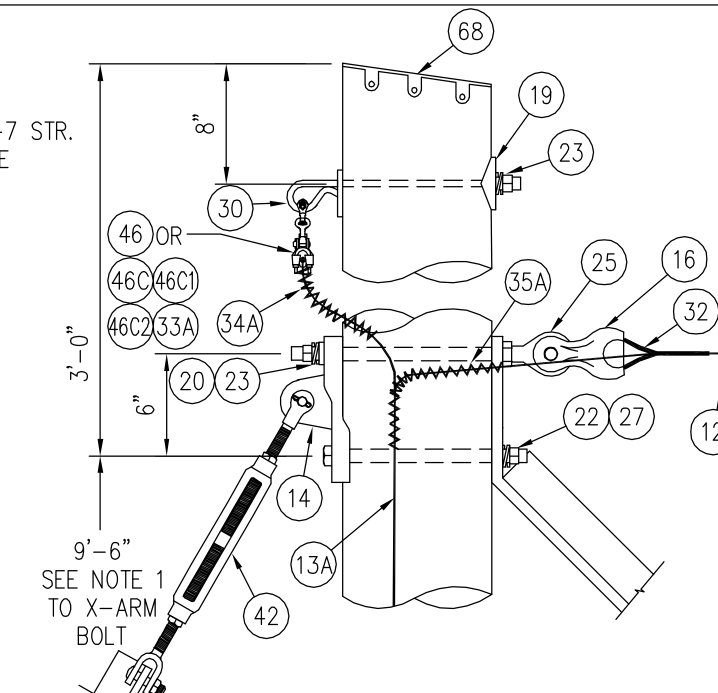
OPGW ASSEMBLY
SEE NOTE 5



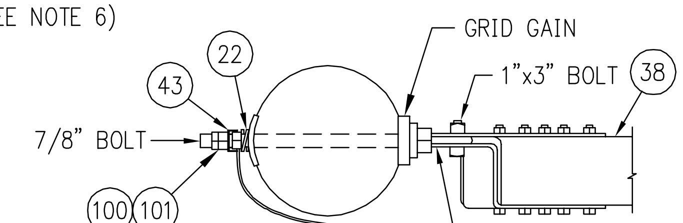
DOUBLE OPTICAL WIRE SUSPENSION ASSEMBLY
(SEE NOTE 6)



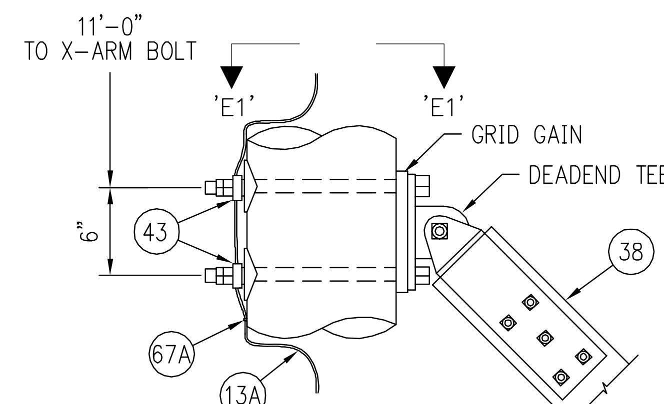
SECTION 'D1'-'D1'



DETAIL 'D'



SECTION 'E1'-'E1'



DETAIL 'E'

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.

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 1898

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

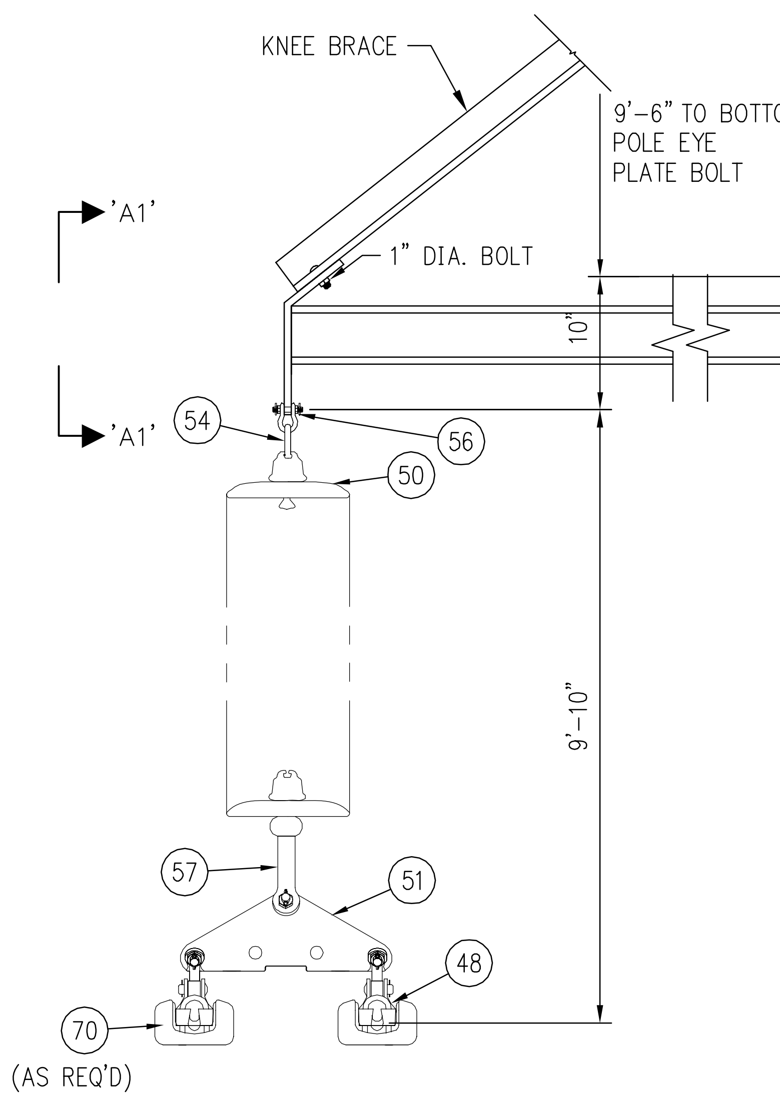
REV	DATE	DR	CK	DESCRIPTION
1	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

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

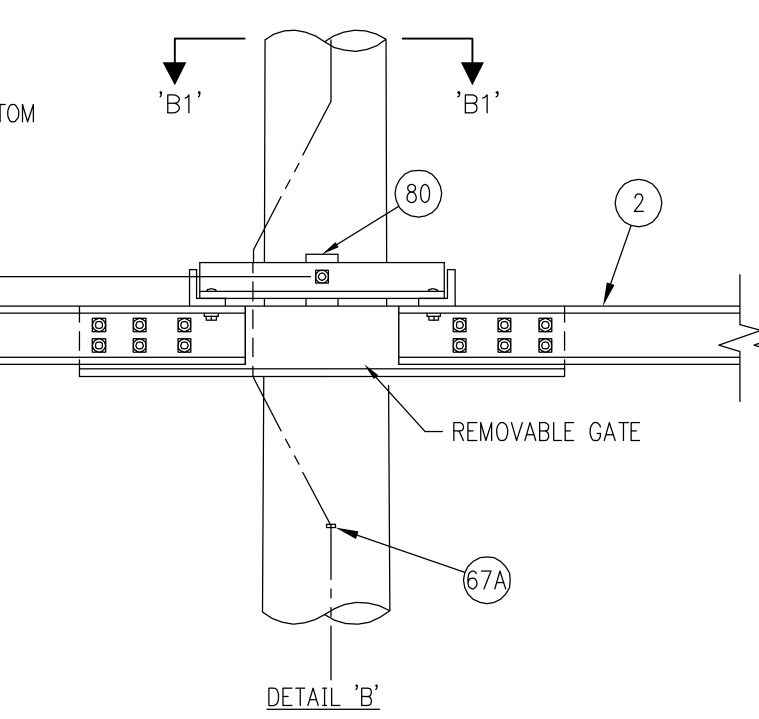
TANGENT SUSPENSION STRUCTURE TYPE 'A'

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	
DATE: 11/05	CHECKED BY: KAW		DATE
DRAWING NUMBER: PLOT: 1=1	345–1.0		1 REV.

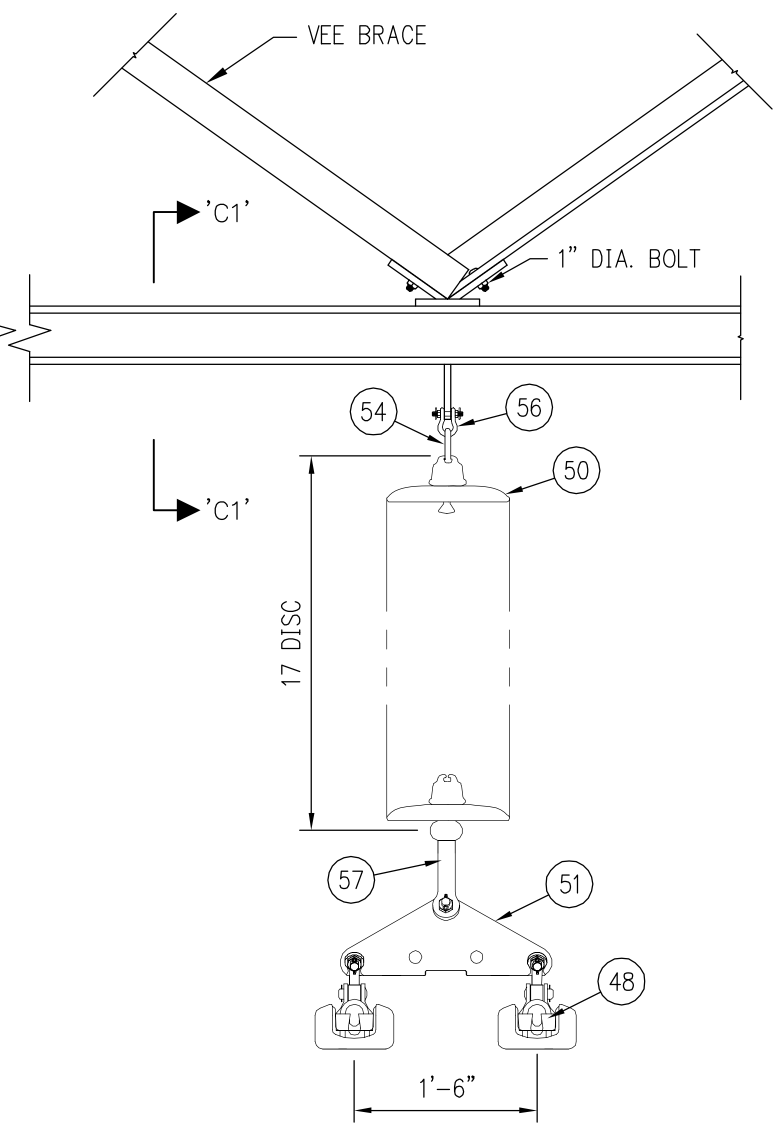
FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-1.0.dwg 02-07-2006 11:30 DSM BMcD



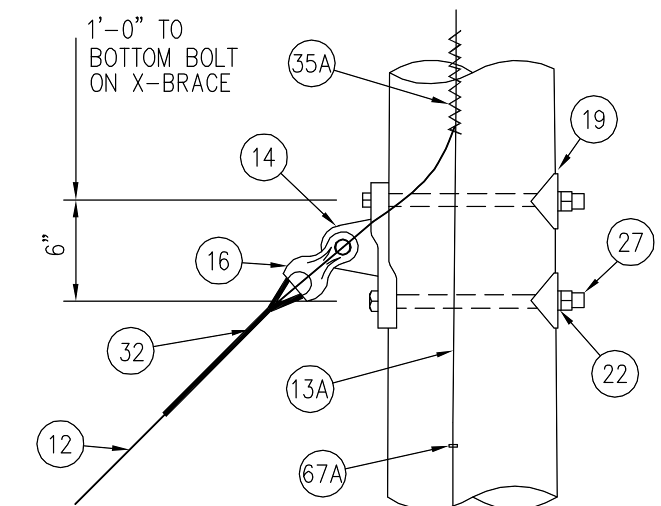
DETAIL 'A'



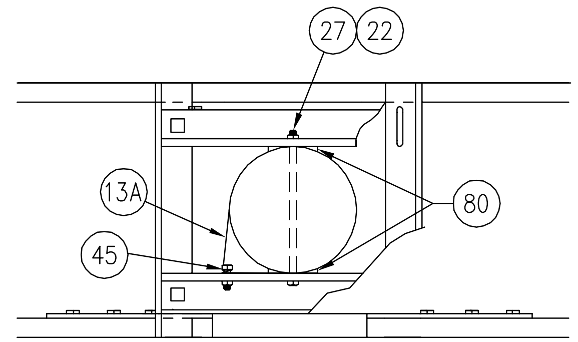
DETAIL 'B'



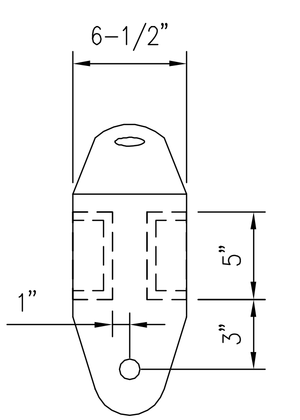
DETAIL 'C'



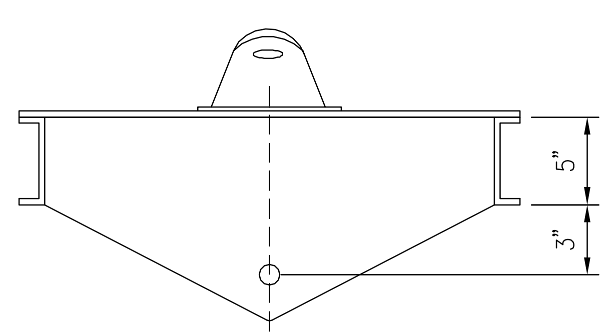
DETAIL 'F'
(AS REQUIRED)



SECTION 'B1'-'B1'



SECTION 'A1'-'A1'



SECTION 'C1'-'C1'

Burns & McDonnell SINCE 1898

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

PROPRIETARY
This document is the property of Vermont Electric Power Company, Inc. and contains proprietary and confidential information which must not be duplicated, used or disclosed other than as expressly authorized by Vermont Electric Power Company, Inc.

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

TANGENT SUSPENSION
POLE TOP DETAILS
TYPE 'A'

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	
DATE: 11/05	CHECKED BY: KAW		DATE
DRAWING NUMBER: PLOT: 1=1	345–1.1		1 REV.

FILE: N:\Velco\36445 NR-NH EP\Cadd\STANDARD POLES\345KV\345-1.1.dwg 02-07-2006 11:30 DSM BMcD

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" x12", 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
MATERIAL REQUIRED FOR DOUBLE OPTICAL WIRE SUSPENSION					
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
SIDE GUY MATERIAL ONLY					
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
MATERIAL USED AS REQUIRED					
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

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

Burns & McDonnell SINCE 1898

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

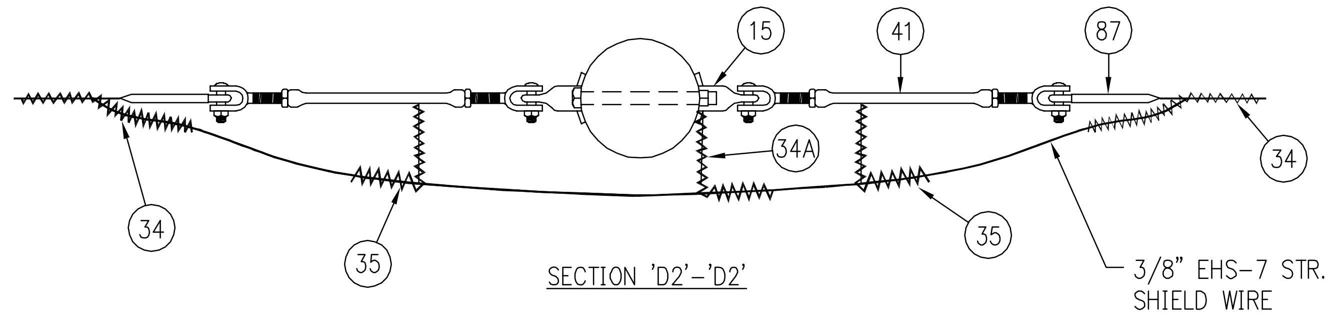
VELCO
VERMONT ELECTRIC POWER CO., INC.
RUTLAND, VERMONT
WEST RUTLAND – NEW HAVEN 345 KV

TANGENT SUSPENSION
BILL OF MATERIALS
TYPE 'A'

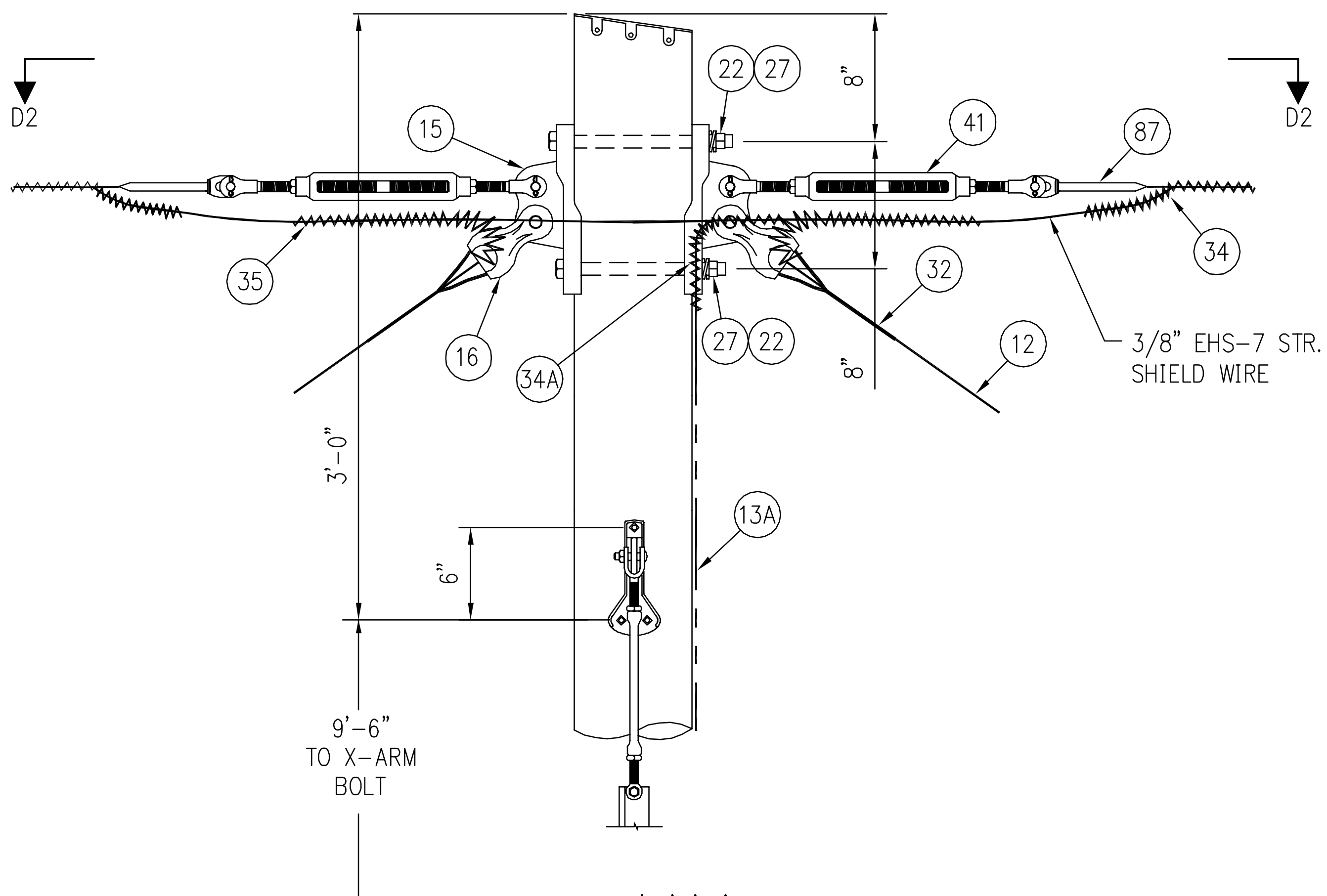
SCALE: NONE | DRAWN BY: BMcD | APPROVED BY:
DATE: 11/05 | CHECKED BY: KAW | DATE
DRAWING NUMBER: 345-1.2 | REV. 1
PLOT: 1=1

FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-1.2.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 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



SECTION 'D2'-'D2'



SECTION 'D1'-'D1'

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 SINCE 1898

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

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

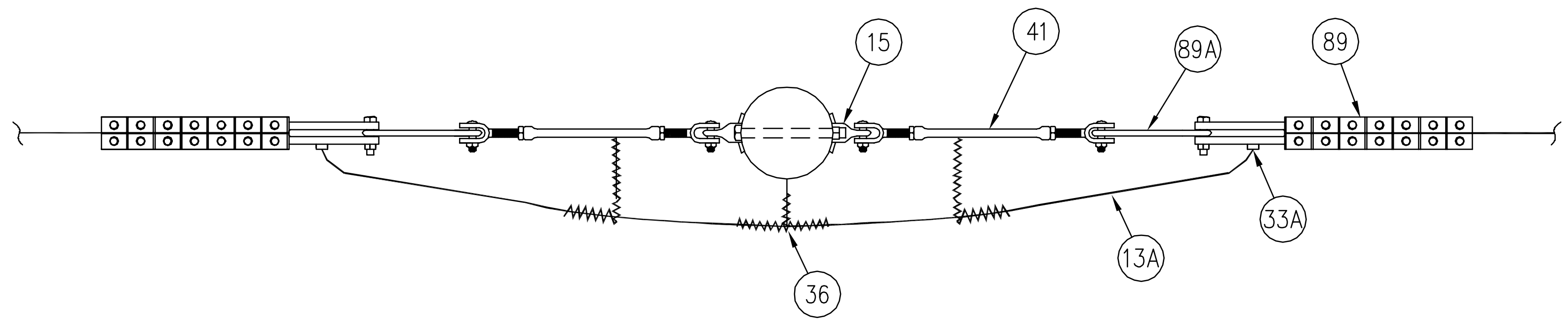
VELCO — VERMONT ELECTRIC POWER CO., INC. RUTLAND, VERMONT

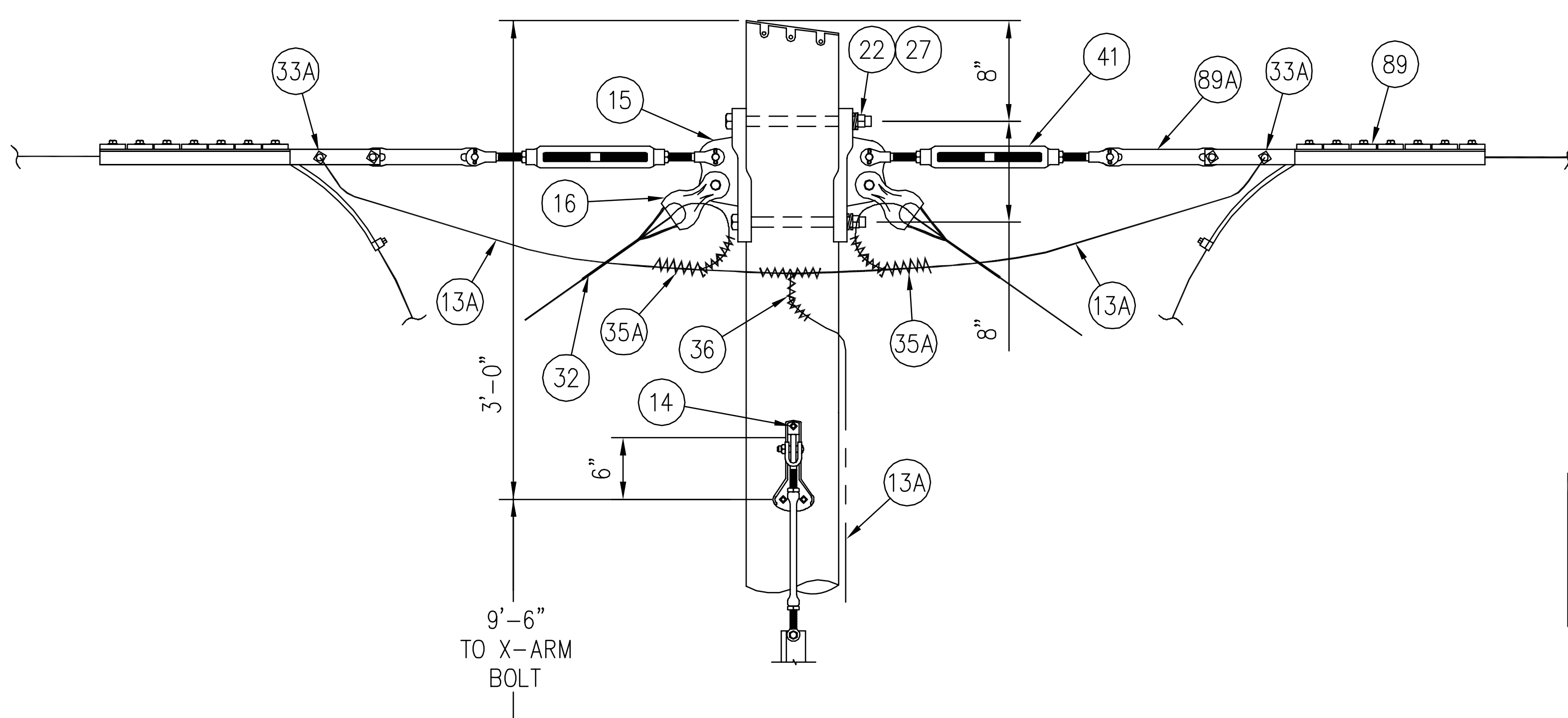
WEST RUTLAND – NEW HAVEN 345 KV

SHIELD WIRE DEAD END ATTACHMENT TYPE 'A' STRUCTURE

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	
DATE: 11/05	CHECKED BY: KAW		DATE
DRAWING NUMBER: PLOT: 1=1	345-1.3		1 REV.

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





SECTION 'D1'-'D1'

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 SINCE 1898

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

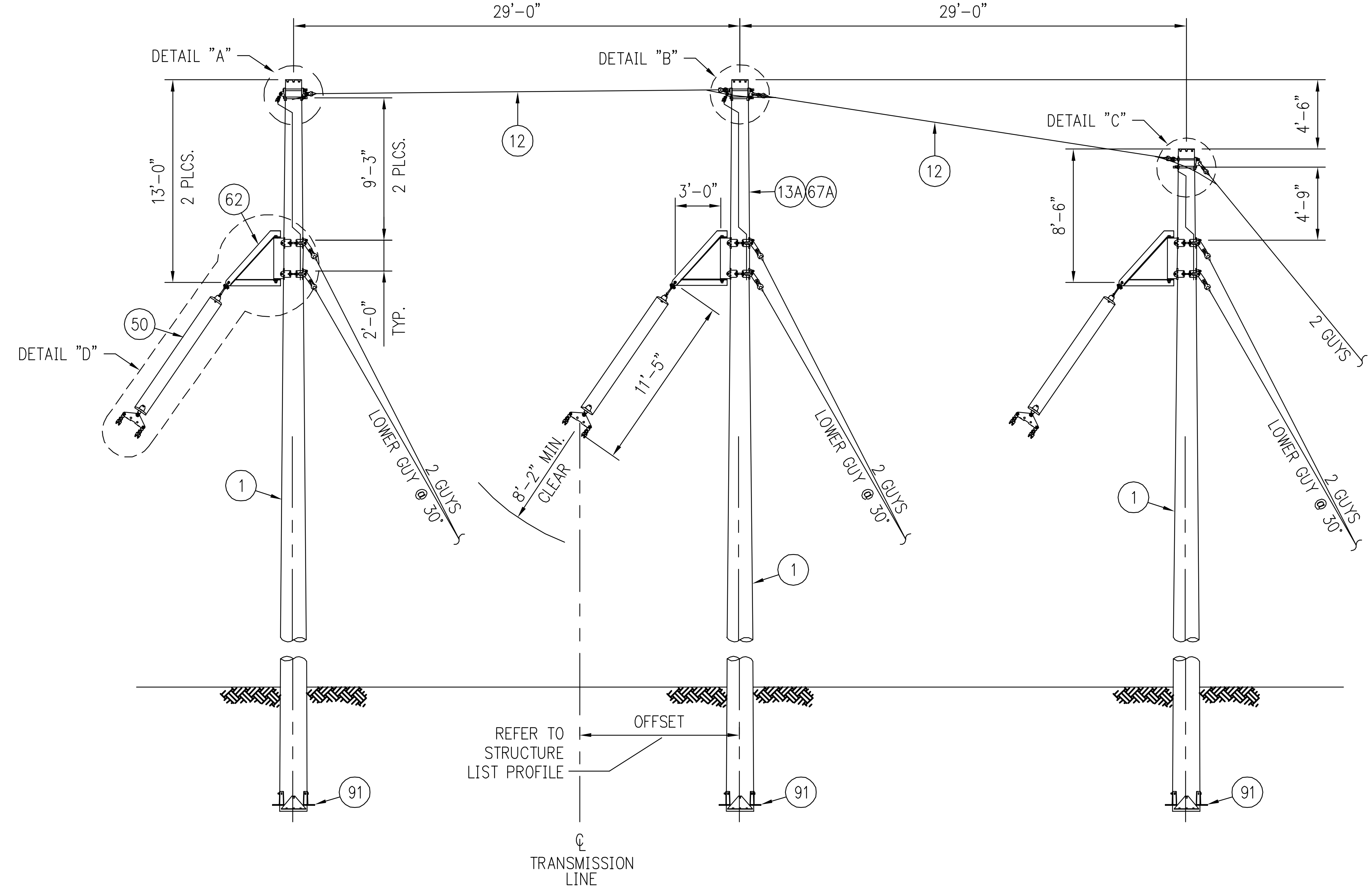
REV	DATE	DR	CK	DESCRIPTION
1	1/01/08	JAH	JRW	CONFORMED TO CONSTRUCTION RECORDS
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

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

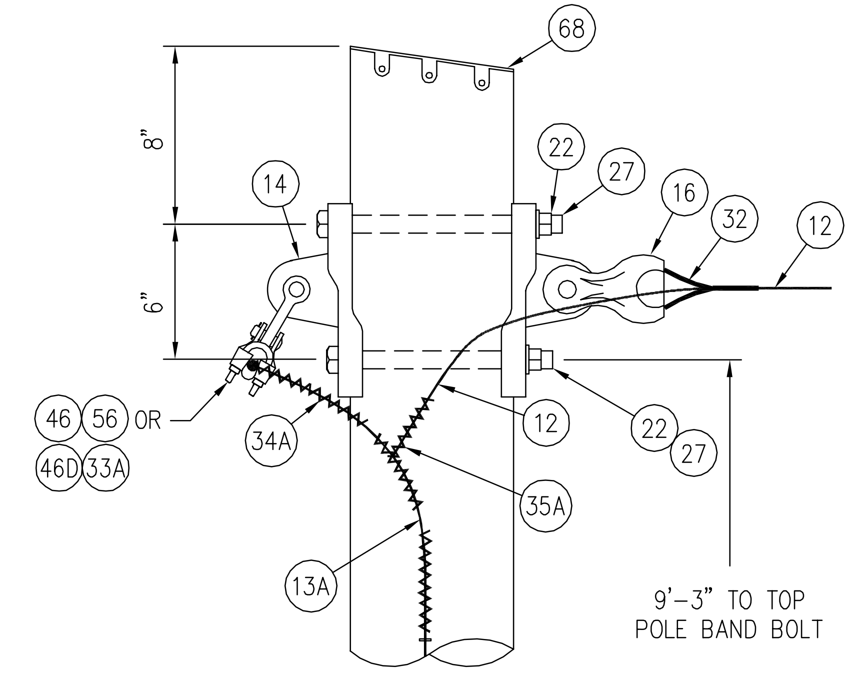
OPTICAL WIRE DEAD END ATTACHMENT TYPE 'A' STRUCTURE

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	
DATE: 11/05	CHECKED BY: KAW		DATE
DRAWING NUMBER: PLOT: 1=1	345-1.4		1 REV.

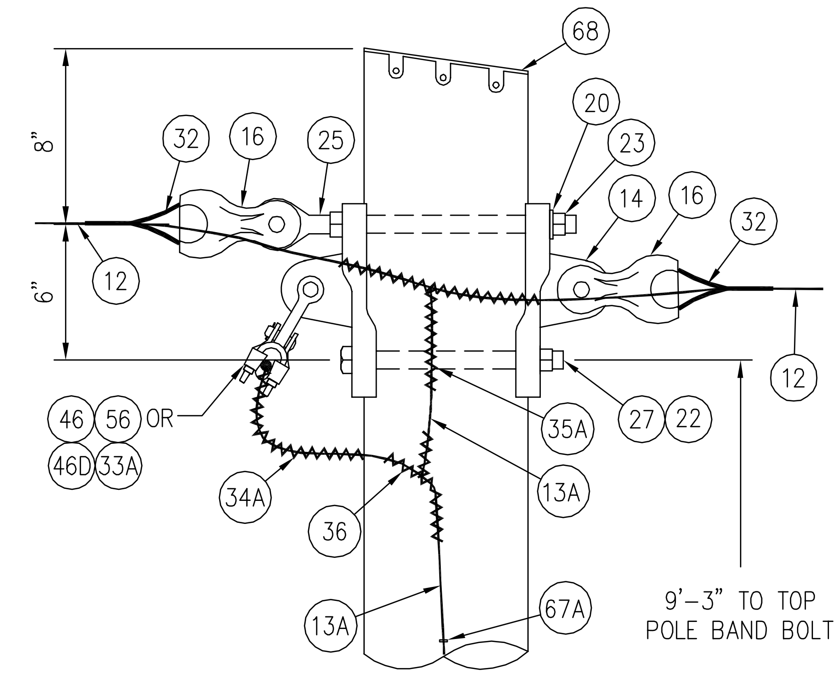
FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-1.4.dwg 02-07-2006 11:29 DSM BMcD



ELEVATION



DETAIL "A"



DETAIL "B"

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 1898

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

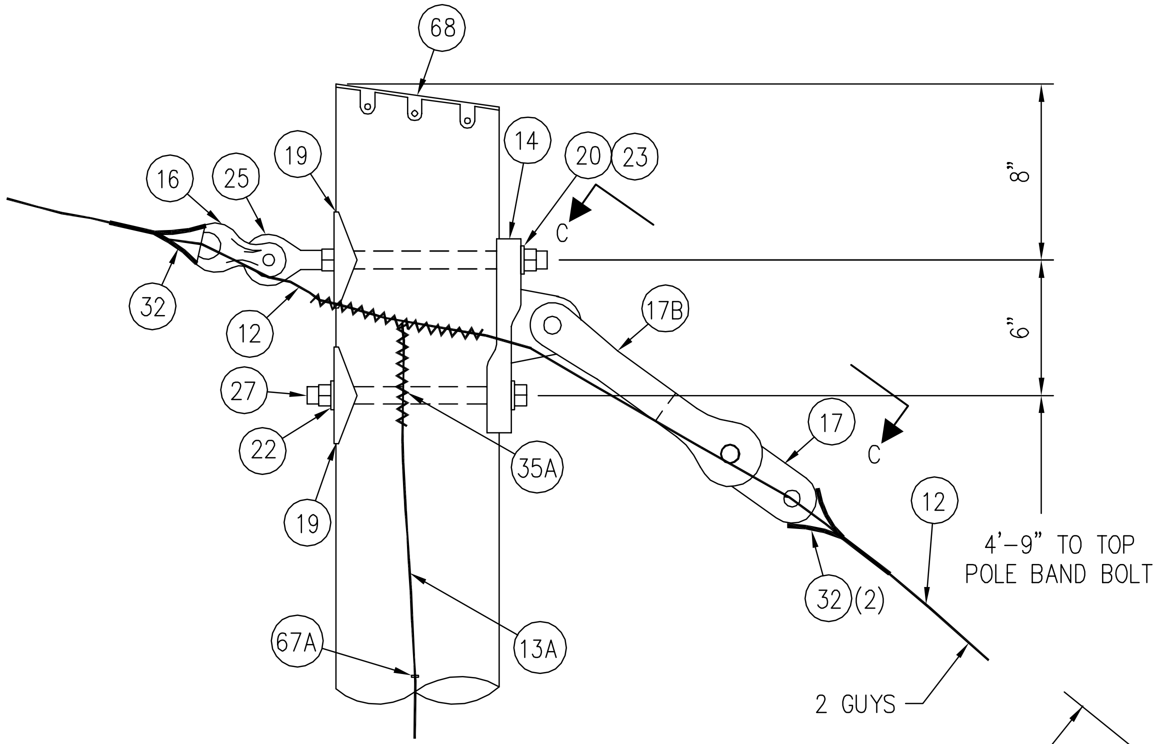
REV	DATE	DR	CK	DESCRIPTION
1	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

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

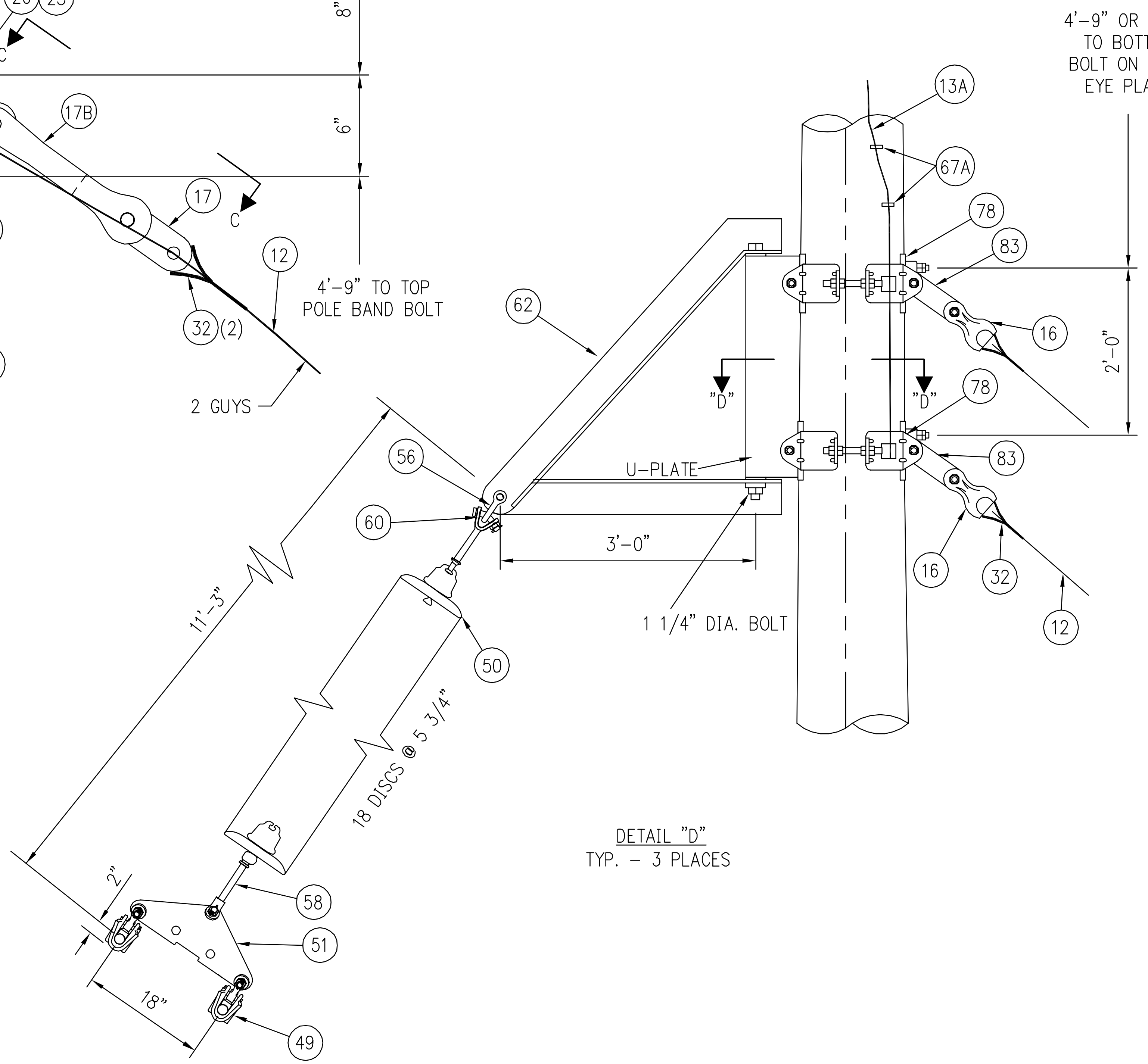
SUSPENSION ANGLE STRUCTURE
TYPE 'SA2' (12° TO 22°)

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

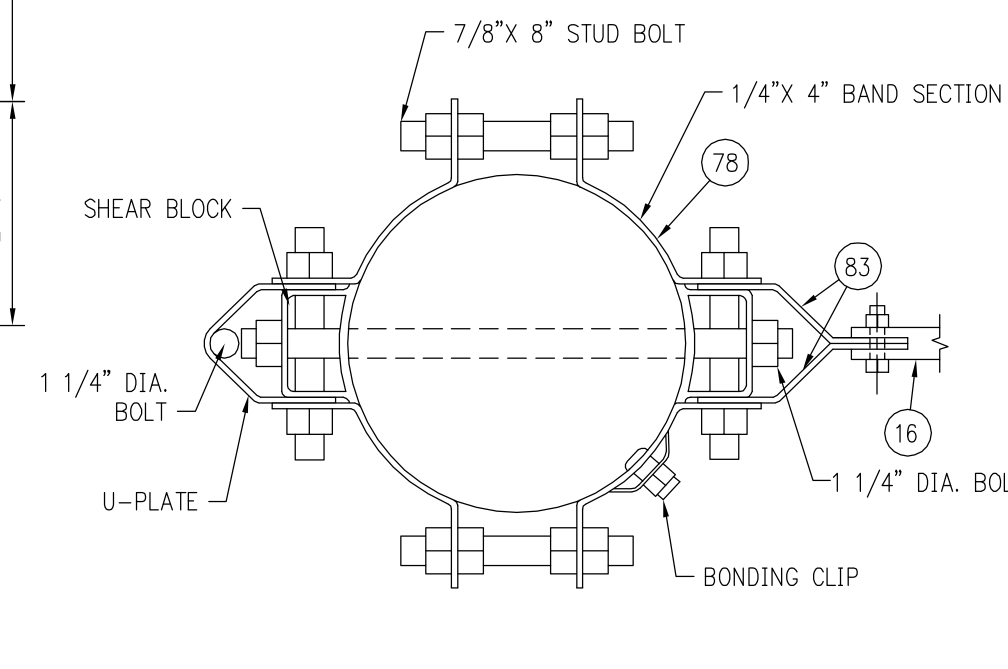
FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-3.0.dwg 02-07-2006 13:26 DSM BMcD



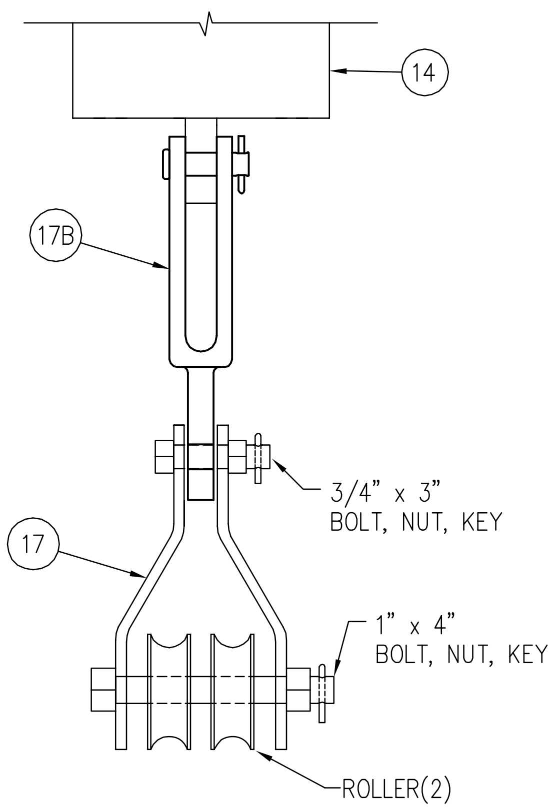
DETAIL "C"



DETAIL "D"
TYP. – 3 PLACES



SECTION "D"-"D"



SECTION C-C

Burns & McDonnell
SINCE 1898

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

PROPRIETARY
This document is the property of
Vermont Electric Power Company, Inc.
and contains proprietary and confidential information
which must not be duplicated, used or disclosed other
than as expressly authorized by
Vermont Electric Power Company, Inc.

REV	DATE	DR	CK	DESCRIPTION
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

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

SUSPENSION ANGLE
POLE TOP DETAILS
TYPE 'SA2' (12° TO 22°)

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	
DATE: 11/05	CHECKED BY: KAW		DATE
DRAWING NUMBER: PLOT: 1=1	345–3.1		2 REV.

FILE: N:\Velco\36445 NR-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

Burns & McDonnell SINCE 1898

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

REV	DATE	DR	CK	DESCRIPTION
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

VELCO

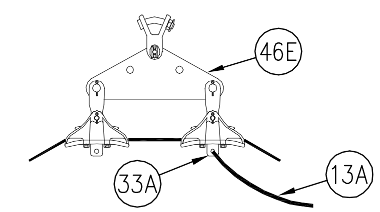
VERMONT ELECTRIC POWER CO., INC.
RUTLAND, VERMONT

WEST RUTLAND – NEW HAVEN 345 KV

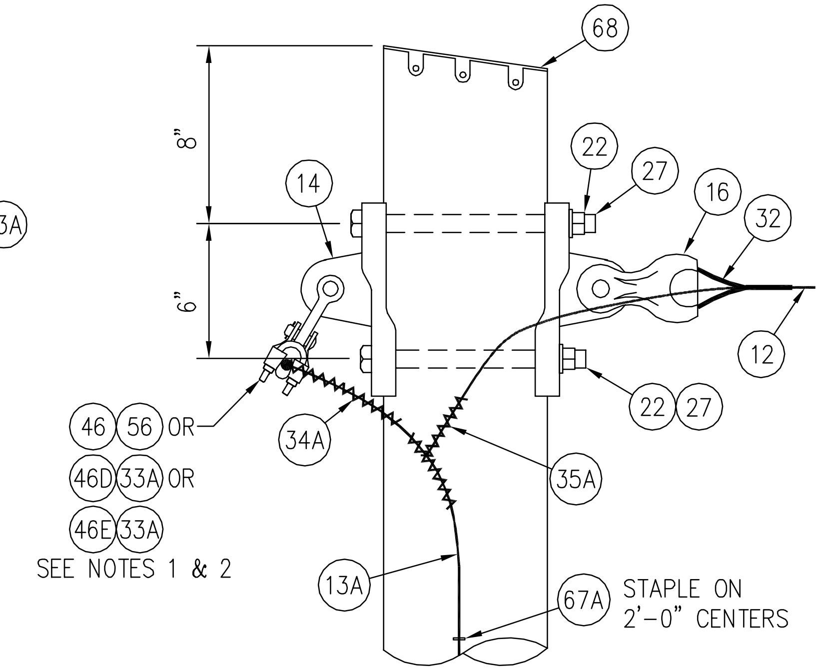
SUSPENSION ANGLE
BILL OF MATERIALS
TYPE 'SA2' (12° TO 22°)

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.

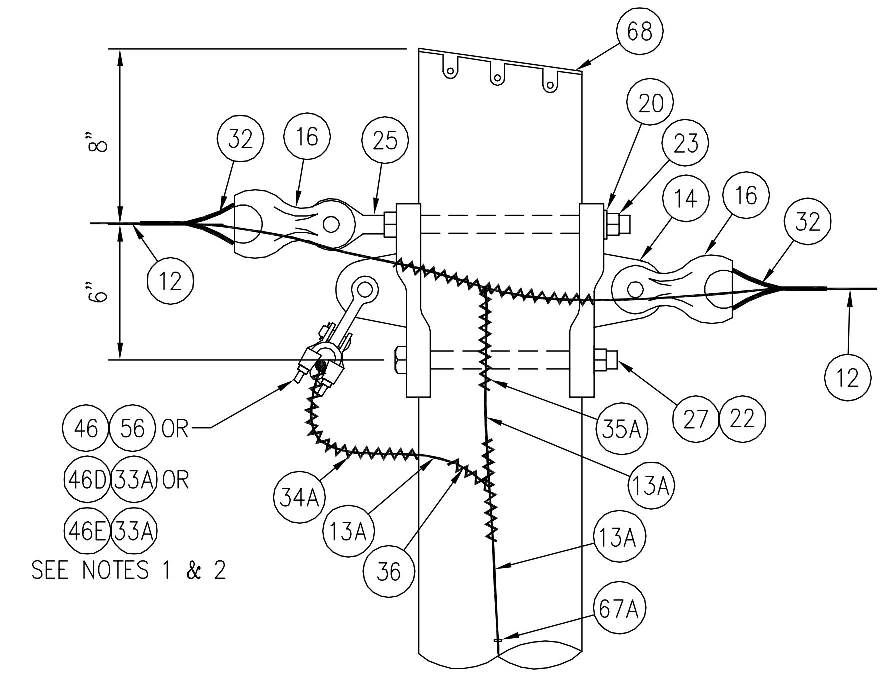
FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-3.2.dwg 02-07-2006 13:26 DSM BMcD



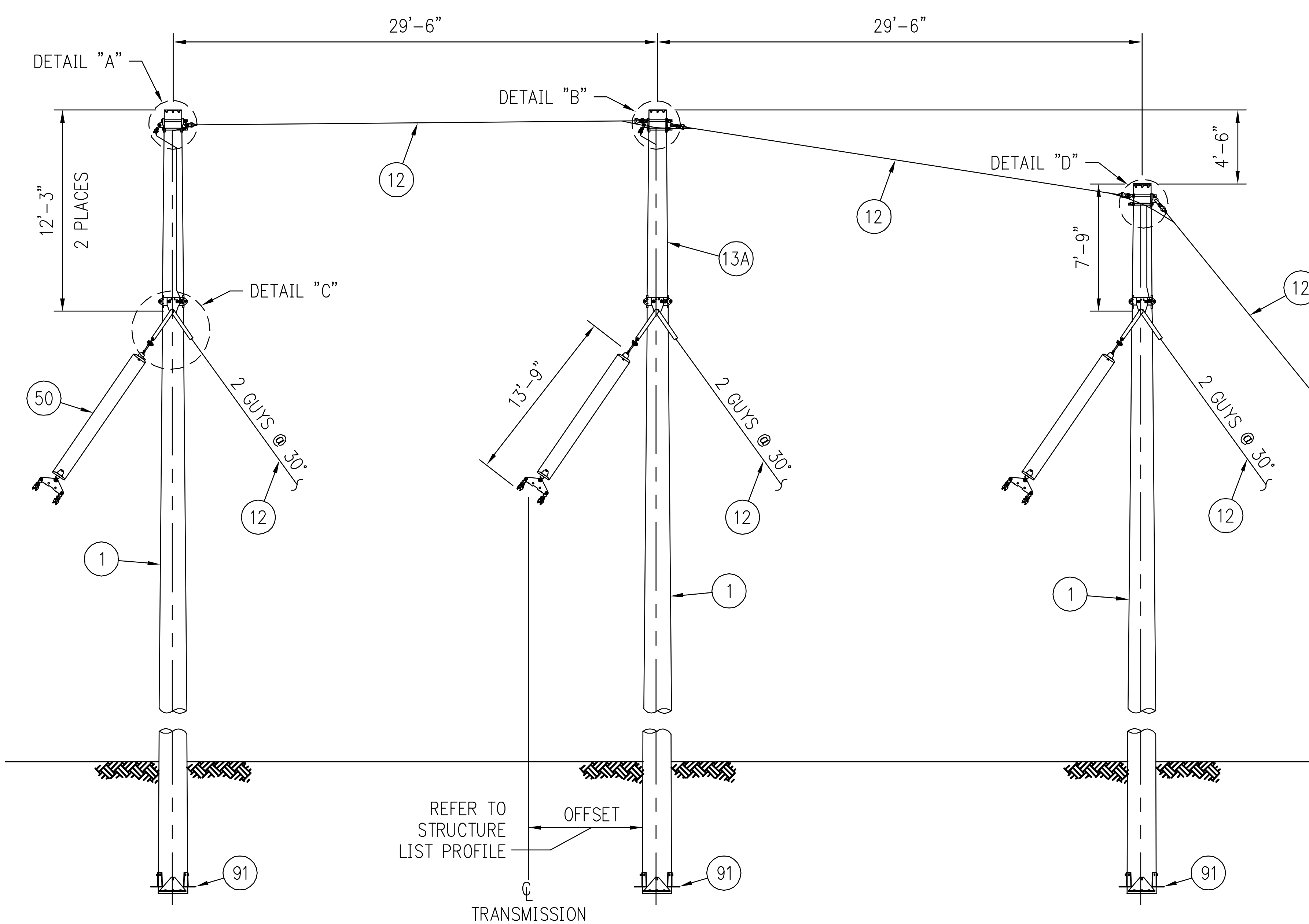
DOUBLE OPTICAL WIRE SUSPENSION ASSEMBLY
(SEE NOTES 1 & 2)



DETAIL "A"



DETAIL "B"



ELEVATION

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

Burns & McDonnell SINCE 1898

CONFORMED TO CONSTRUCTION RECORDS

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

VELCO

VERMONT ELECTRIC POWER CO., INC.
RUTLAND, VERMONT

WEST RUTLAND – NEW HAVEN 345 KV

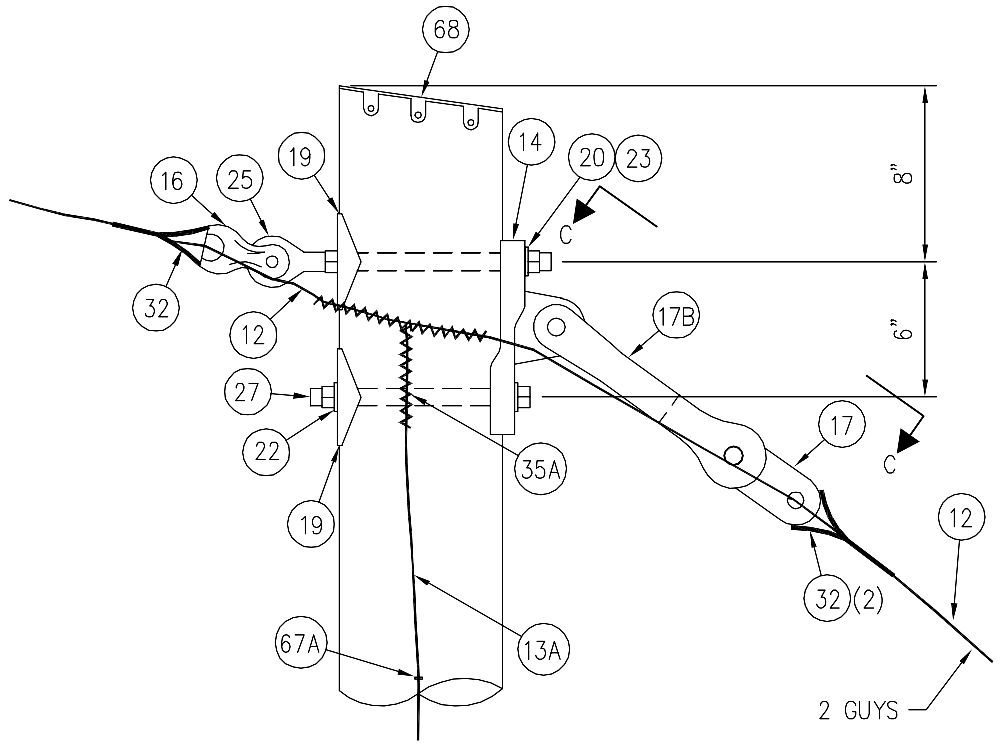
SUSPENSION ANGLE STRUCTURE
TYPE 'SA3' (22° TO 35°)

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	
DATE: 11/05	CHECKED BY: KAW		DATE
DRAWING NUMBER: PLOT: 1=1	345–4.0		1 REV.

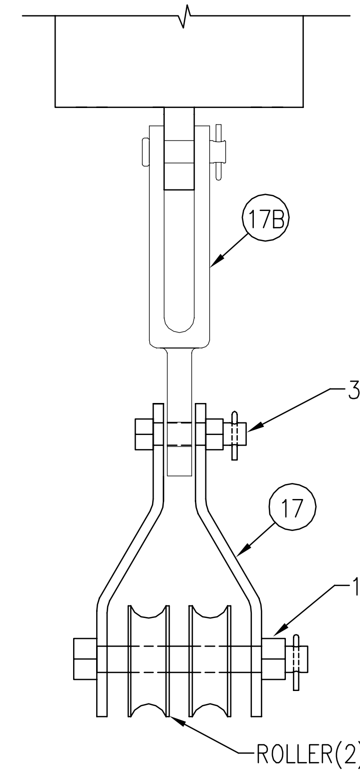
FILE: N:\Velco\36445 WR–NH EP\Cadd\STANDARD POLES\345KV\345-4.0.dwg 02-07-2006 13:12 DSM BMcD

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

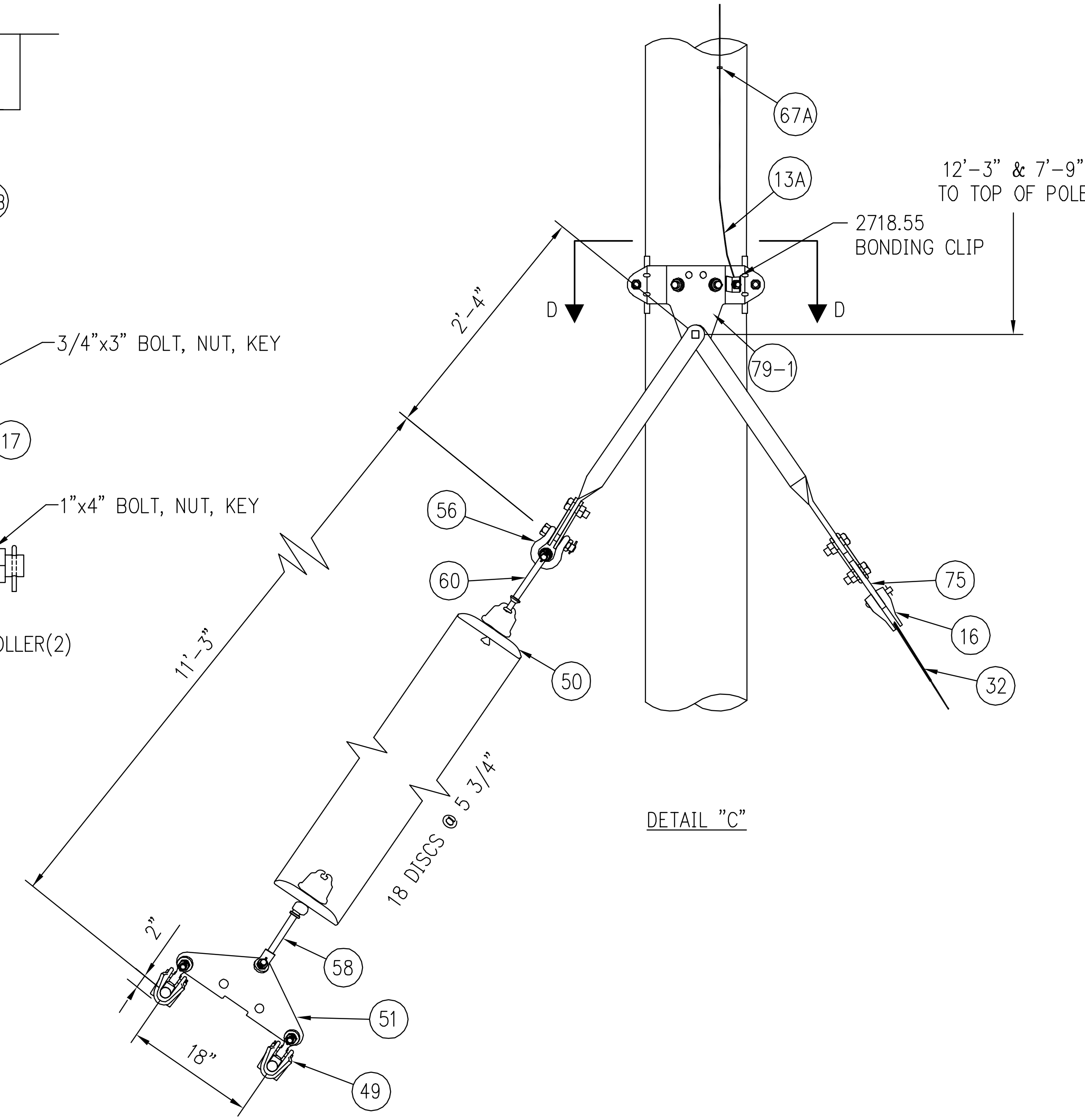
FOR ANCHOR AND GUY GROUNDING DETAILS, SEE DWG. #345–10.0 & #345–10.1
FOR POLE GUYING DETAILS, SEE DWG. #345–10.2
FOR GROUNDING DETAILS, SEE DWG. #345–11.0
FOR FOUNDATION DETAILS, SEE DWG. #345–FDN–1 THRU FDN–4



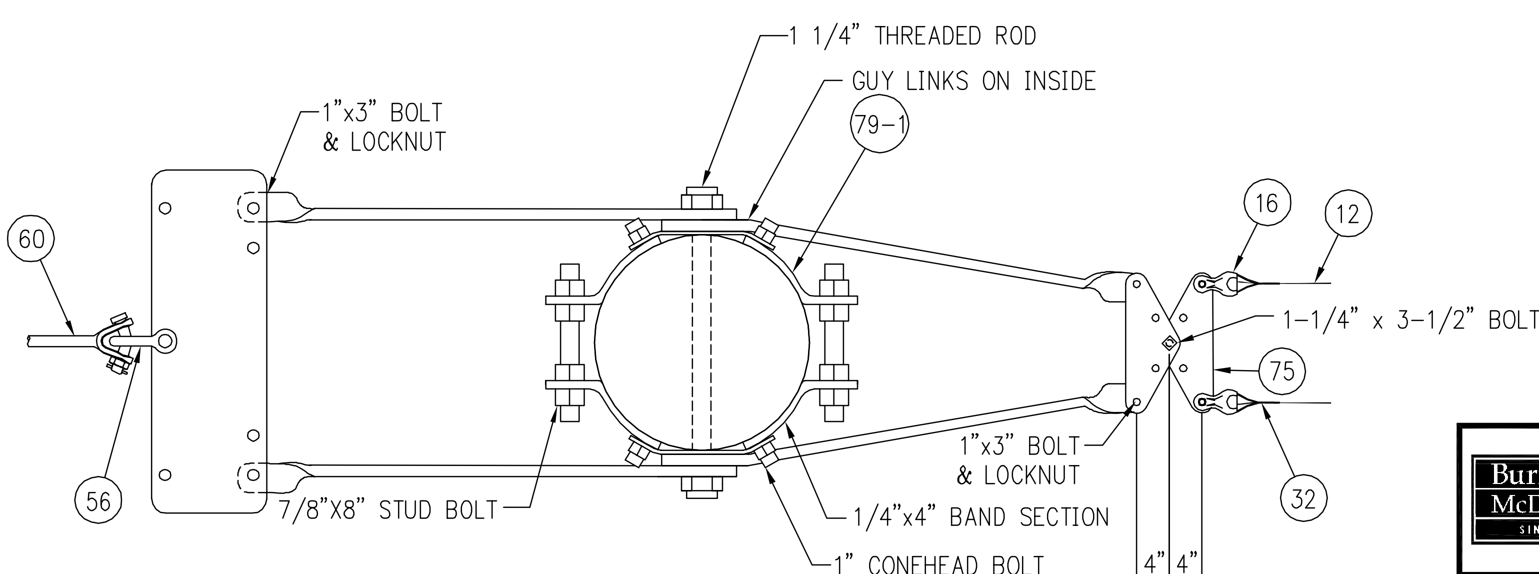
DETAIL "D"



SECTION C–C



DETAIL "C"



SECTION D–D

Burns & McDonnell
SINCE 1898

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

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: PLOT: 1=1	345–4.1		2 REV.

FILE: N:\Velco\36445 MR-NH EP\Codd\STANDARD POLES\345KV\345-4.1.dwg 02-07-2006 13:12 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 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
MATERIAL REQUIRED FOR DOUBLE OPTICAL WIRE SUSPENSION					
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
MATERIAL USED AS REQUIRED					
68	0204390	AR	POLE ROOF, NON METALLIC	OSMOSE	70-110-020-016

Burns & McDonnell SINCE 1898

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

PROPRIETARY
This document is the property of Vermont Electric Power Company, Inc. and contains proprietary and confidential information which must not be duplicated, used or disclosed other than as expressly authorized by Vermont Electric Power Company, Inc.

REV	DATE	DR	CK	DESCRIPTION
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

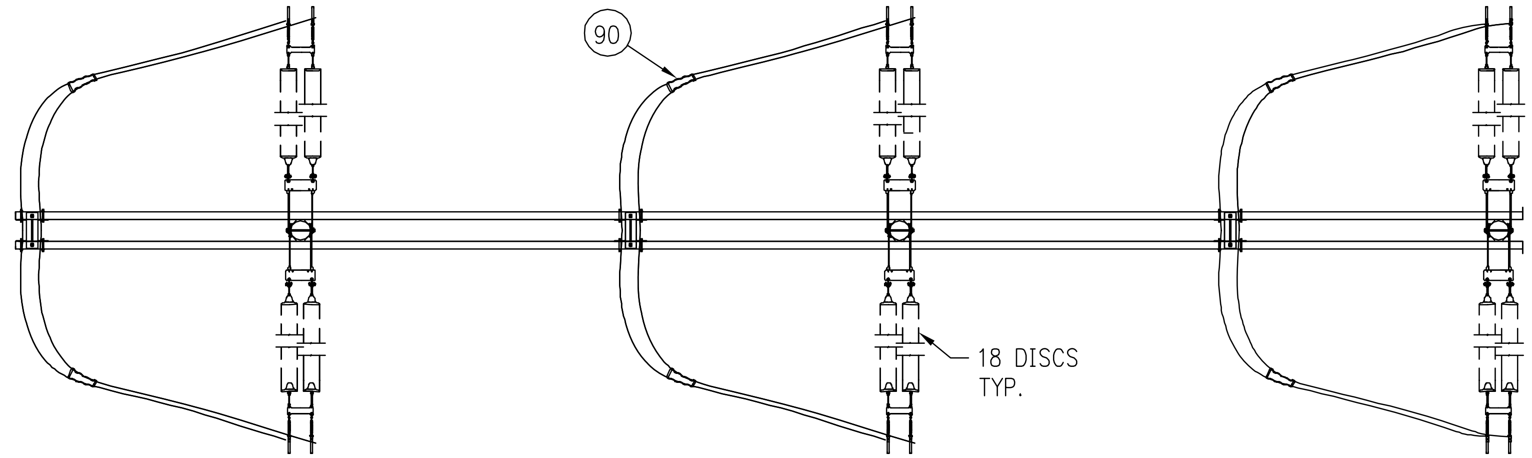
VELCO

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

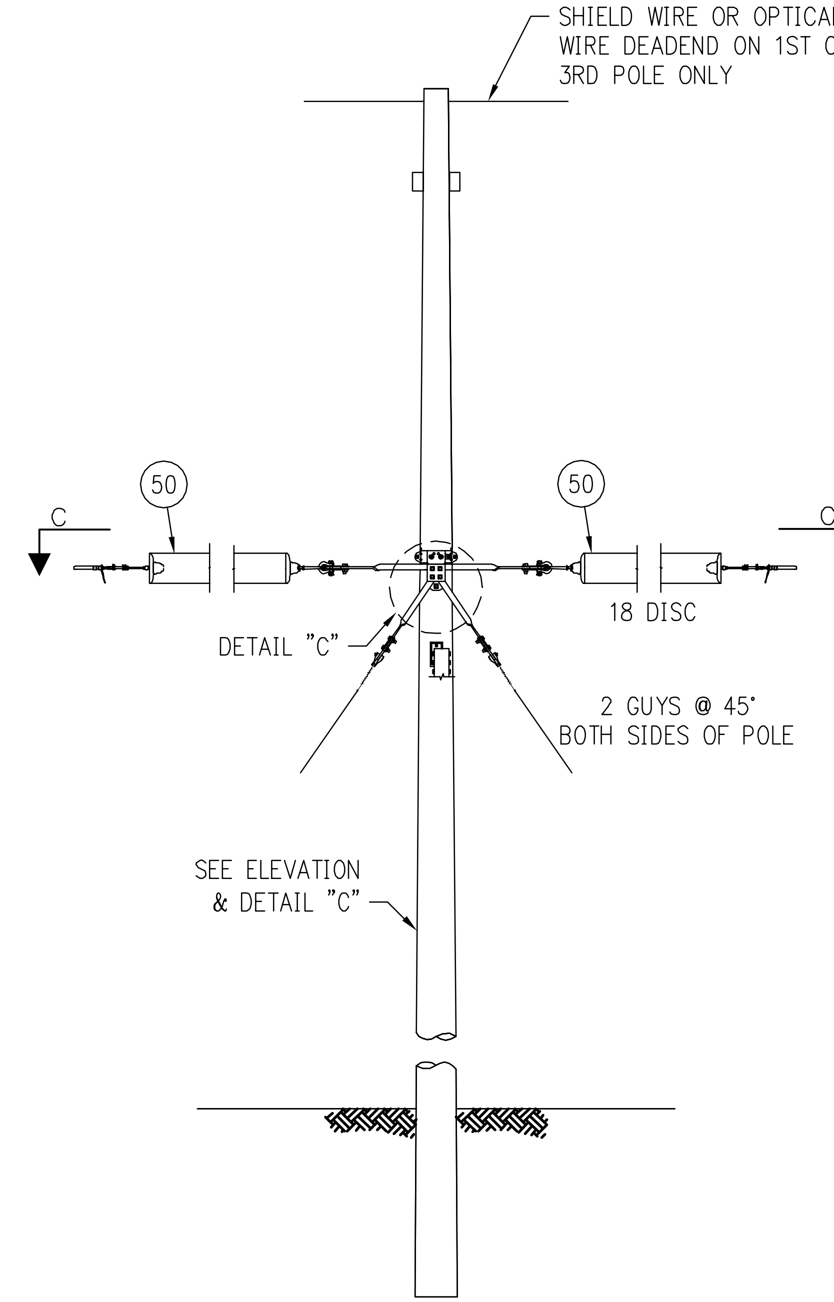
SUSPENSION ANGLE
BILL OF MATERIALS
TYPE 'SA3' (22° TO 35°)

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

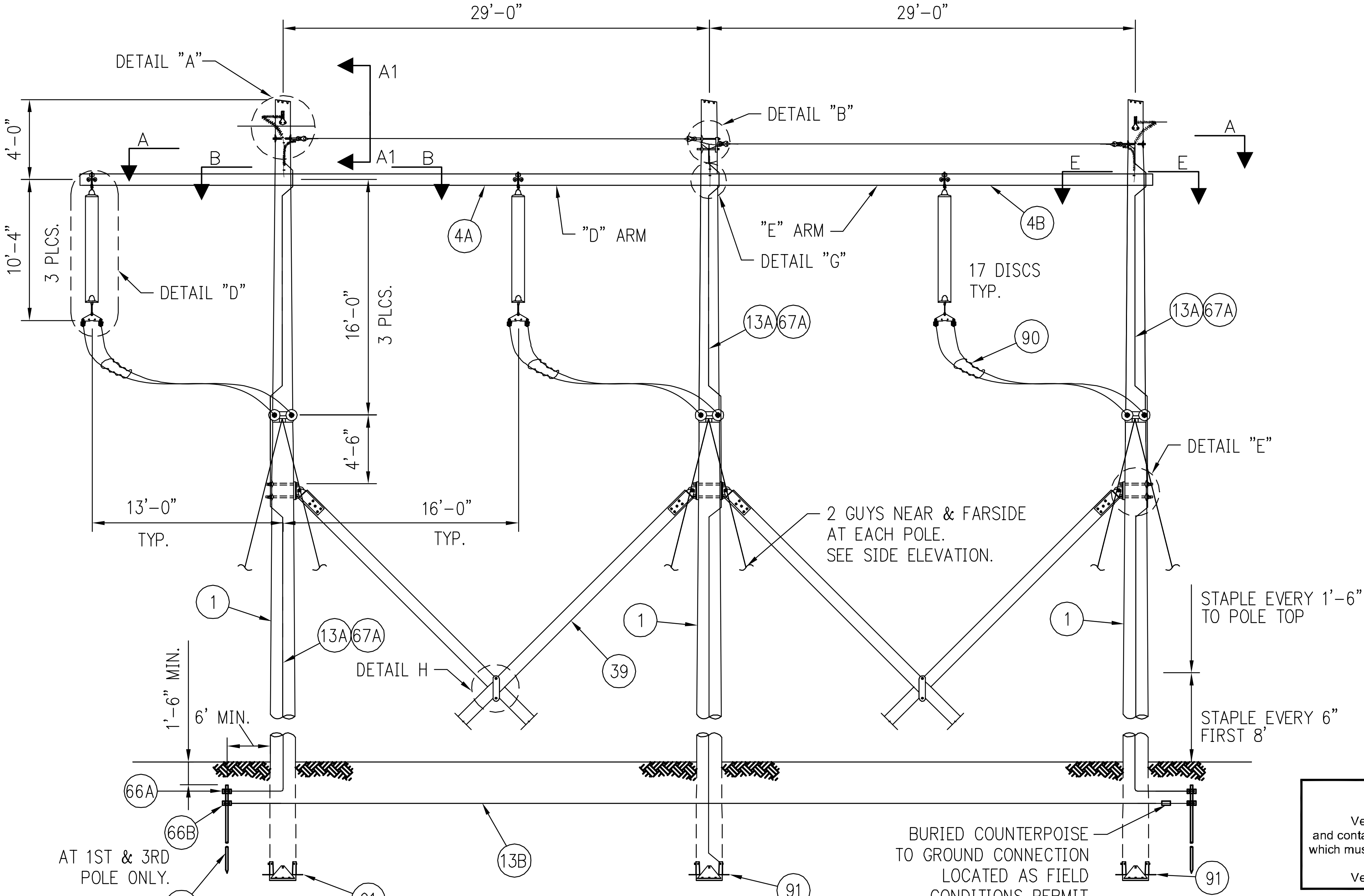
FILE: N:\Velco\36445 NR-NH EP\Cadd\STANDARD POLES\345KV\345-4.2.dwg 02-07-2006 13:12 DSM BMcD



SECTION A–A



SIDE ELEVATION
TYPICAL



ELEVATION

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 1898

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

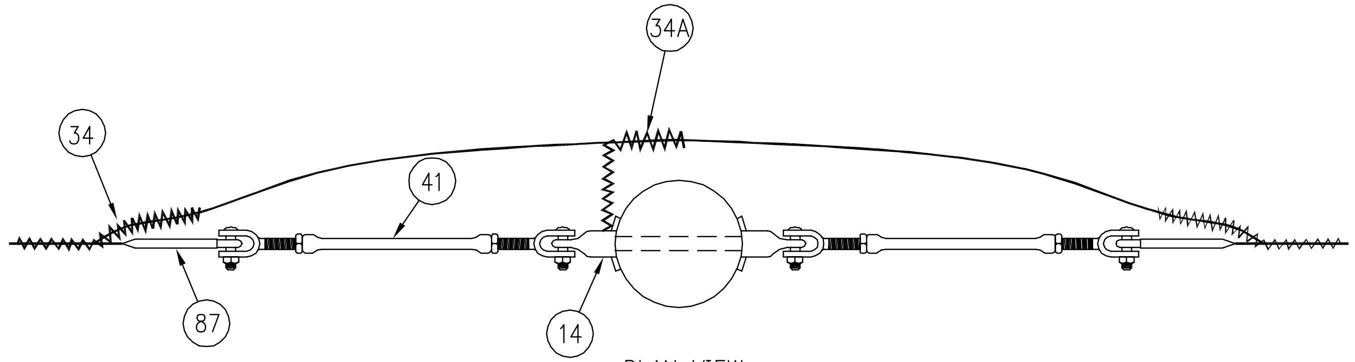
REV	DATE	DR	CK	DESCRIPTION
2	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
1	6/14/06	CSM	JRW	REVISED POLE BAND MATERIALS AND RE–ISSUED FOR CONSTRUCTION
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

VELCO — VERMONT ELECTRIC POWER CO., INC.
RUTLAND, VERMONT
WEST RUTLAND – NEW HAVEN 345 KV

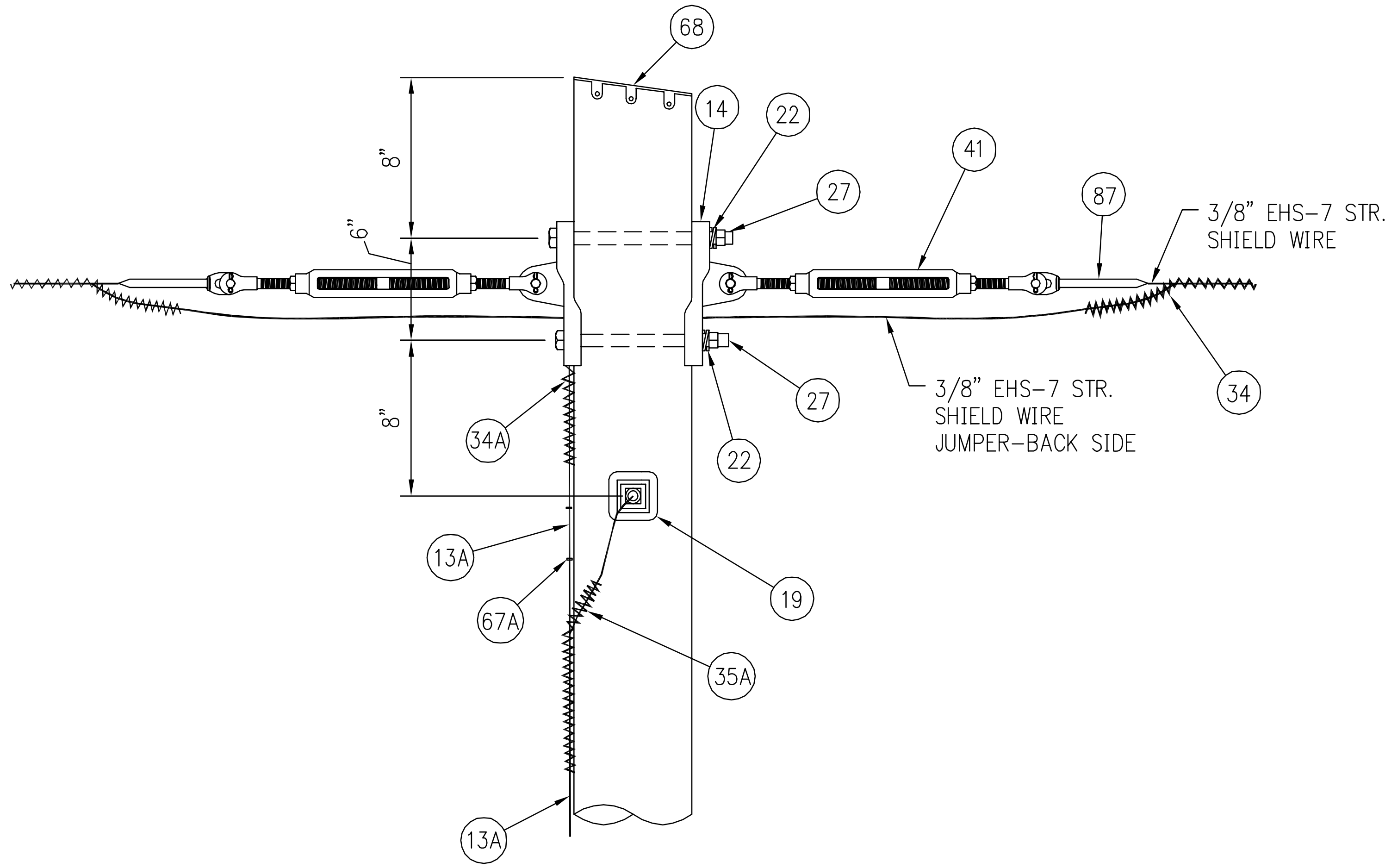
STRAIGHT LINE DEAD END
STRUCTURE
TYPE 'DE1'

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

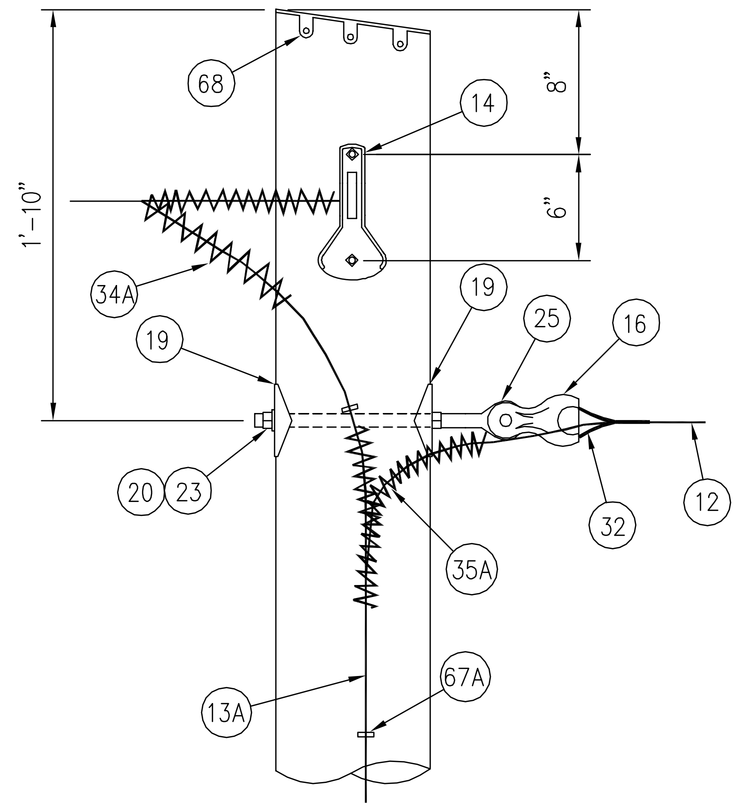
FILE: N:\Velco\36445 WR–NH EP\Cadd\STANDARD POLES\345KV\345–5.0.dwg 02–07–2006 13:12 DSM BMcD



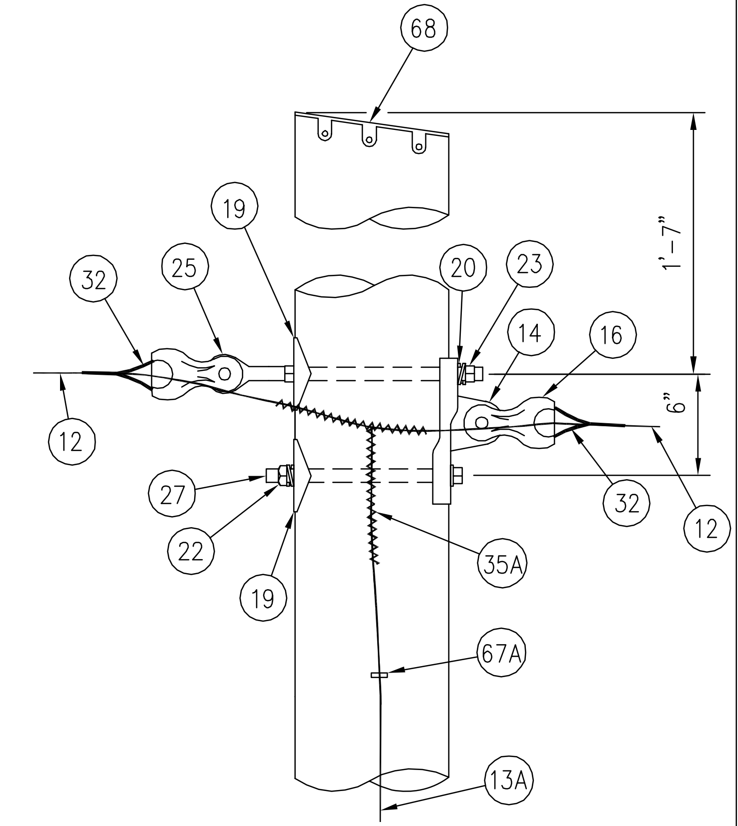
PLAN VIEW
(ITEMS AT SHIELD WIRE LEVEL SHOWN ONLY)



SECTION 'A1'-'A1'
(SIDE ELEV.)
(TYPICAL 1ST & 3RD POLE)



DETAIL "A"
(TYPICAL 1ST & 3RD POLE)



DETAIL "B"

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

Burns & McDonnell
SINCE 1898

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

VELCO

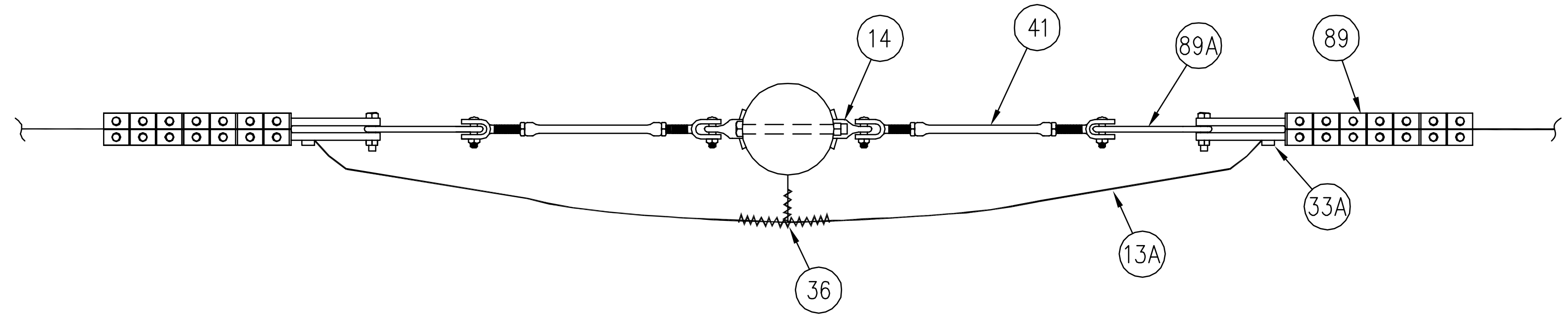
VERMONT ELECTRIC POWER CO., INC.
RUTLAND, VERMONT

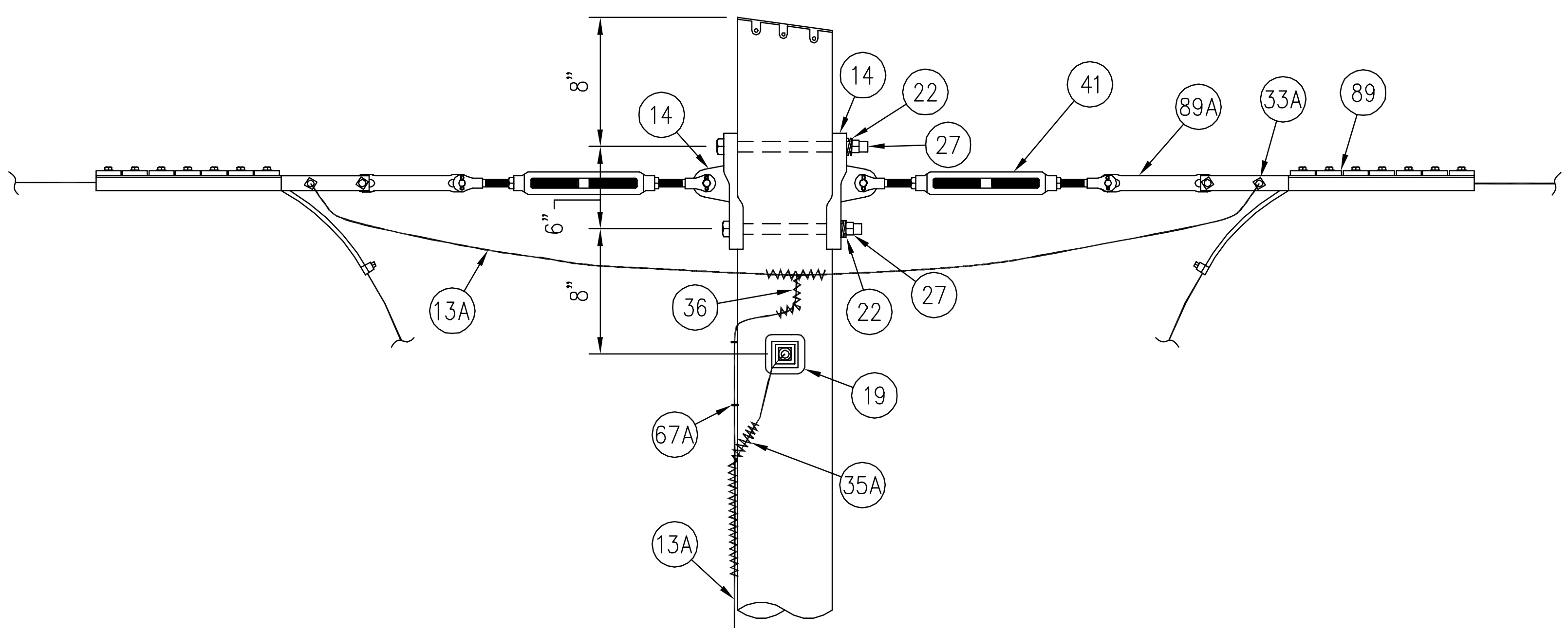
WEST RUTLAND – NEW HAVEN 345 KV

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: PLOT: 1=1	345–5.1		1 REV.

FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-5.1.dwg 02-07-2006 13:12 DSM BMcD





SECTION 'A1'-'A1'

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

Burns & McDonnell SINCE 1898

CONFORMED TO CONSTRUCTION RECORDS

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

VELCO

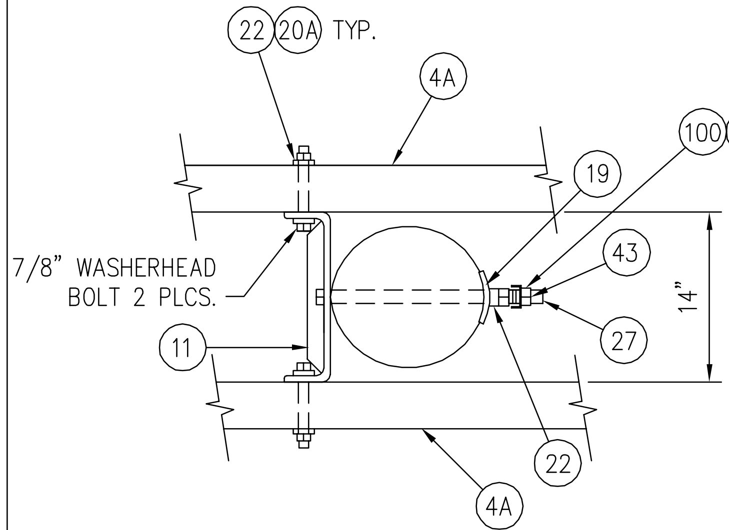
VERMONT ELECTRIC POWER CO., INC.
RUTLAND, VERMONT

WEST RUTLAND – NEW HAVEN 345 KV

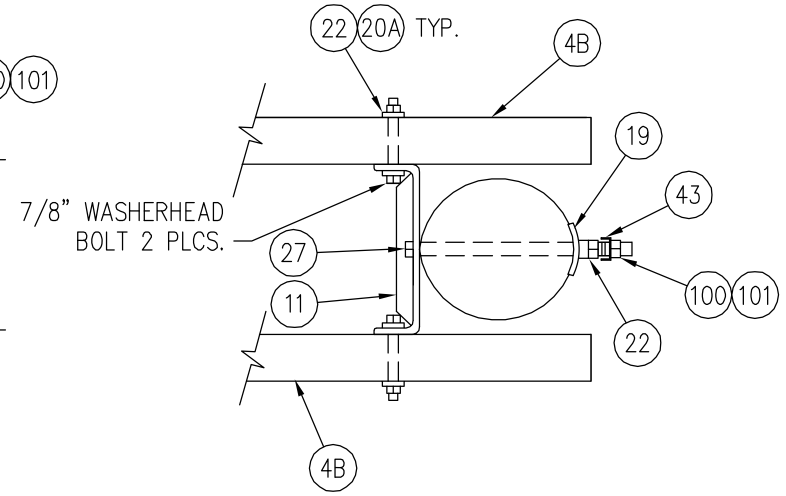
STRAIGHT LINE DEAD END
OPTICAL WIRE DEADEND
TYPE 'DE1'

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	
DATE: 11/05	CHECKED BY: KAW		DATE
DRAWING NUMBER: PLOT: 1=1	345–5.2		1 REV.

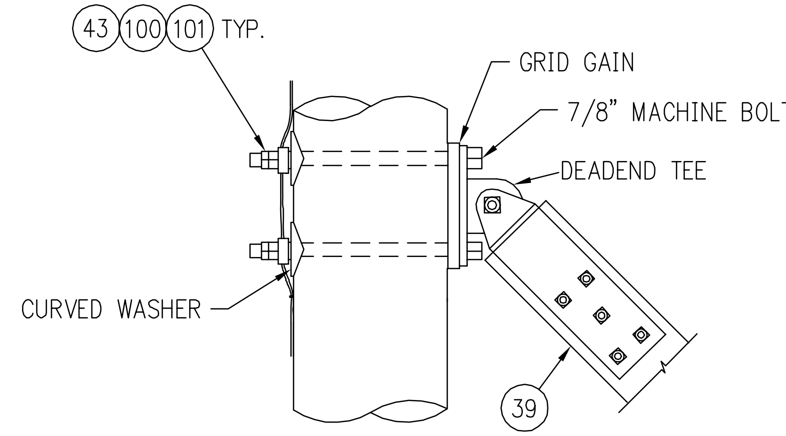
FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-5.2.dwg 02-07-2006 13:12 DSM BMcD



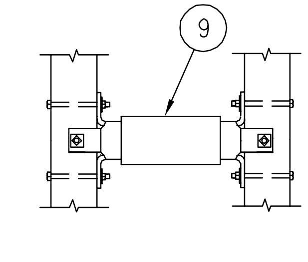
SECT. B-B



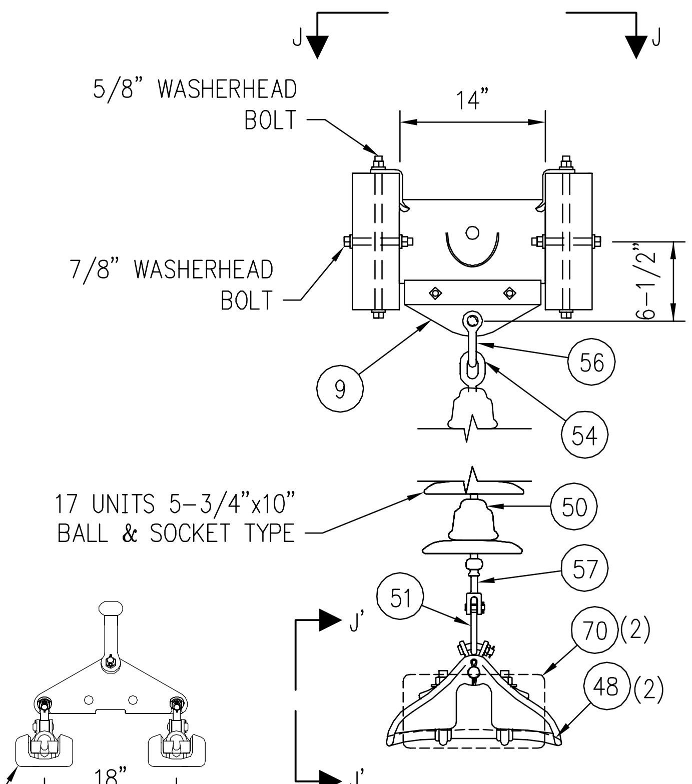
SECT. E-E



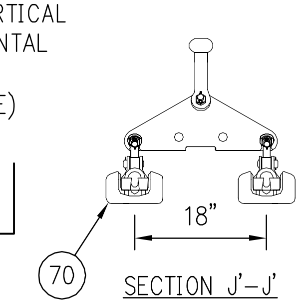
DETAIL "E"
(TYPICAL 1ST & 3RD POLE)



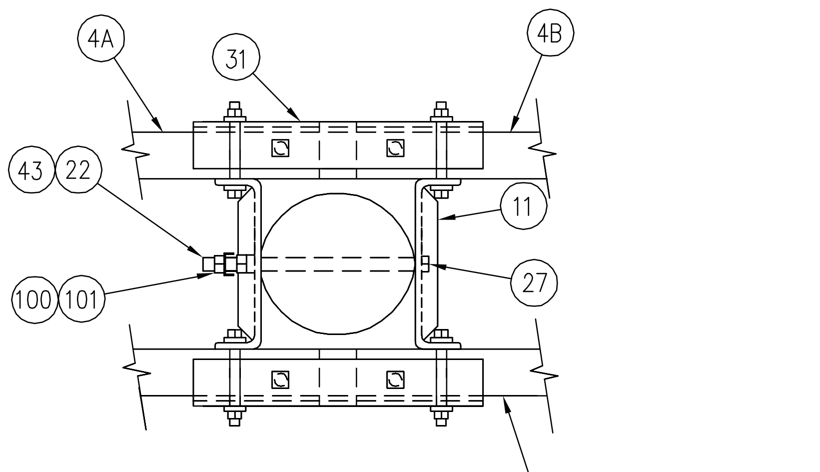
DETAIL J-J



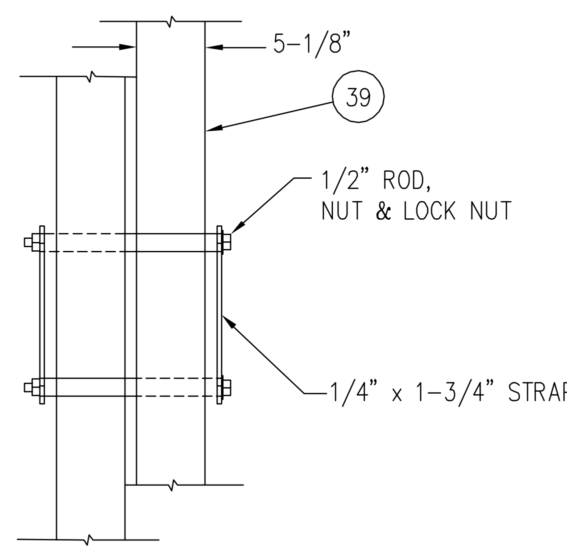
DETAIL "D"
SIDE ELEV.
TYPICAL 3 PLACES



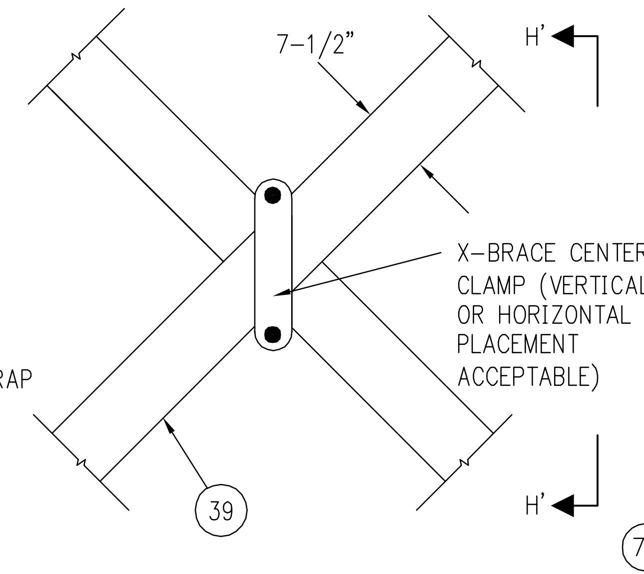
SECTION J'-J'



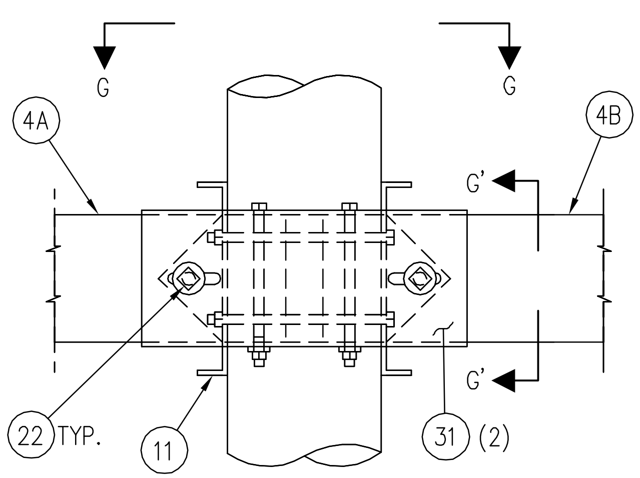
SECT. G-G



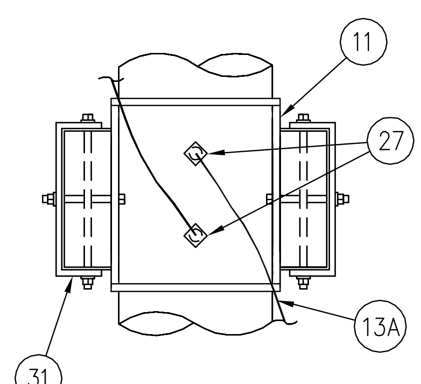
SECTION H'-H'



DETAIL H



DETAIL "G"



SECT. G'-G'

Burns & McDonnell
SINCE 1898

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

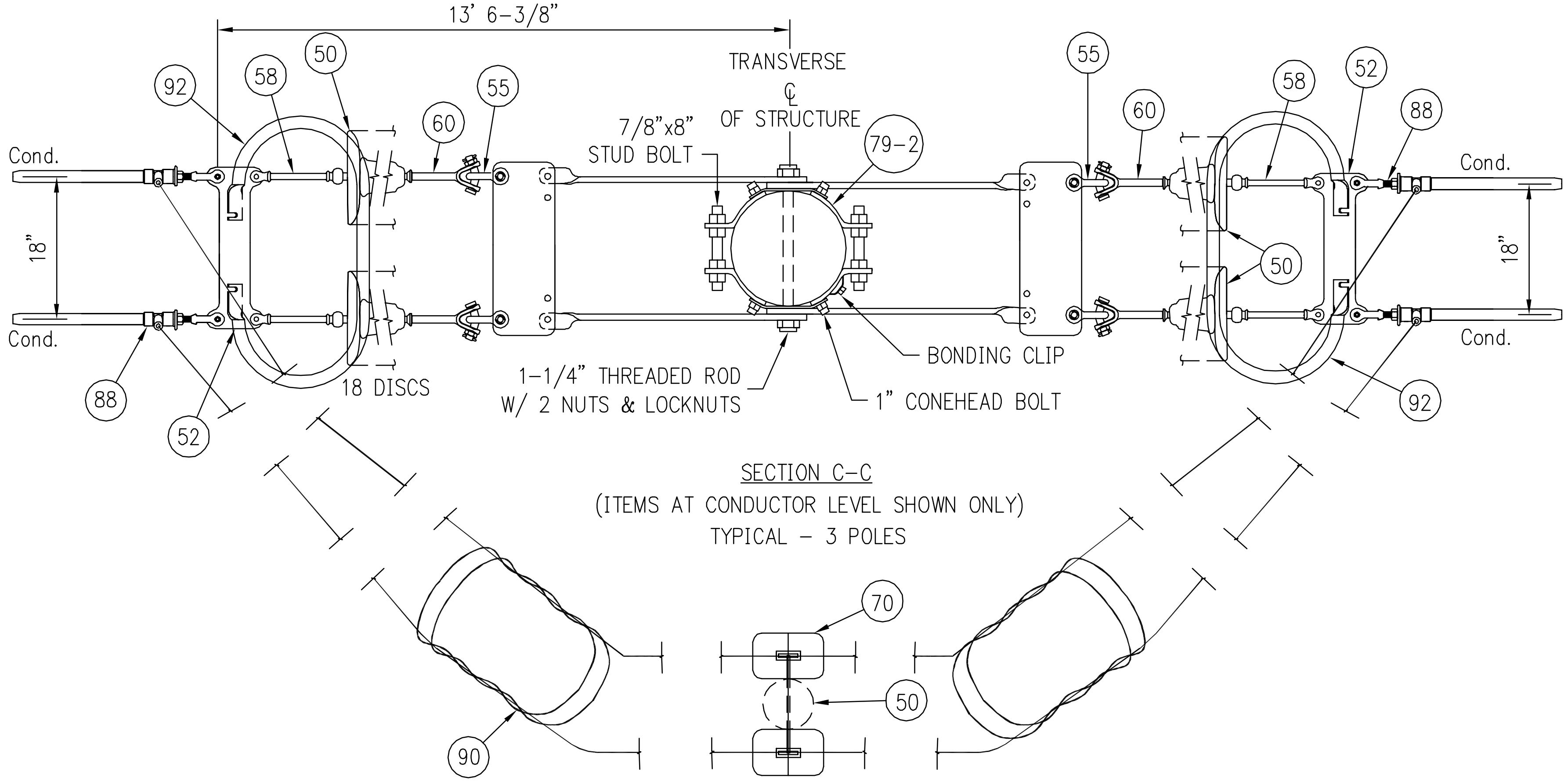
REV	DATE	DR	CK	DESCRIPTION
1	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

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

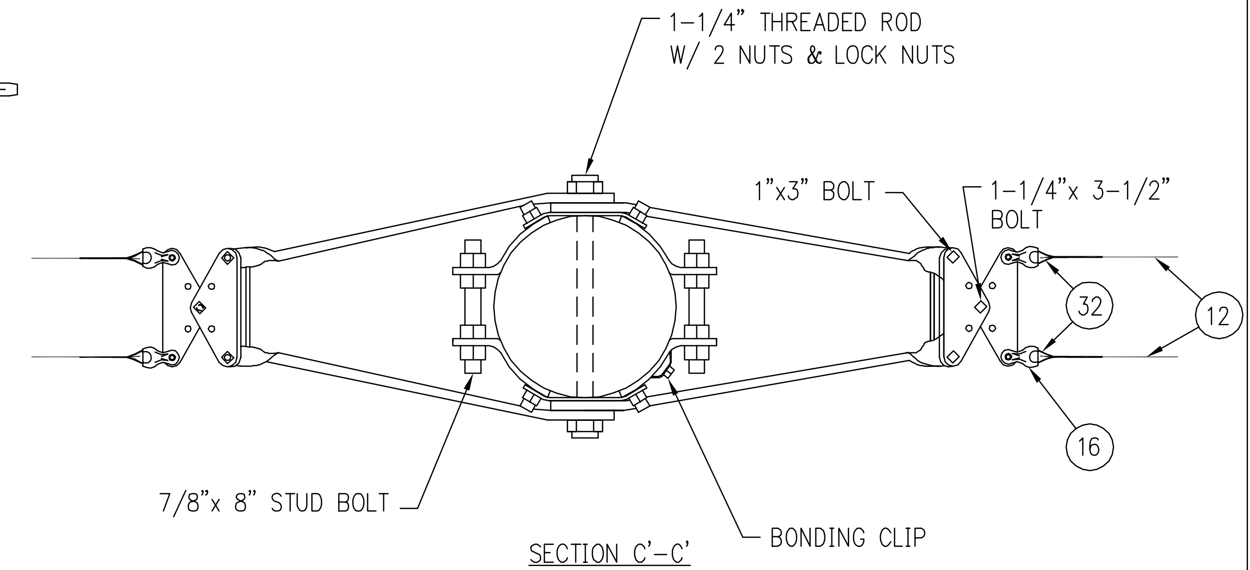
STRAIGHT LINE DEAD END
POLE TOP DETAILS – TIMBER CONNECTIONS
TYPE 'DE1'

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

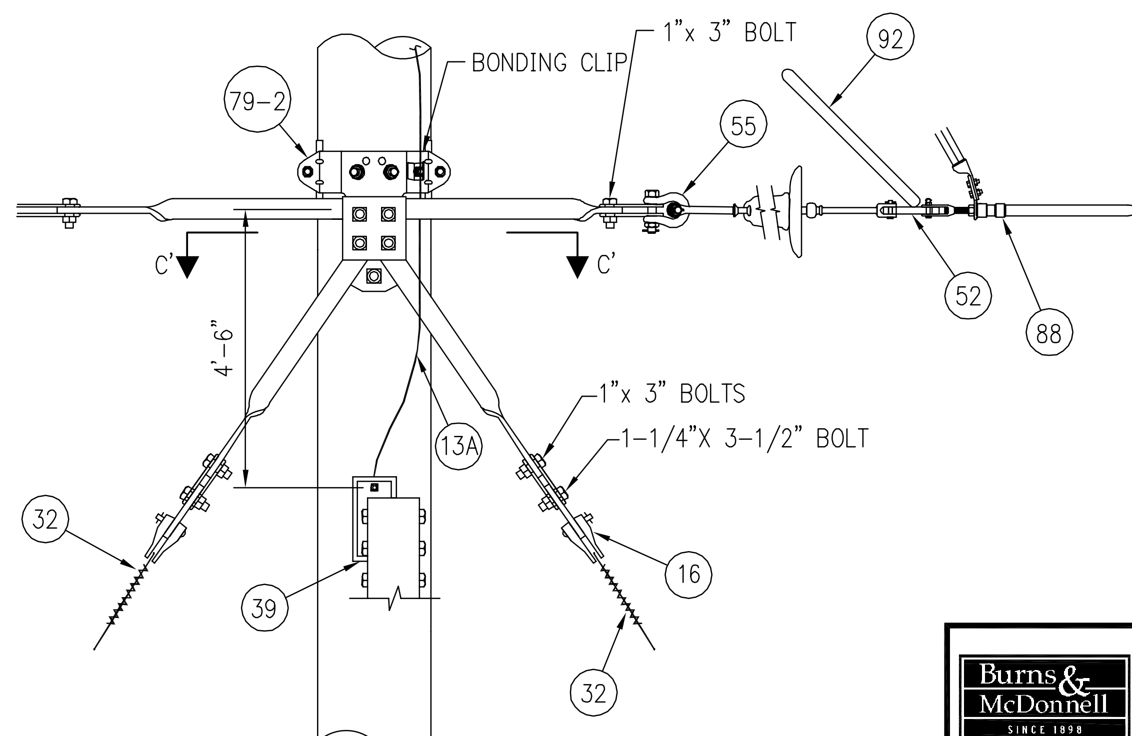
FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-5.3.dwg 02-07-2006 13:12 DSM BMcD



SECTION C-C
(ITEMS AT CONDUCTOR LEVEL SHOWN ONLY)
TYPICAL - 3 POLES



SECTION C'-C'



DETAIL "C"
SIDE ELEVATION
TYP. 3 PLACES

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

Burns & McDonnell SINCE 1898

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

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: PLOT: 1=1	345-5.4		2 REV.

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

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

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

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

Burns & McDonnell SINCE 1898

CONFORMED TO CONSTRUCTION RECORDS

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

VELCO

VERMONT ELECTRIC POWER CO., INC.
RUTLAND, VERMONT

WEST RUTLAND – NEW HAVEN 345 KV

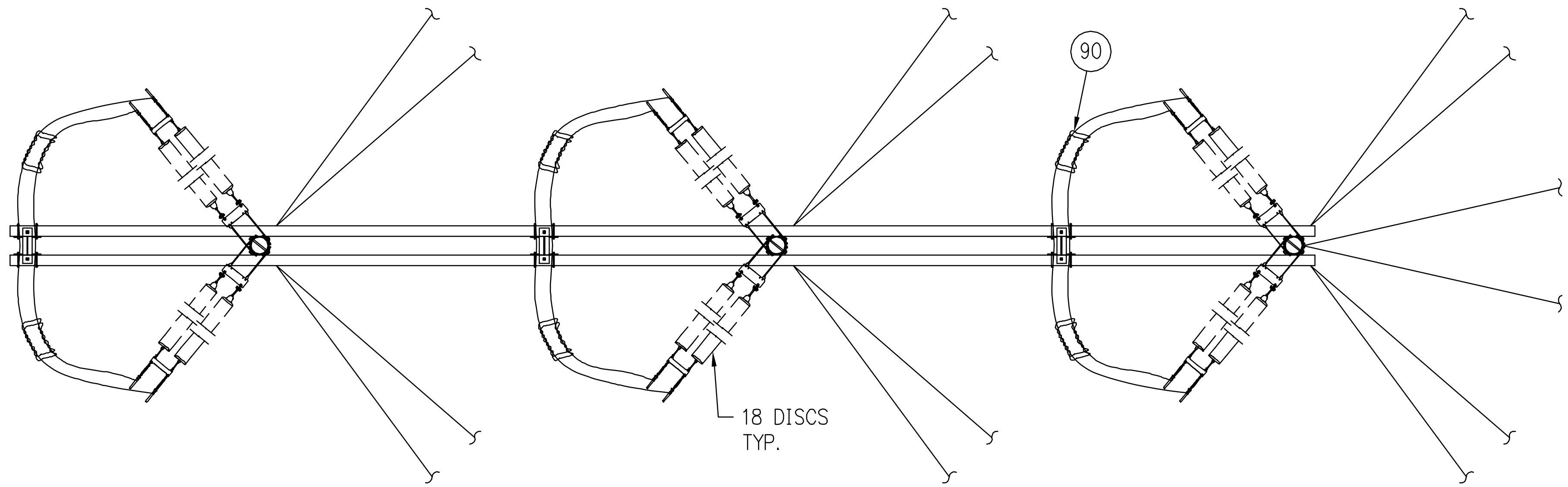
STRAIGHT LINE DEAD END
BILL OF MATERIALS
TYPE 'DE1'

SCALE: NONE | DRAWN BY: BMcD | APPROVED BY: | 6/06 DATE

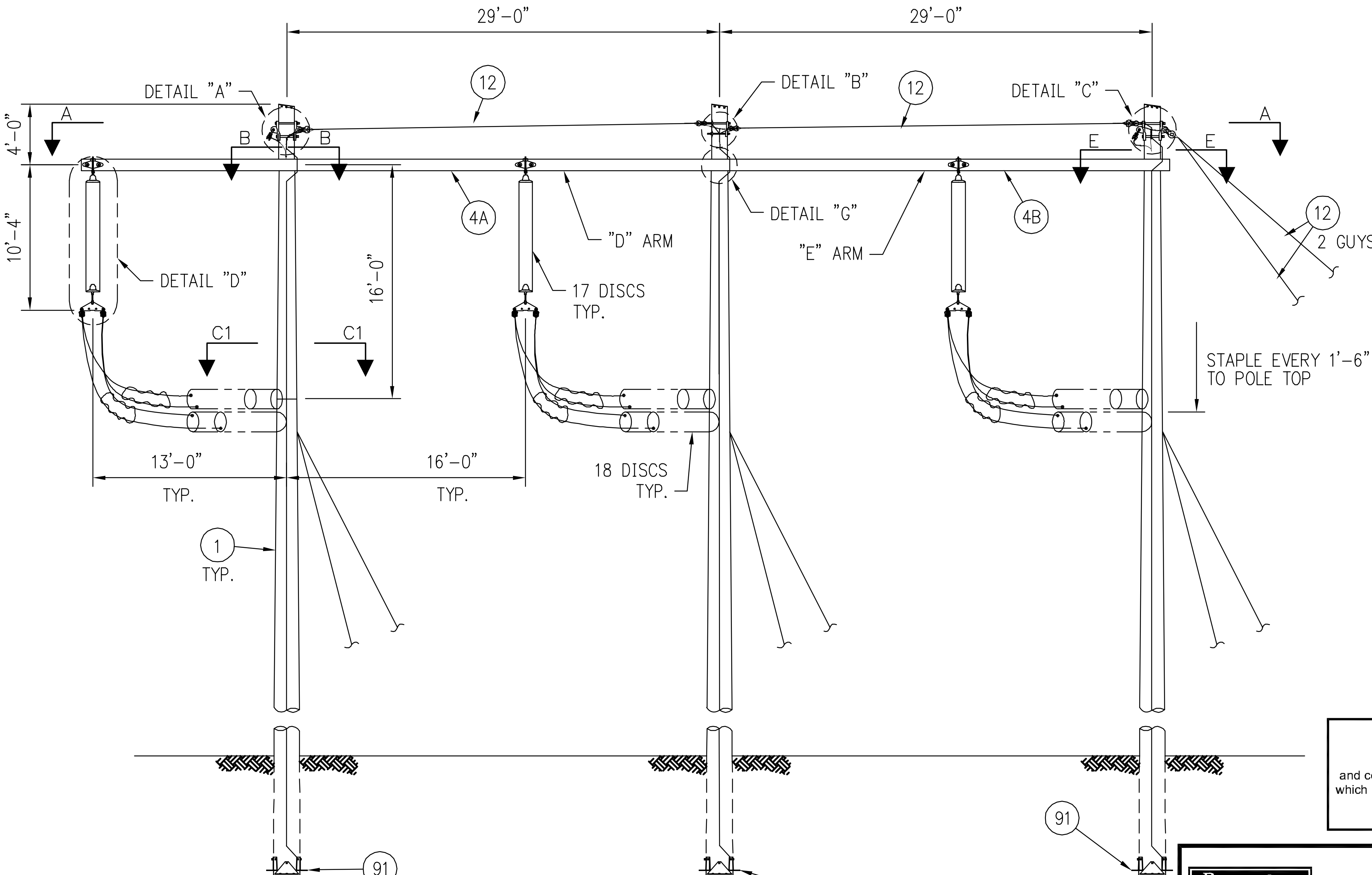
DATE: 11/05 | CHECKED BY: KAW

DRAWING NUMBER: 345-5.5 | PLOT: 1=1 | 2 REV.

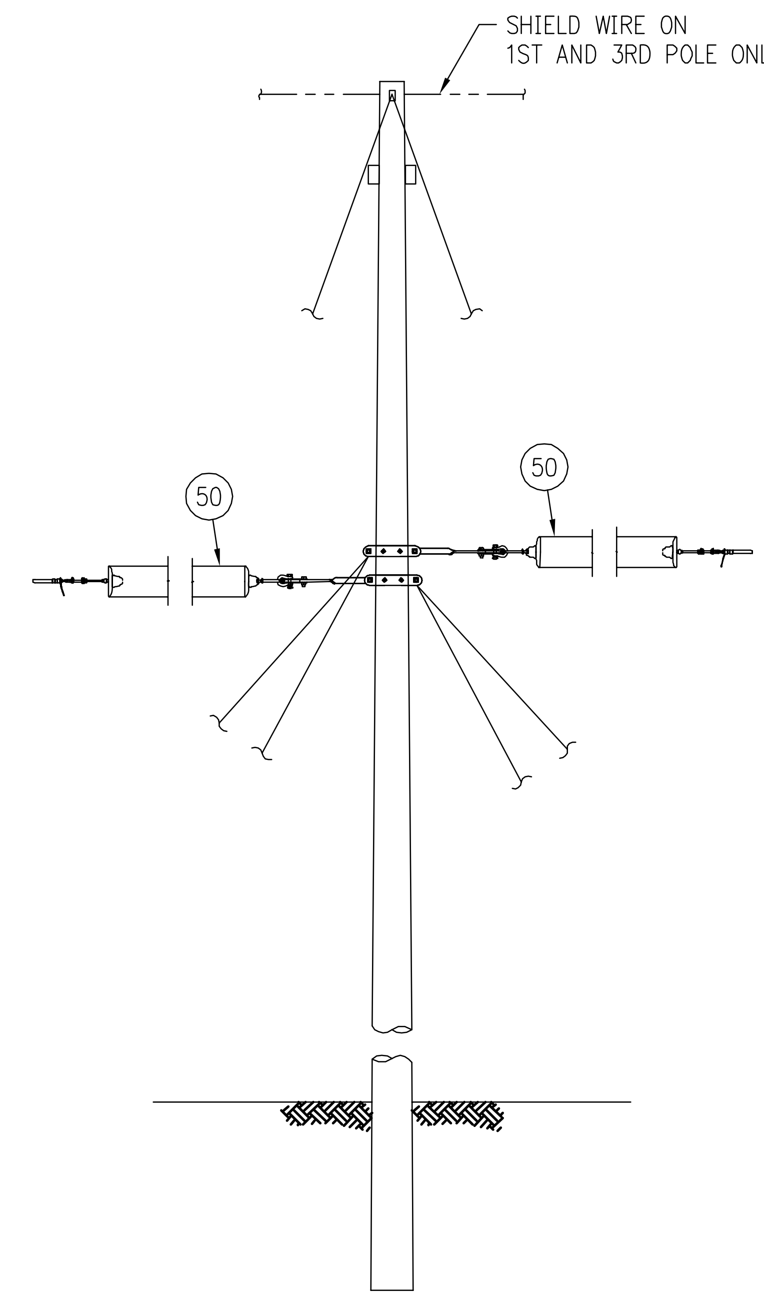
FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-5.5.dwg 02-07-2006 13:12 DSM BMcD



SECTION A-A



ELEVATION



SIDE ELEVATION

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 1898

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

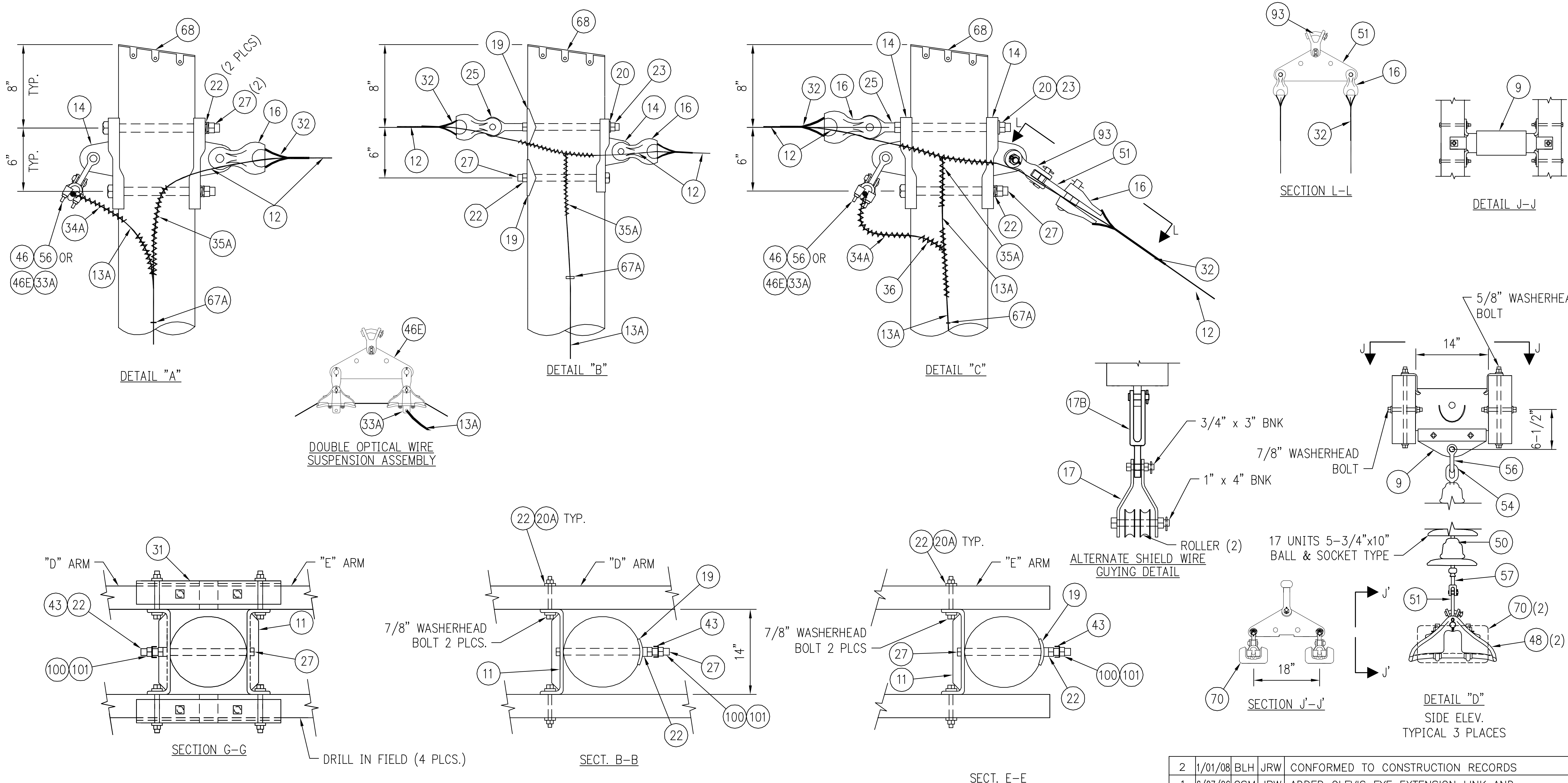
REV	DATE	DR	CK	DESCRIPTION
1	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

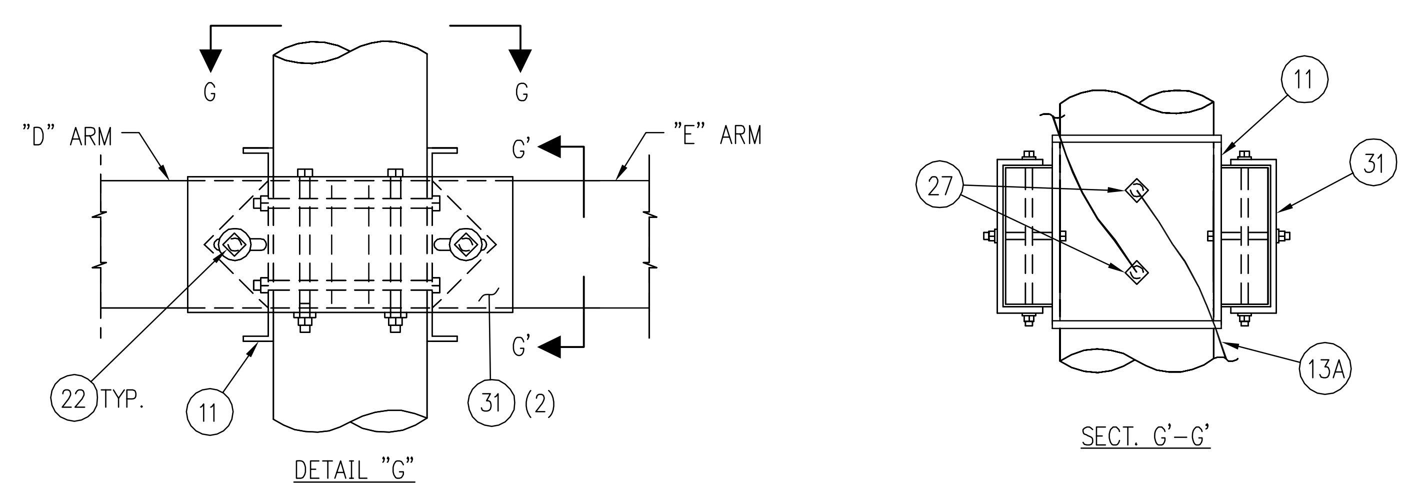
VELCO
VERMONT ELECTRIC POWER CO., INC.
RUTLAND, VERMONT
WEST RUTLAND – NEW HAVEN 345 KV

ANGLE DEAD END STRUCTURE 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.

FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-6.0.dwg 02-07-2006 13:12 DSM BMcD





CONFORMED TO CONSTRUCTION RECORDS

Burns & McDonnell SINCE 1898

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

PROPRIETARY

This document is the property of Vermont Electric Power Company, Inc. and contains proprietary and confidential information which must not be duplicated, used or disclosed other than as expressly authorized by Vermont Electric Power Company, Inc.

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

VELCO

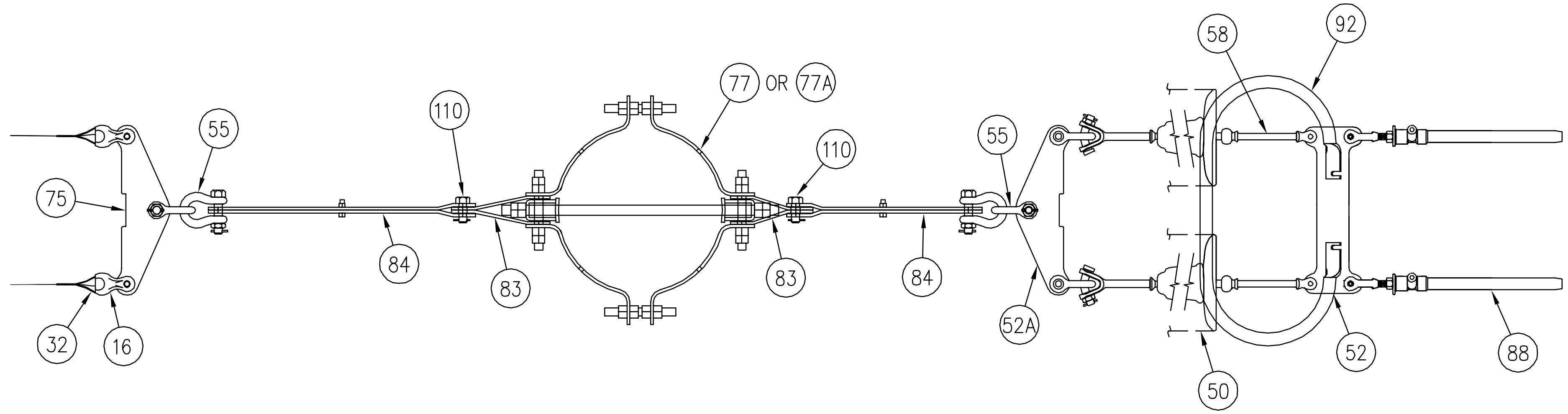
VERMONT ELECTRIC POWER CO., INC.
RUTLAND, VERMONT

WEST RUTLAND – NEW HAVEN 345 KV

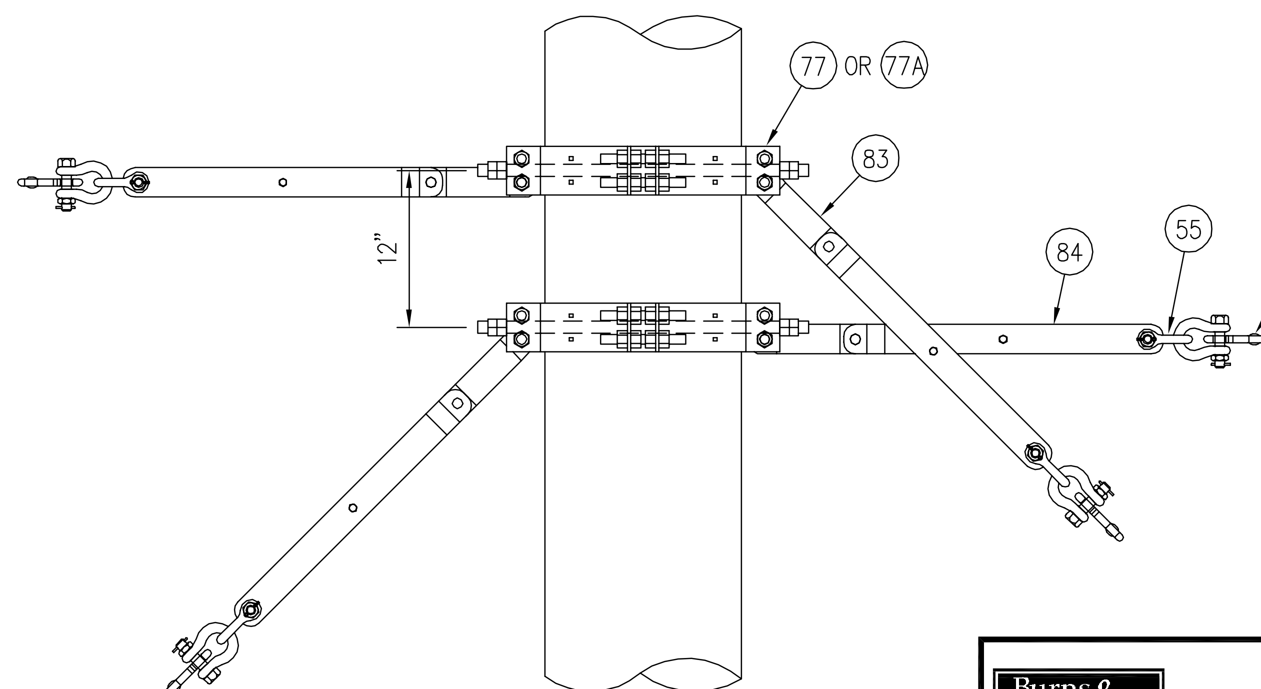
ANGLE DEAD END
POLE TOP DETAILS
TYPE 'DE2' (7° TO 55°)

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

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



SECTION C1–C1



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: PLOT: Q	345–6.2		2 REV.

FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-6.2.dwg 02-07-2006 13:12 DSM BMcD

BILL OF MATERIALS

MARK	STOCK NO.	QUANTITY	DESCRIPTION	MANUFACTURER	CATALOG NUMBER
1		3	POLE, WOOD		
4		1	CROSSARM, WOOD, 345KV, LAM, ASSEMBLY	HUGHES	
			0000530 2 5-1/8"x9"x42'-4"(TYPE D)		
			0000490 2 5-1/8"x9"x29'-4"(TYPE E)		
9	0203410	3	SPACER FITTING 5-1/8"x9" DBL CROSSARM, 14"	HUGHES	3414.10WV-140
			SEPERATION, ADJUSTABLE		
11		4	PLATE, POLE, ARM F/5-1/8"x9" DBL X-ARM, 14"	HUGHES	A2173-A
			SEPERATION, W/2 7/8" WASHERHEAD BOLTS		
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"	MACLEAN	EPR-77S-7
			PIN		
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	ANDERSON	GTCL-23A
			WIRE SUSPENSION CLAMP, SX-48/33/520		
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	CHANCE	6484
			1/2"-7 STRAND		
46	0100050	1	CLAMP, SHIELD WIRE, SUSP. 3/8"EHS-7 STRAND	MACLEAN	FS-46-N
			(.20-.46) W/O FITTING		
46E		1	CLAMP ASSEMBLY, OPTICAL WIRE, DBL. SUSP. W/2	ALCOA	OSPSS4
			CLEVIS EYE, 1 YOKE PLATE, 1 Y-CLEVIS CLEVIS,		
			SX-48/33/520		ACFS-120-15-23-RYCE
48	0101850	6	CLAMP, COND, FORMULA, SUSPENSION, 1.2"MAX	MACLEAN	
			DIA, 15"L, 23K, W/90° Y-CLEVIS EYE FITTING F/		
			954MCM 45/7 ACSR, CORONA FREE		
50		267	INSULATOR, SUSP, 30K M&E, 5-3/4"x10", BALL	LAPP	5960A-70
			& SOCKET, GRAY		
51		4	PLATE, YOKE, TRI, 18" SPCG, 15/16" HOLES, 40K	MACLEAN	ASM-6229-3
			ULT, 5/8" THICK		
52	0204130	6	PLATE, YOKE, DOGBONE, 18" SPCG, 15/16" HOLES,	MACLEAN	M6606-4A
			40K ULT, 5/8" THICK, GALV. W/CORONA RING		
			MOUNTING HOLES		
52A		6	YOKE PLATE TRI 18" SP 1-1/16" HOLES, 50K ULT,	HUBBELL	YPD-50-18549-1
			3/4" THICK		
54	0201600	3	OVAL-EYE BALL, GALV, FORGED STEEL, 30K,	ANDERSON	BE-30
			3-23/32" LONG		
55		24	SHACKLE, ANCHOR, BNK, 80K 1-1/2" W, W/1"	MACLEAN	ASH-78-BC
			BOLT, NUT COTTER		
56	0206010	4	SHACKLE, ANCHOR, BNK, 35K, W/ 3/4" BOLT NUT	ANDERSON	AS-35-BNK
			& COTTER KEY		
57	0207860	3	SOCKET, CLEVIS, 4-1/2" L, 13/16"W, 2"D, 5/8" P,	MACLEAN	SCL-55B
			30K		
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",	CHANCE	9167
			ROLLED POINT		
70	0202550	6	WEIGHT, HOLD DOWN,150#, W/ HARDWARE, FOR	MACLEAN	ASM-389-150
			FORMULA CLAMP 954MCM ACSR 45/7		
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,	CHANCE	5340
			THIMBLE EYE		
73	0205950	14	GUY MARKER, FULL RND, YEL, 84"x 1.5",	CHANCE	84FRPM-YEL
			3/16-1/2" W/PIGTAIL POLYETHYLENE		
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	ALCOA	C43648
			FITTING 954MCM 45/7 ACSR		
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	HUGHES	A1895-3-XX
			RODS, W/4 NUTS, 4 LOCKNUTS & LAG SCREWS		
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	HUGHES	
			(#3157); 2 ROLLERS (#28083); 1 BOLT		
			3/4"x3" BNK; 1 BOLT 1"x4" BNK.		
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

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 DEADEND ASSBLY MATS AND RE-ISSUED FOR CONSTRUCTION
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

Burns & McDonnell SINCE 1898

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

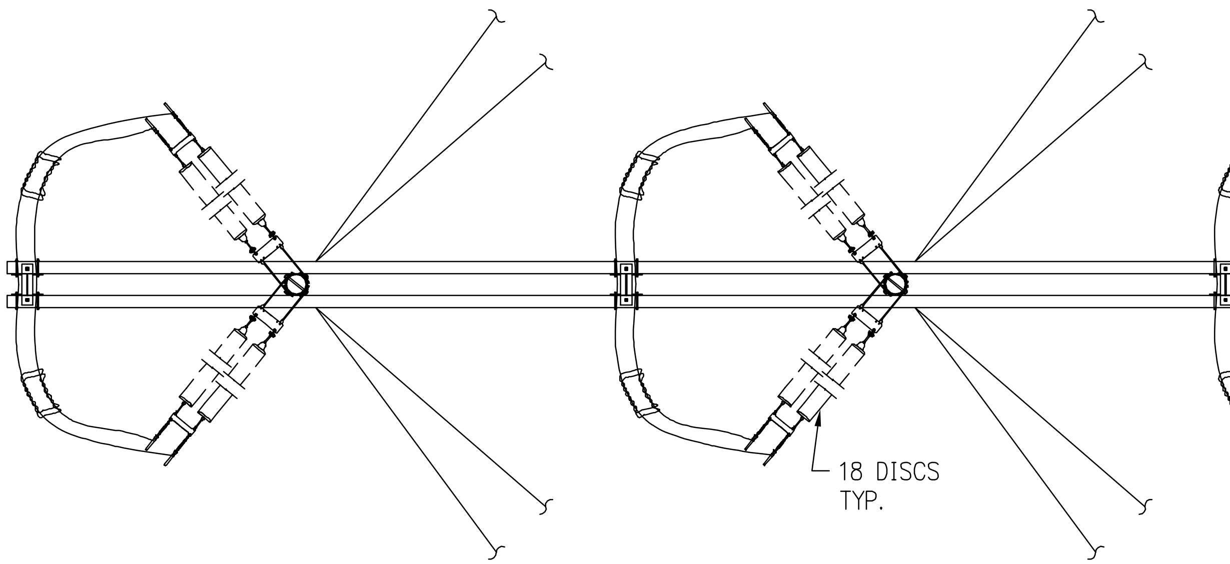
VELCO

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

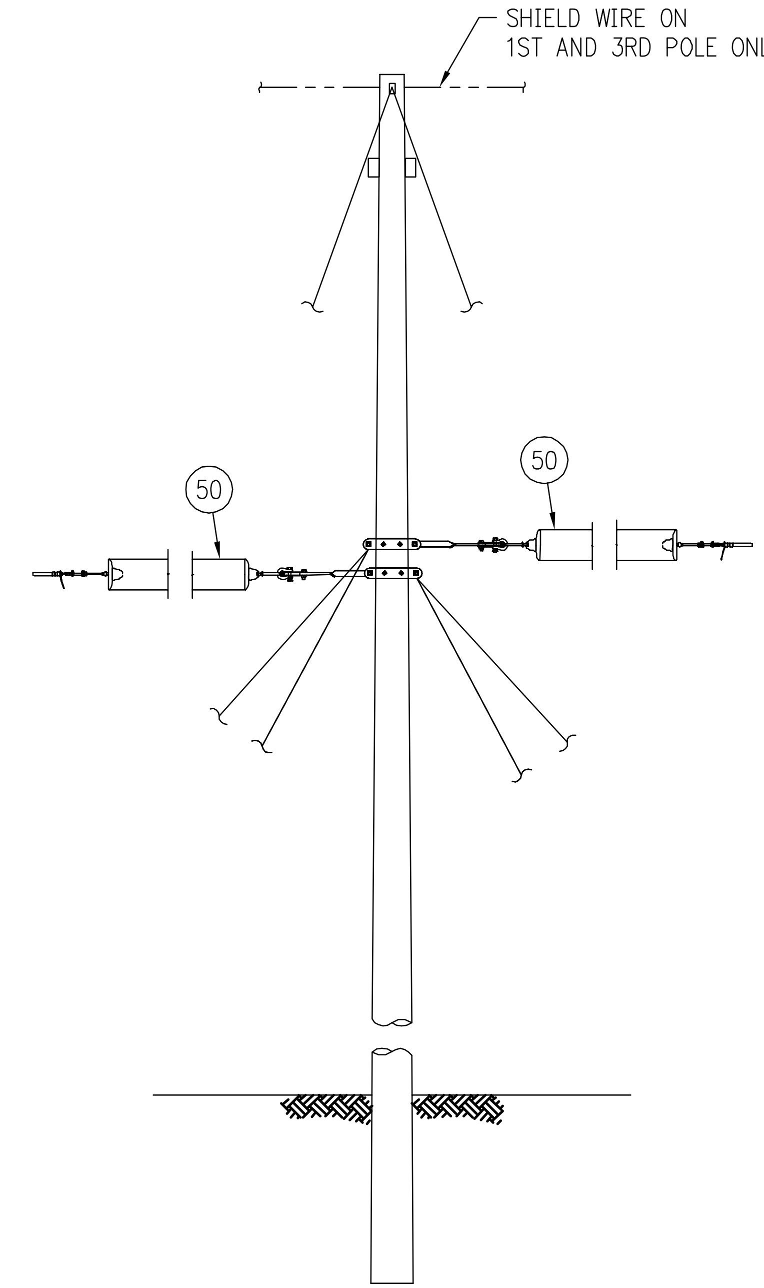
ANGLE DEAD END
BILL OF MATERIALS
TYPE 'DE2' (7° TO 55°)

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	6/06
DATE: 11/05	CHECKED BY: KAW		DATE
DRAWING NUMBER: PLOT: 1=1	345-6.3		2 REV.

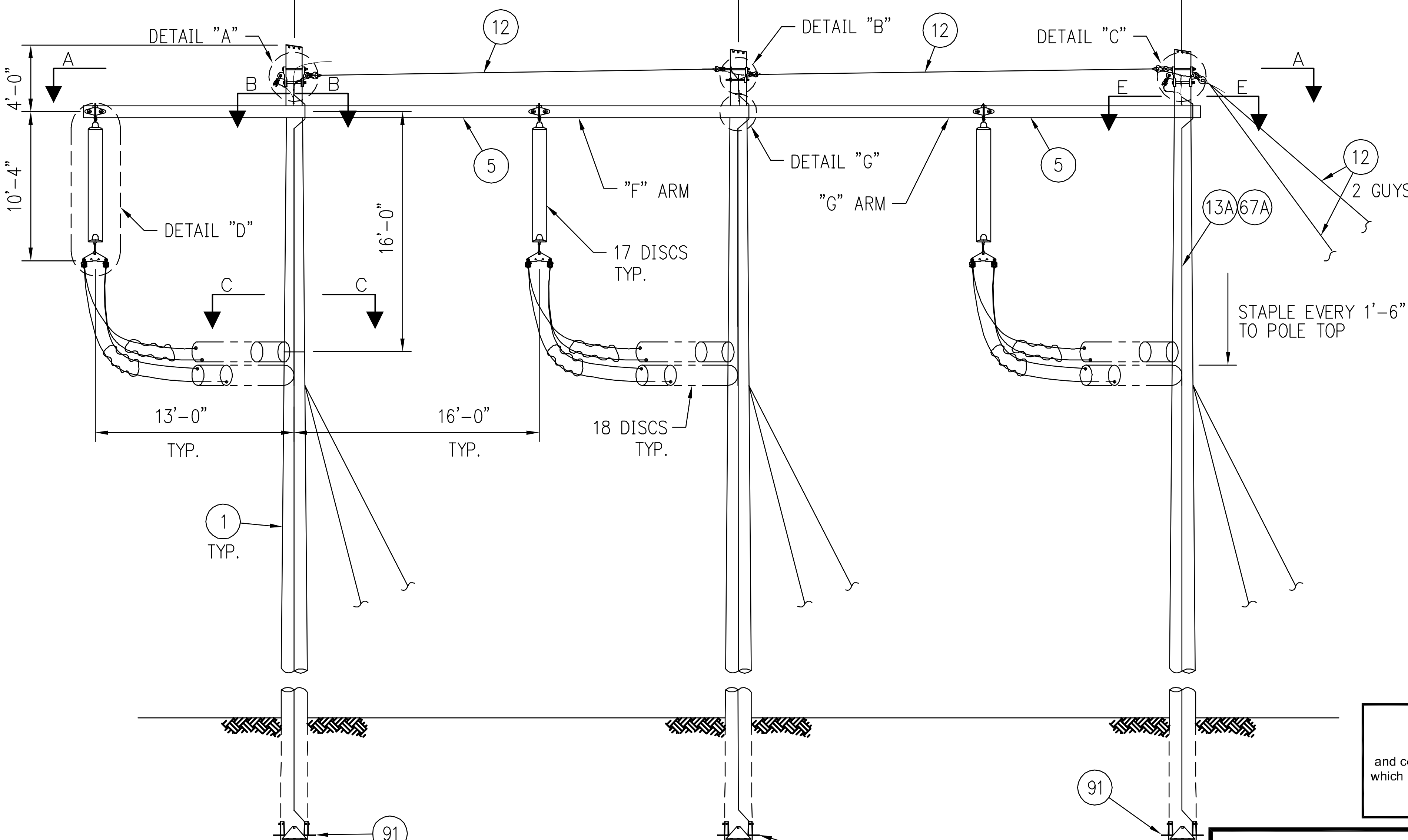
FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-6.3.dwg 02-07-2006 13:12 DSM BMcD



SECTION A-A



SIDE ELEVATION



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

ELEVATION

Burns & McDonnell SINCE 1898

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

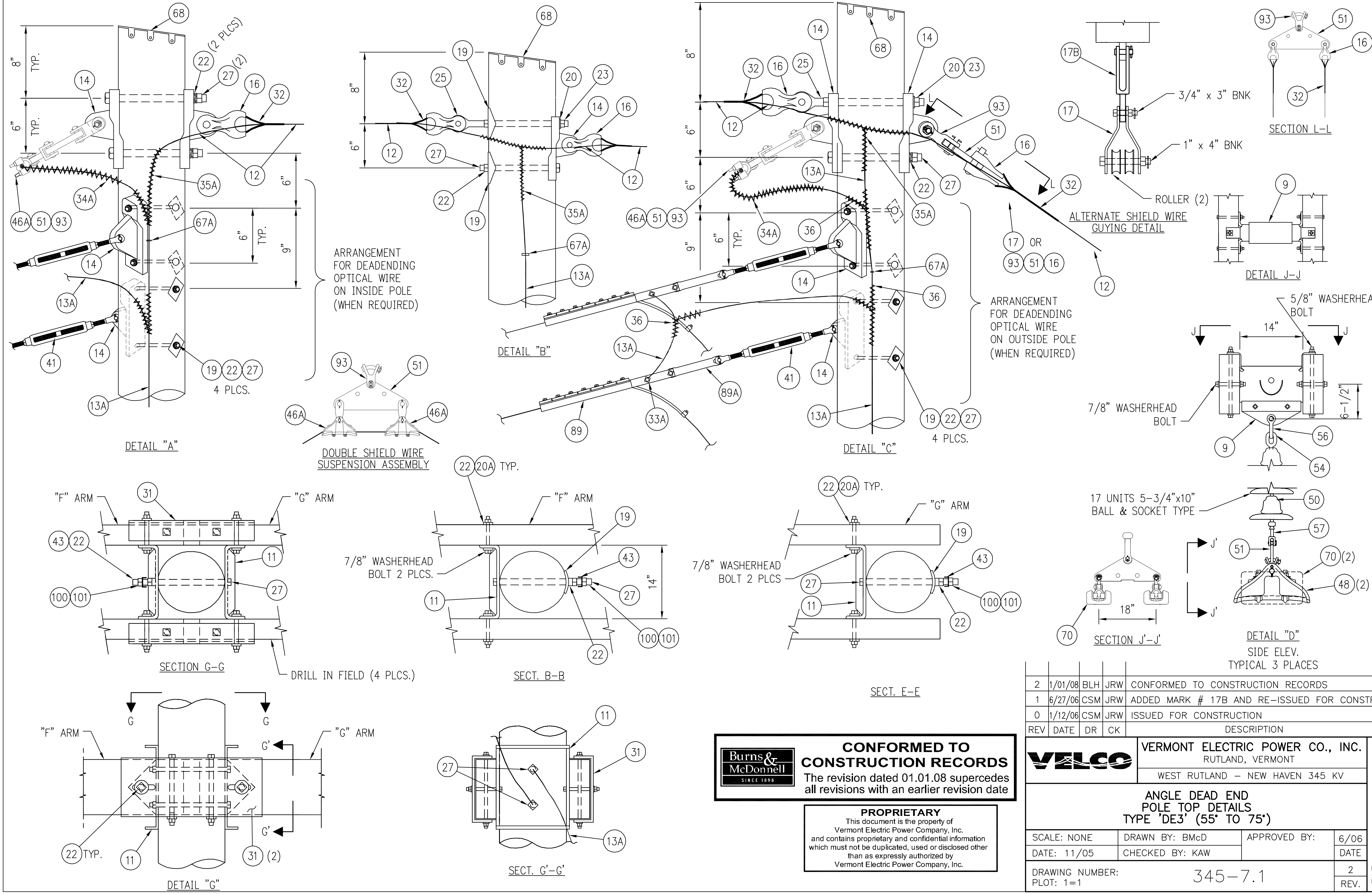
REV	DATE	DR	CK	DESCRIPTION
1	1/01/08	BLH	JRW	CONFORMED TO CONSTRUCTION RECORDS
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

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

ANGLE DEAD END
STRUCTURE
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.

FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-7.0.dwg 02-07-2006 13:12 DSM BMcD



CONFORMED TO CONSTRUCTION RECORDS

Burns & McDonnell SINCE 1898

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

PROPRIETARY

This document is the property of Vermont Electric Power Company, Inc. and contains proprietary and confidential information which must not be duplicated, used or disclosed other than as expressly authorized by Vermont Electric Power Company, Inc.

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

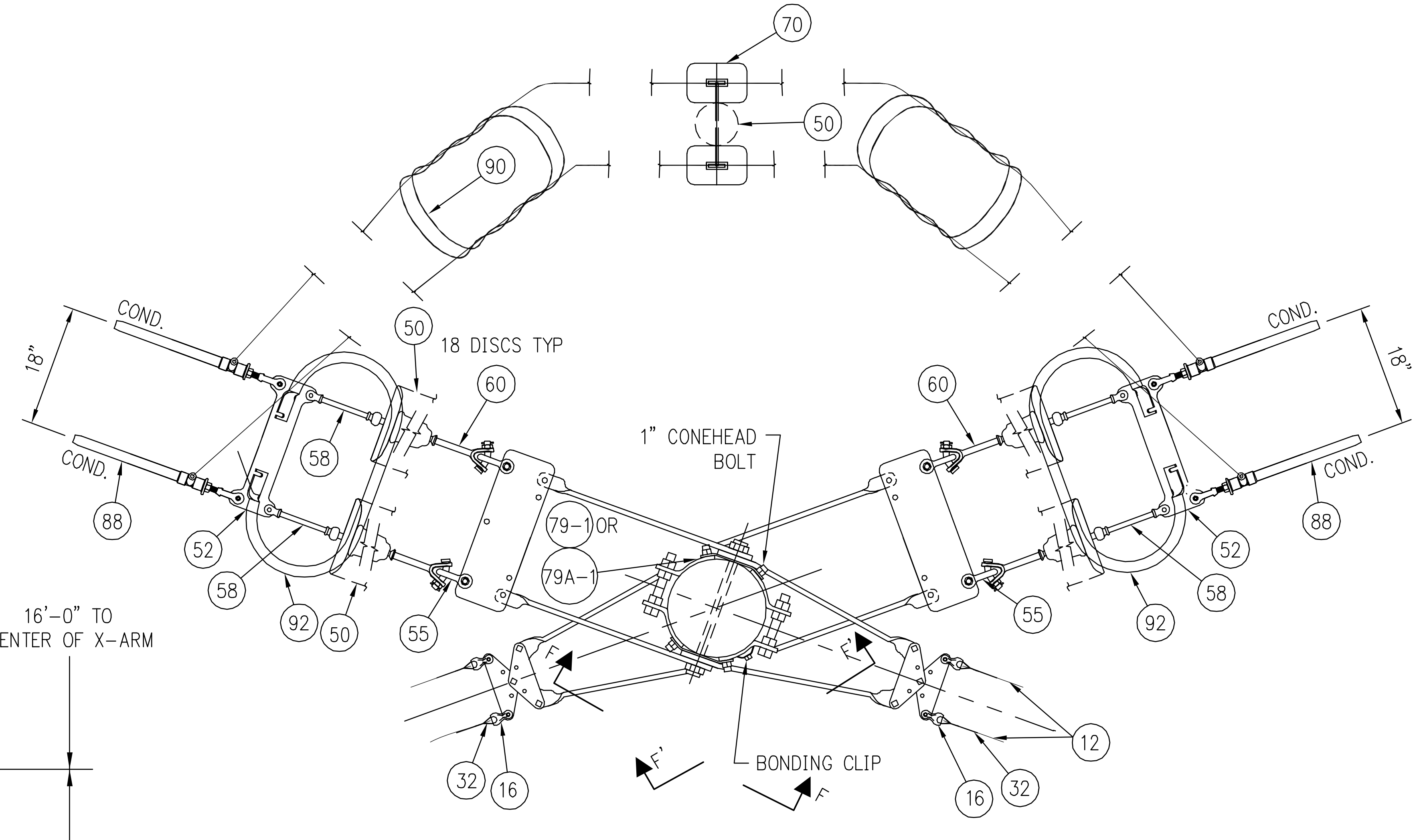
VERMONT ELECTRIC POWER CO., INC.
RUTLAND, VERMONT

WEST RUTLAND – NEW HAVEN 345 KV

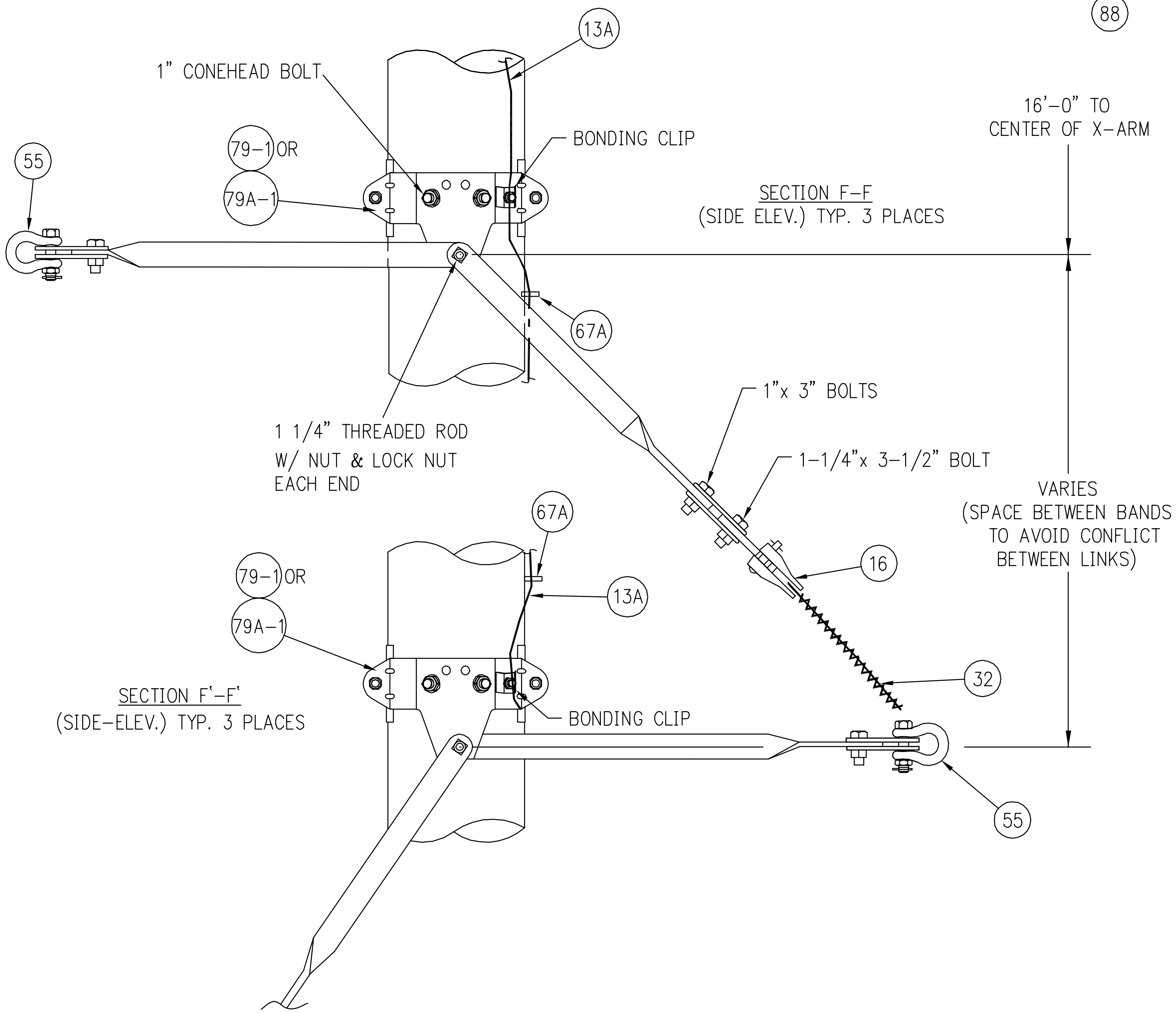
ANGLE DEAD END
POLE TOP DETAILS
TYPE 'DE3' (55° TO 75°)

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

FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-7.1.dwg 02-07-2006 13:13 DSM BMcD



SECTION C-C (ROTATED)



SECTION F-F
(SIDE ELEV.) TYP. 3 PLACES

SECTION F'-F'
(SIDE-ELEV.) TYP. 3 PLACES

Burns & McDonnell SINCE 1898

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

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: PLOT: 1=1	345-7.2		2 REV.

FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-7.2.dwg 02-07-2006 13:13 DSM BMcD

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

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

Burns & McDonnell SINCE 1898

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

VELCO

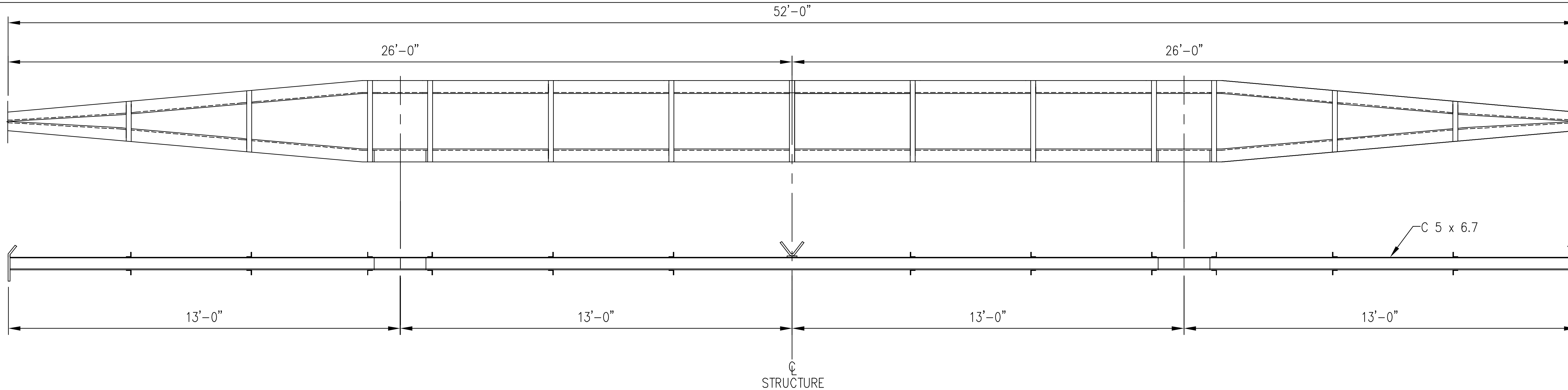
VERMONT ELECTRIC POWER CO., INC.
RUTLAND, VERMONT

WEST RUTLAND – NEW HAVEN 345 KV

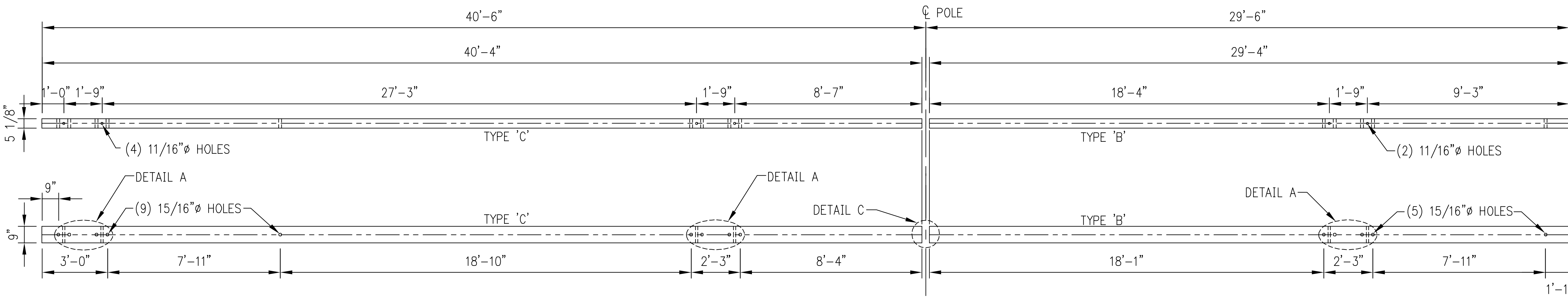
ANGLE DEAD END
BILL OF MATERIALS
TYPE 'DE3' (55° TO 75°)

SCALE: NONE | DRAWN BY: BMcD | APPROVED BY:
DATE: 11/05 | CHECKED BY: KAW | DATE
DRAWING NUMBER: 345-7.3 | REV. 2
PLOT: 1=1

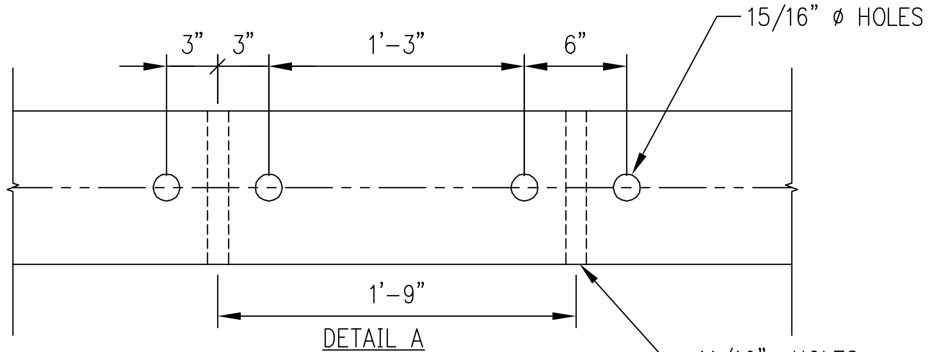
FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-7.3.dwg 02-07-2006 13:13 DSM BMcD



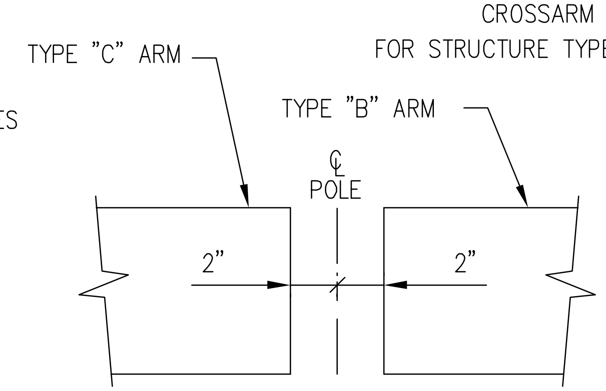
CROSSARM TYPE 'A' (A588 WEATHERING STEEL)
FOR STRUCTURE TYPE 'A' (DWG. #345-1.0)



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



DETAIL A



DETAIL C

CONFORMED TO CONSTRUCTION RECORDS
Burns & McDonnell SINCE 1898
The revision dated 01.01.08 supercedes all revisions with an earlier revision date

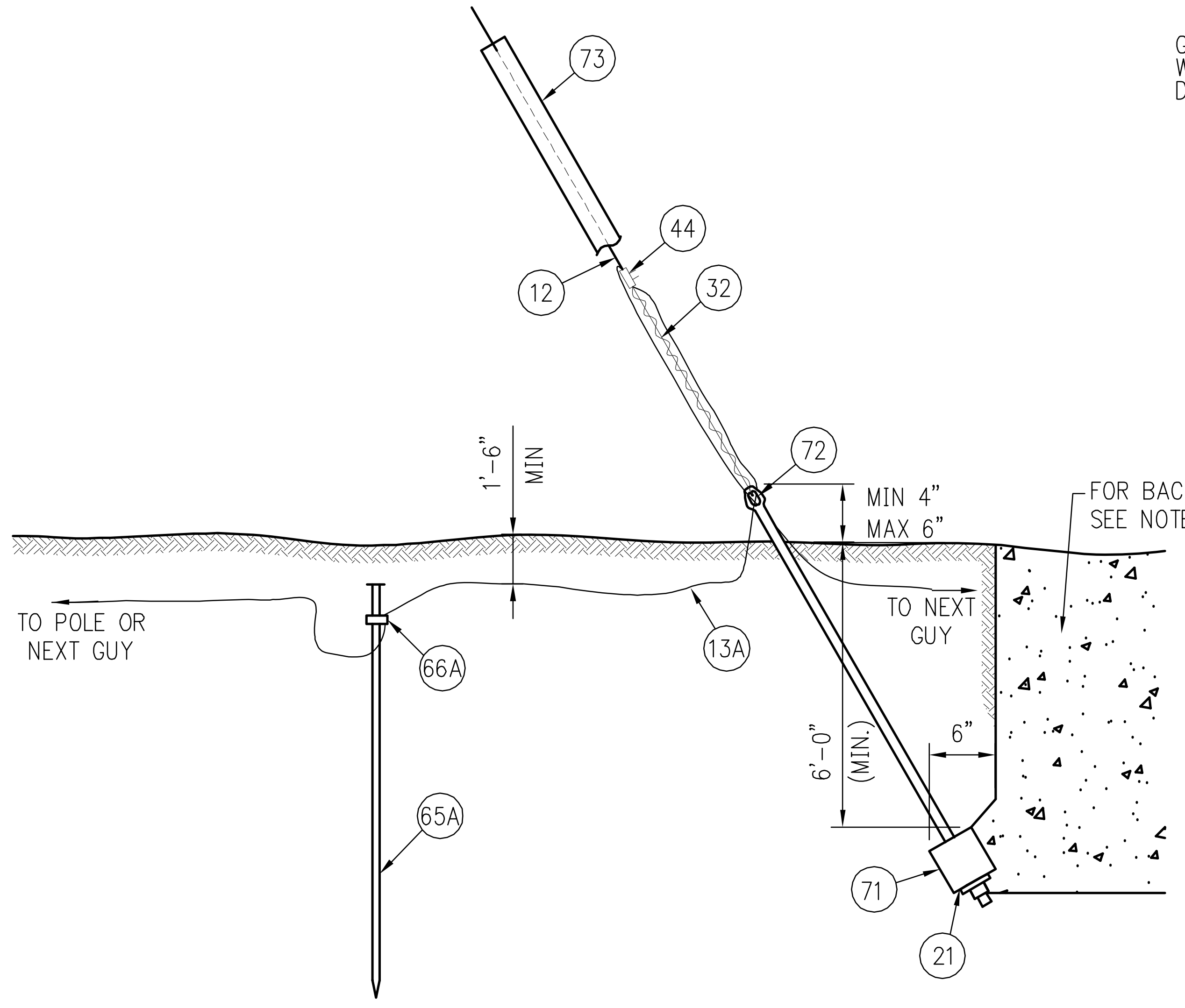
REV	DATE	DR	CK	DESCRIPTION
1	1/01/08	JAH	JRW	CONFORMED TO CONSTRUCTION RECORDS
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

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

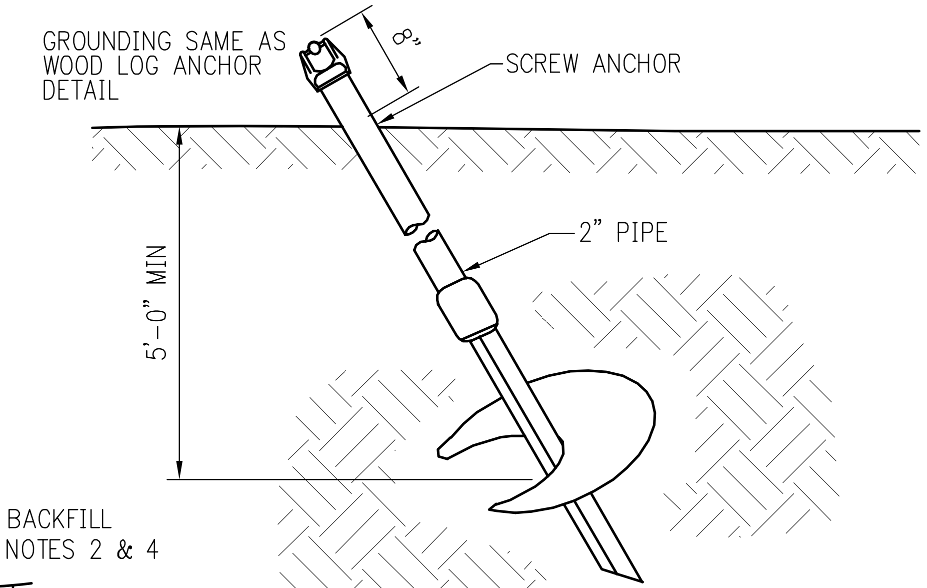
CROSSARM DETAILS

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

FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-9.0.dwg 02-07-2006 13:13 DSM BMcD

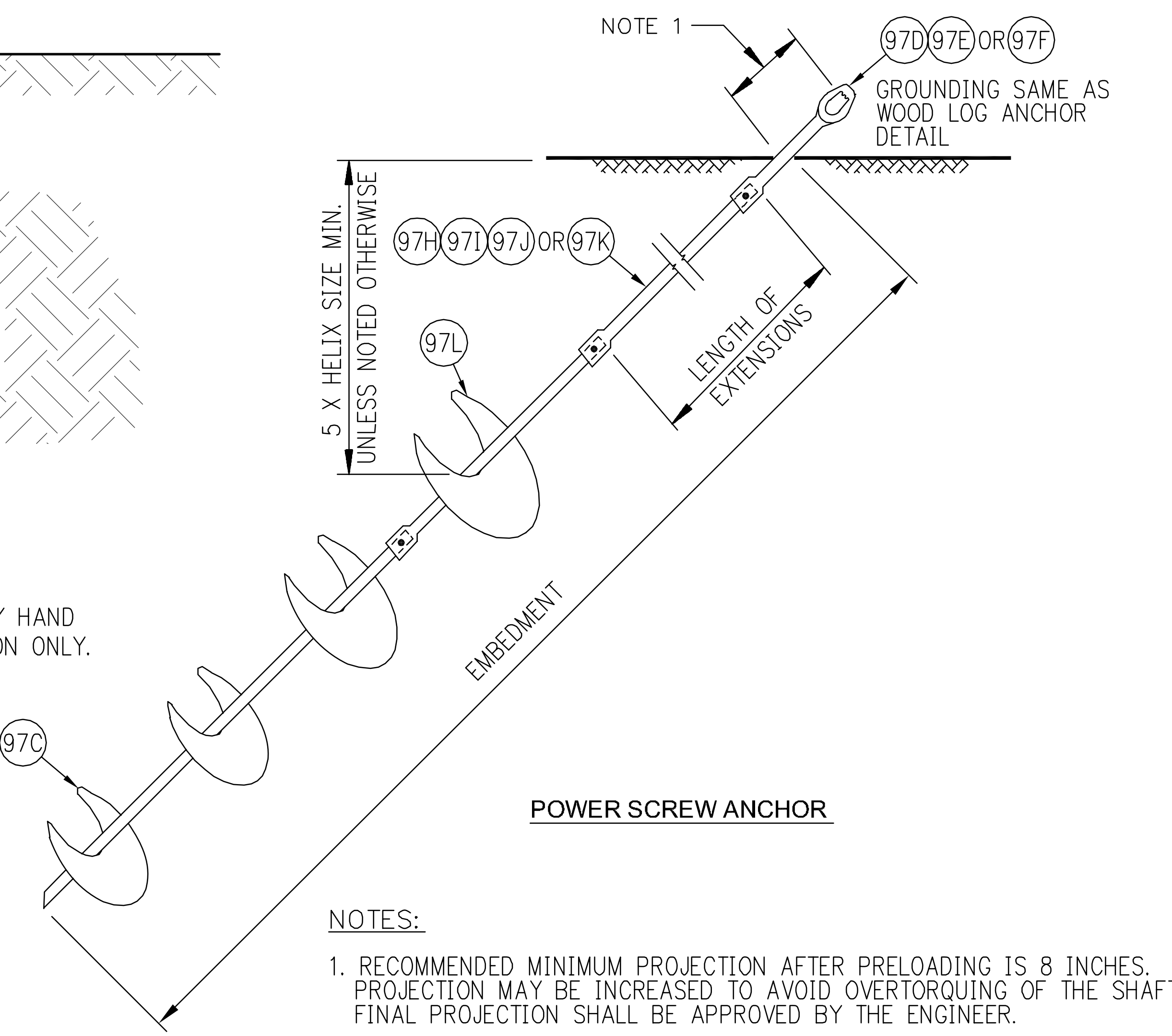


WOOD LOG ANCHOR



SWAMP ANCHOR

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

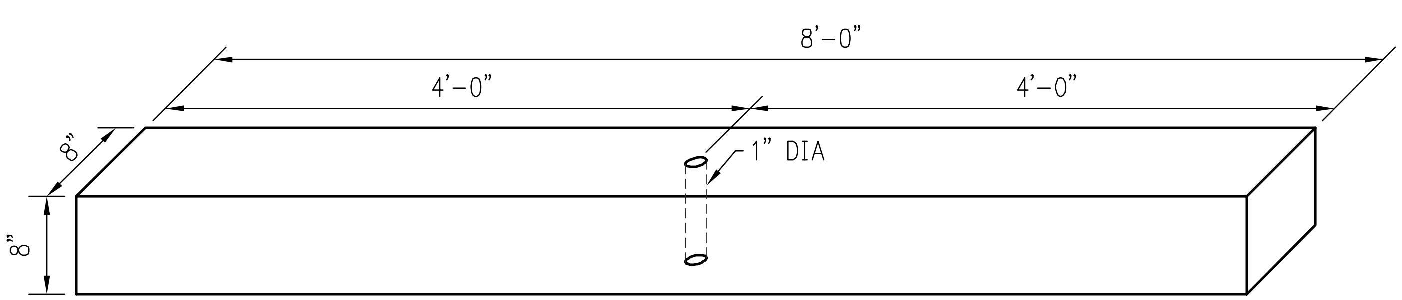


POWER SCREW ANCHOR

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 1898

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

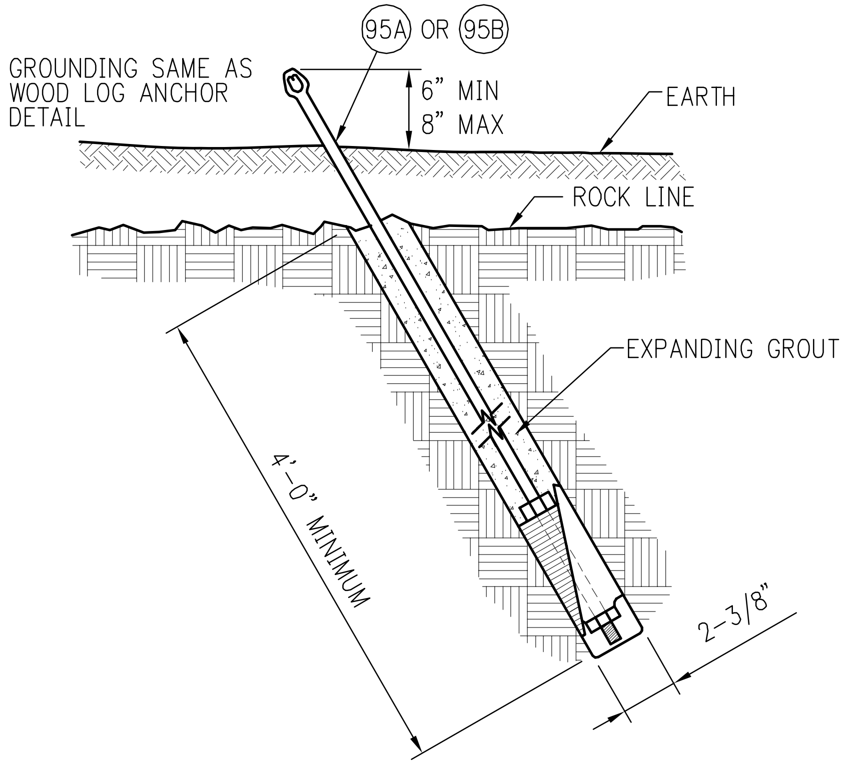
REV	DATE	DR	CK	DESCRIPTION
1	1/01/08	JAH	JRW	CONFORMED TO CONSTRUCTION RECORDS
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

VELCO — VERMONT ELECTRIC POWER CO., INC.
RUTLAND, VERMONT
WEST RUTLAND – NEW HAVEN 345

ANCHOR AND GUY GROUNDING DETAILS

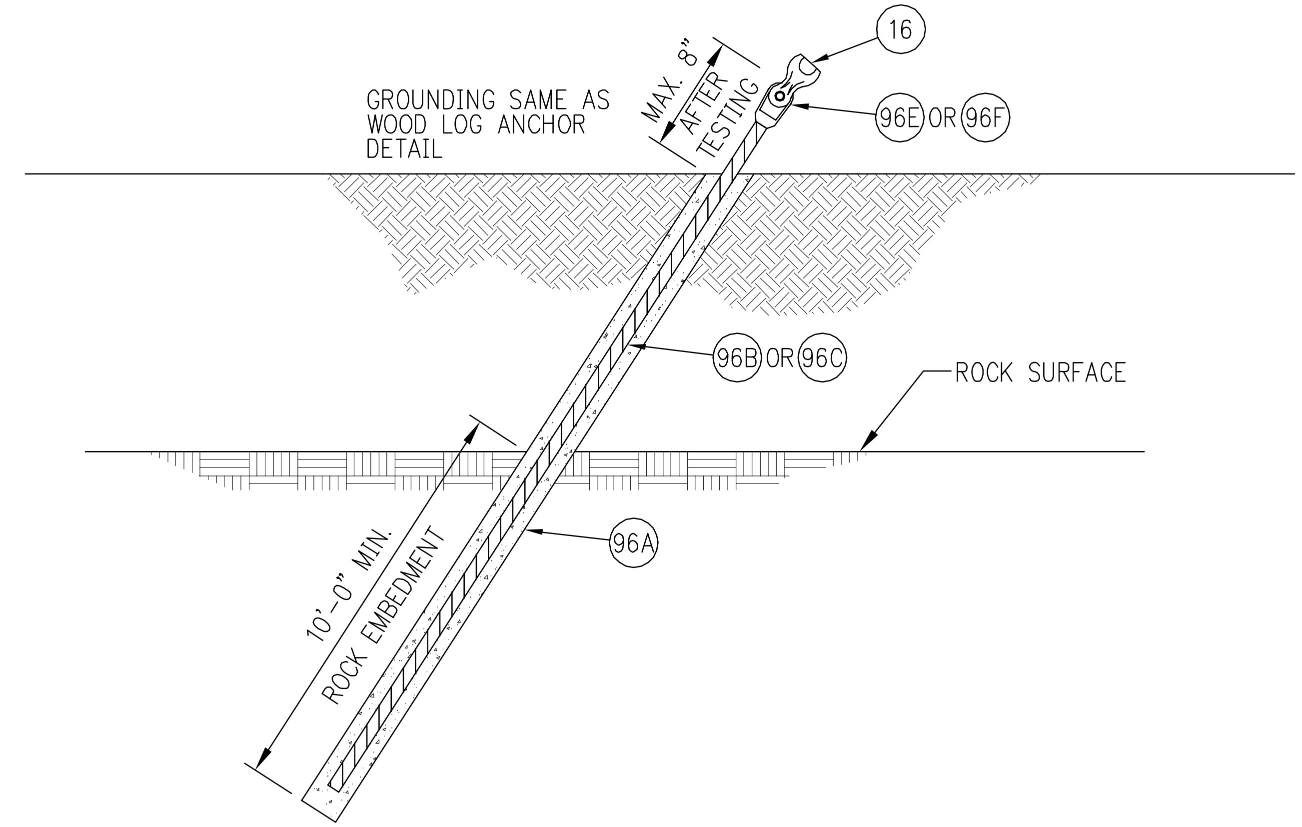
SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	
DATE: 11/05	CHECKED BY: KAW		DATE
DRAWING NUMBER: PLOT: 1=1	345–10.0		1 REV.

FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-10.0.dwg 09-20-2005 16:27 6



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

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

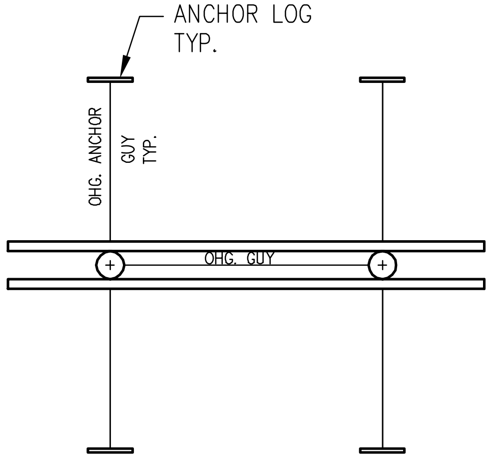
VERMONT ELECTRIC POWER CO., INC.
RUTLAND, VERMONT

WEST RUTLAND – NEW HAVEN 345KV

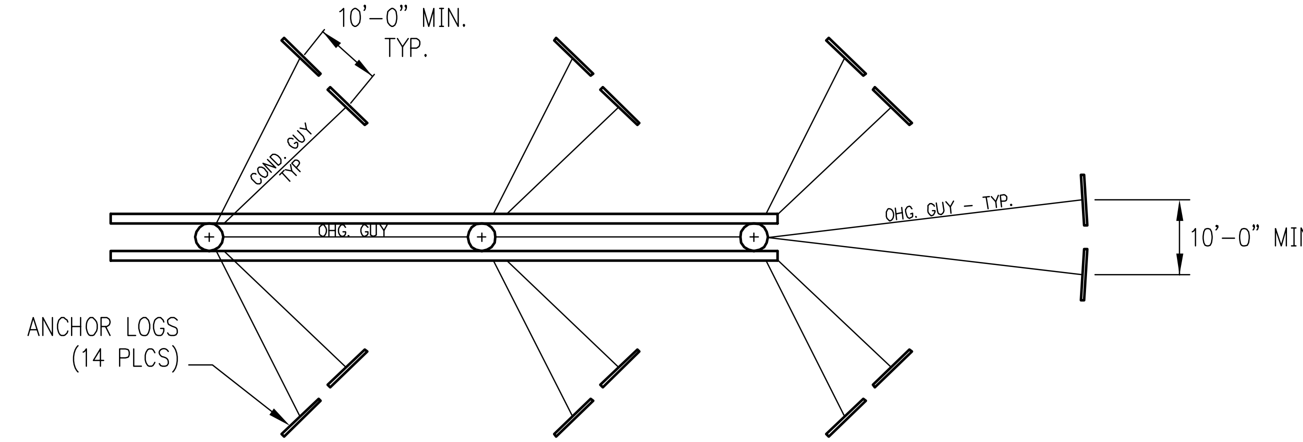
ROCK ANCHOR DETAILS

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	
DATE: 11/05	CHECKED BY: KAW		DATE
DRAWING NUMBER: PLOT: 1=1	345-10.1		1 REV.

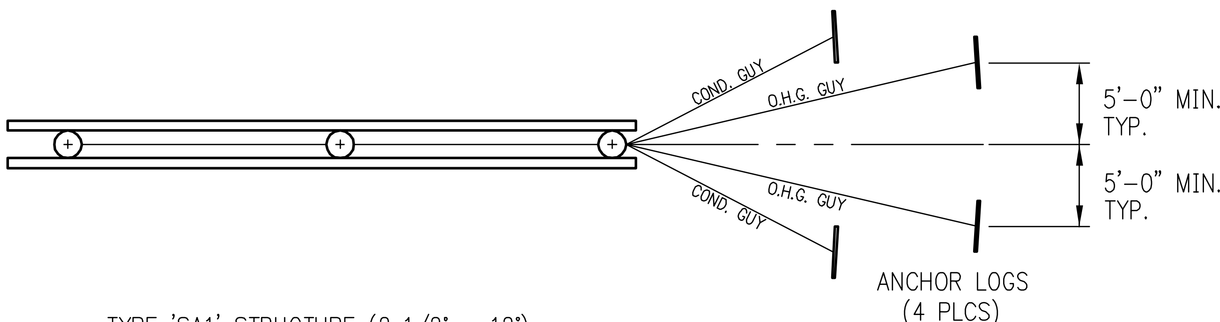
FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-10.1.dwg 09-20-2005 16:27 6



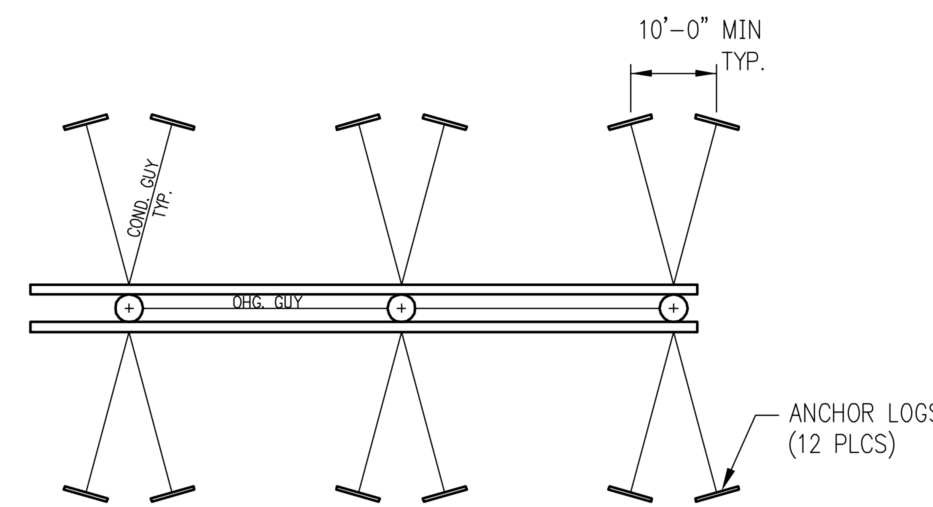
TYPE 'A' STRUCTURE (TANGENT)
WITH DEAD-END SHIELD WIRE



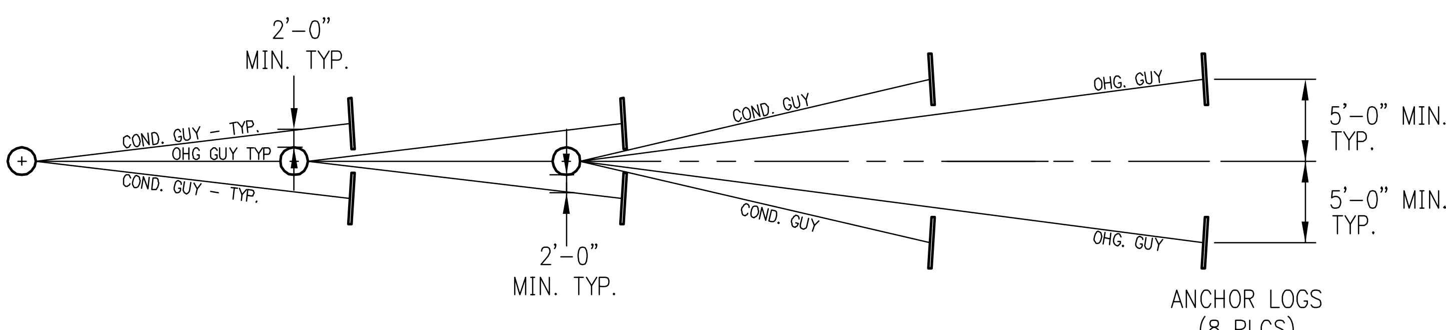
TYPE 'DE2' (35° – 55°)
TYPE 'DE3' (55° – 75°)
TYPE 'DE4' (75° – 90°)



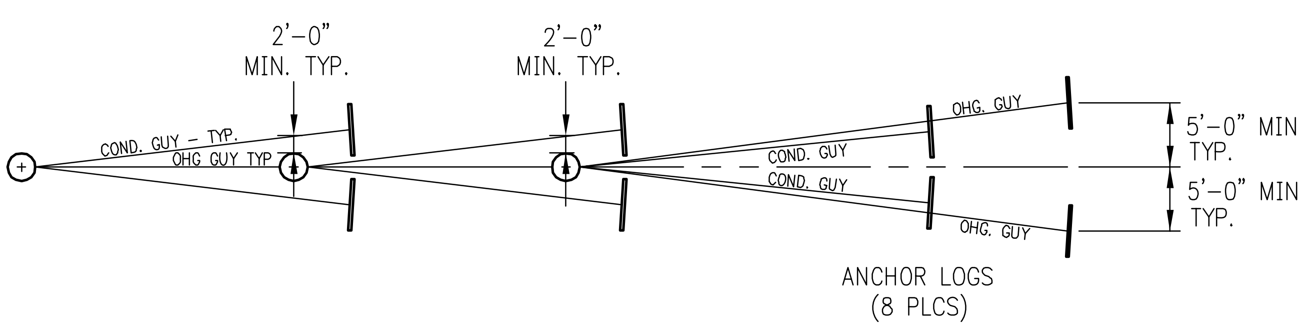
TYPE 'SA1' STRUCTURE (2 1/2° – 12°)



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
SINCE 1898

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

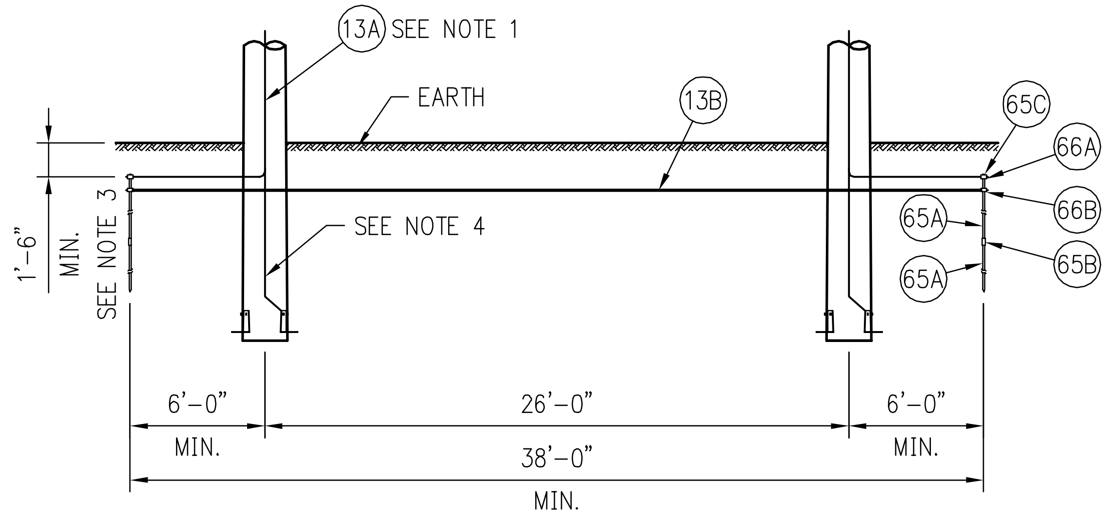
REV	DATE	DR	CK	DESCRIPTION
1	1/01/08	JAH	JRW	CONFORMED TO CONSTRUCTION RECORDS
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

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

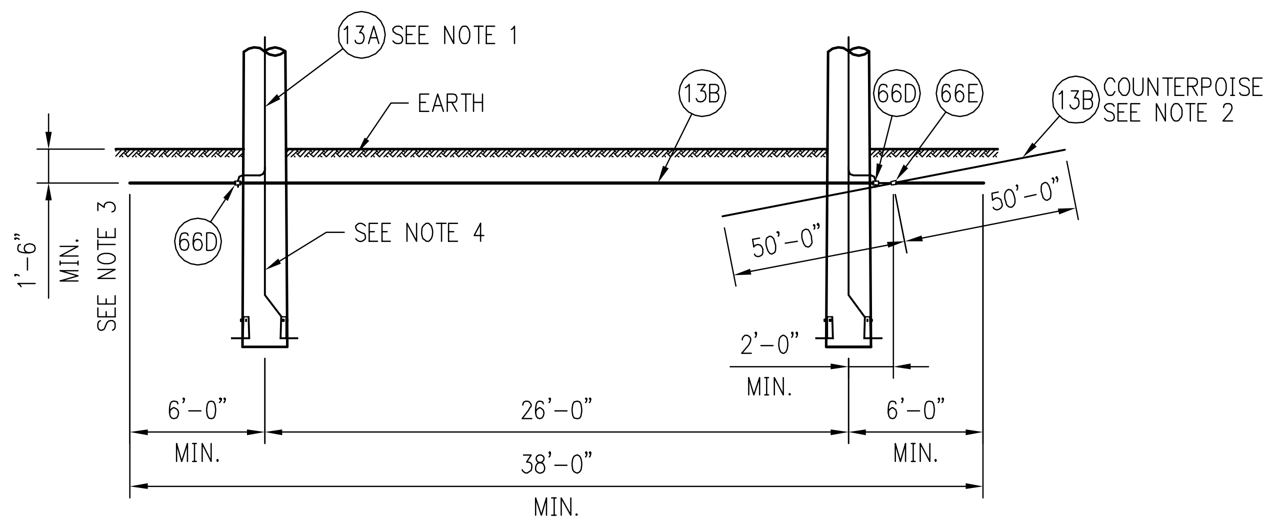
METHOD OF POLE GUYING

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	
DATE: 11/05	CHECKED BY: KAW		DATE
DRAWING NUMBER: PLOT: 1=1	345–10.2		1 REV.

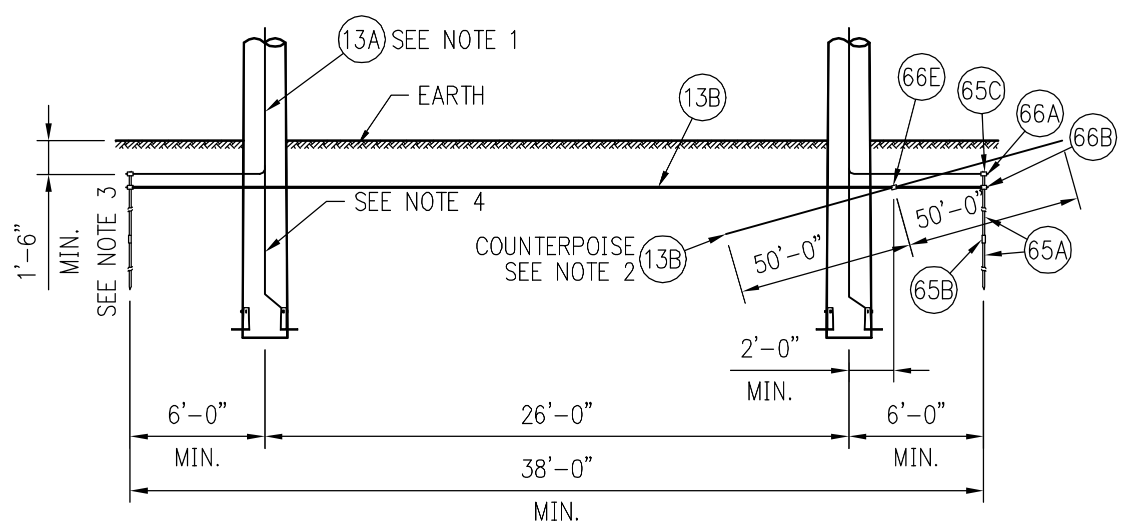
FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-10.2.dwg 02-07-2006 13:13 DSM BMcD



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"	ERICO/CADWELD	
			CU ROD		
			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	ERICO/CADWELD	
			COPPERWELD		
66E		1	EXOTHERMIC WELD, 7 NO. 8 COPPERWELD TO	ERICO/CADWELD	
			7 NO. 8 COPPERWELD		
			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"	ERICO/CADWELD	
			CU ROD		
66E		1	EXOTHERMIC WELD, 7 NO. 8 COPPERWELD TO	ERICO/CADWELD	
			7 NO. 8 COPPERWELD		

NOTES:

1. BONDING WIRE QUANTITY FOR STRUCTURE SHALL BE AS INDICATED ON STRUCTURE DRAWING.
2. 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.
3. INCREASE DEPTH TO 3'-0" IN AREAS WHERE FARMING/PLOWING COULD OCCUR.
4. EXTEND GROUND WIRE TO BASE OF POLE AND ATTACH TO ANCHOR PLATE GROUND LUG.

Burns & McDonnell SINCE 1898

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

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

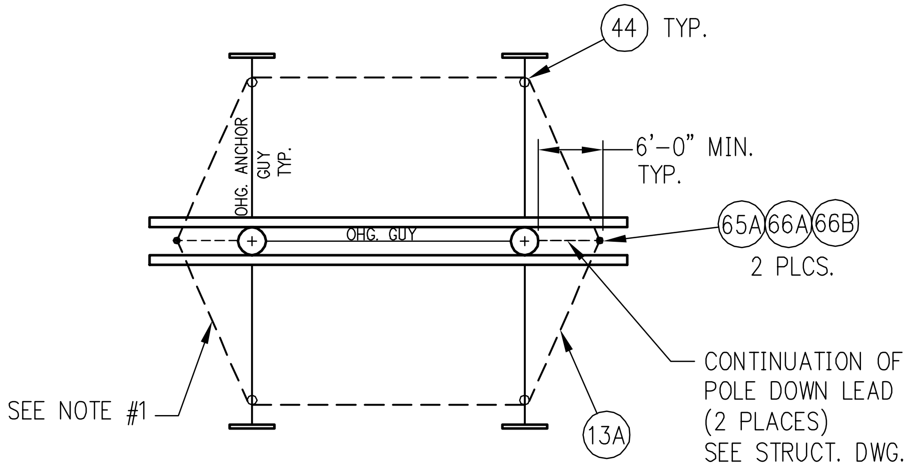
VERMONT ELECTRIC POWER CO., INC.
RUTLAND, VERMONT
WEST RUTLAND – NEW HAVEN 345 KV

2-POLE GROUNDING DETAILS
TYPE A, B & C

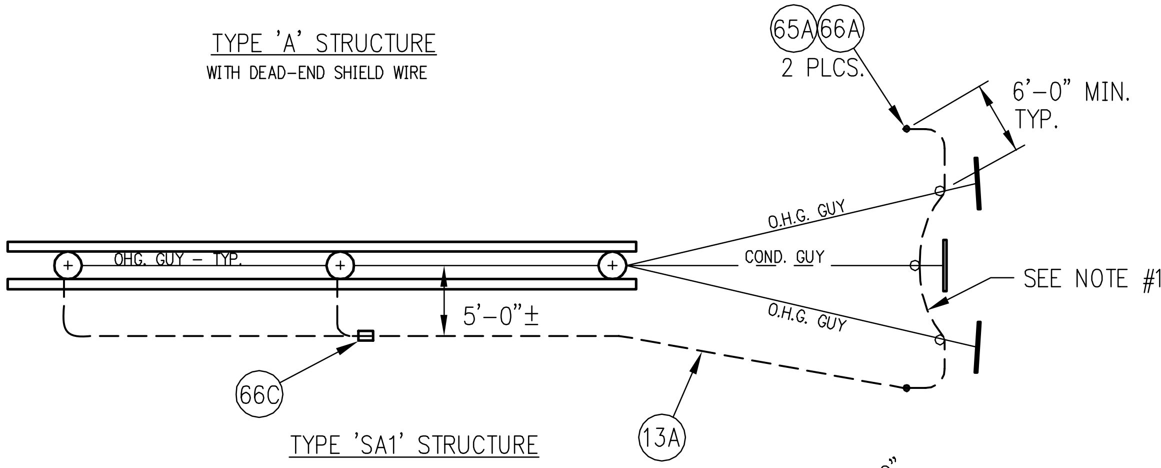
SCALE: NONE | DRAWN BY: BMcD | APPROVED BY:
DATE: 11/05 | CHECKED BY: KAW | DATE
DRAWING NUMBER: 345-11.0
PLOT: 1=1
REV. 1

FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-11.0.dwg 09-20-2005 16:30

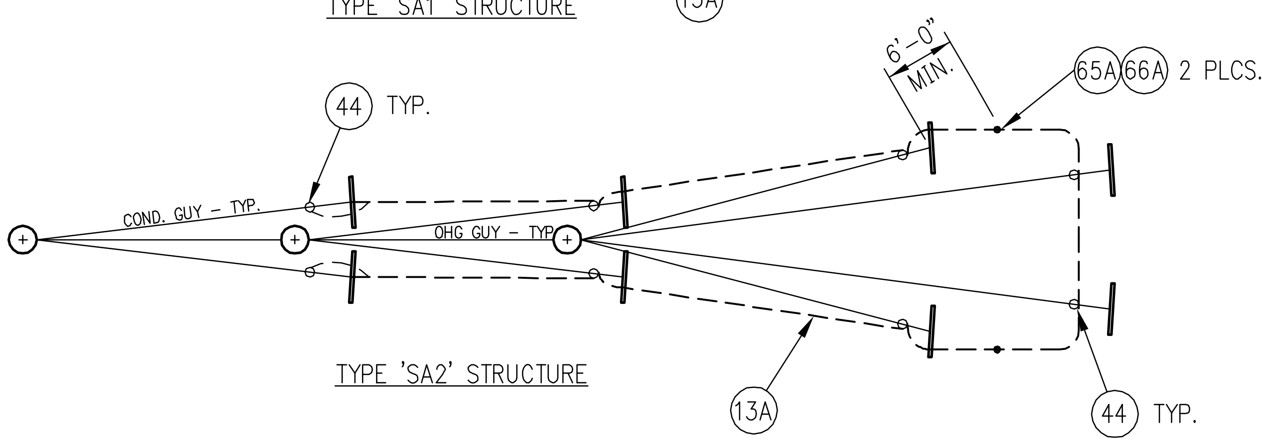
NOTES:
1. – – – DENOTES CONTINUOUS GROUNDING WIRE BURIED 1'-6" MIN. BELOW GRADE
2. GROUND RODS TO BE DRIVEN IN UNDISTURBED EARTH AT A MIN. DISTANCE OF 6'-0" FROM POLES AND ANCHORS.
3. FOR GROUNDING DETAILS, ITEM DESCRIPTION & QUANTITY SEE DWG. #345-10.0 & SPECIFIC STRUCTURE B/M.
4. LOCATION OF BURIED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



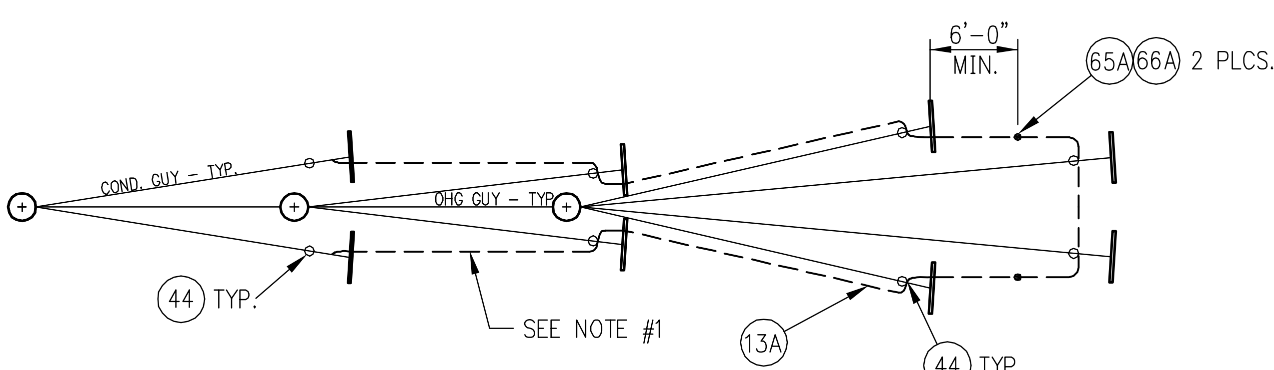
TYPE 'A' STRUCTURE
WITH DEAD-END SHIELD WIRE



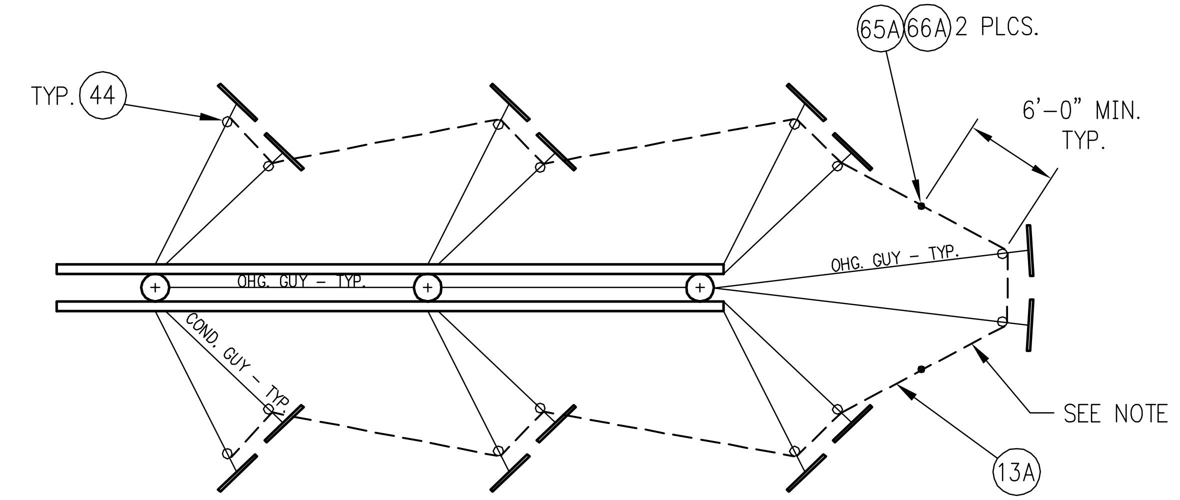
TYPE 'SA1' STRUCTURE



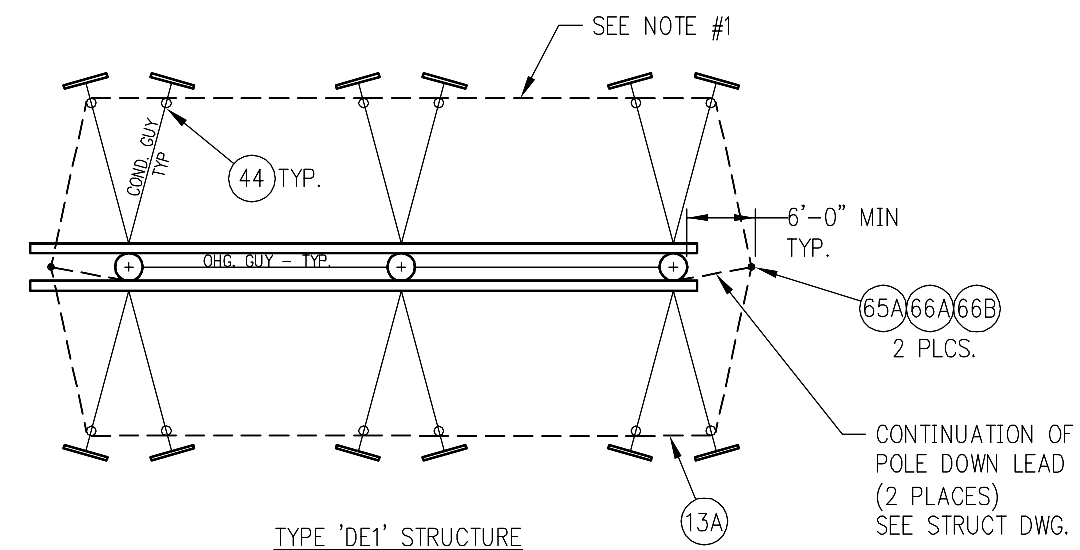
TYPE 'SA2' STRUCTURE



TYPE 'SA3' STRUCTURE



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



TYPE 'DE1' STRUCTURE

Burns & McDonnell SINCE 1898

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

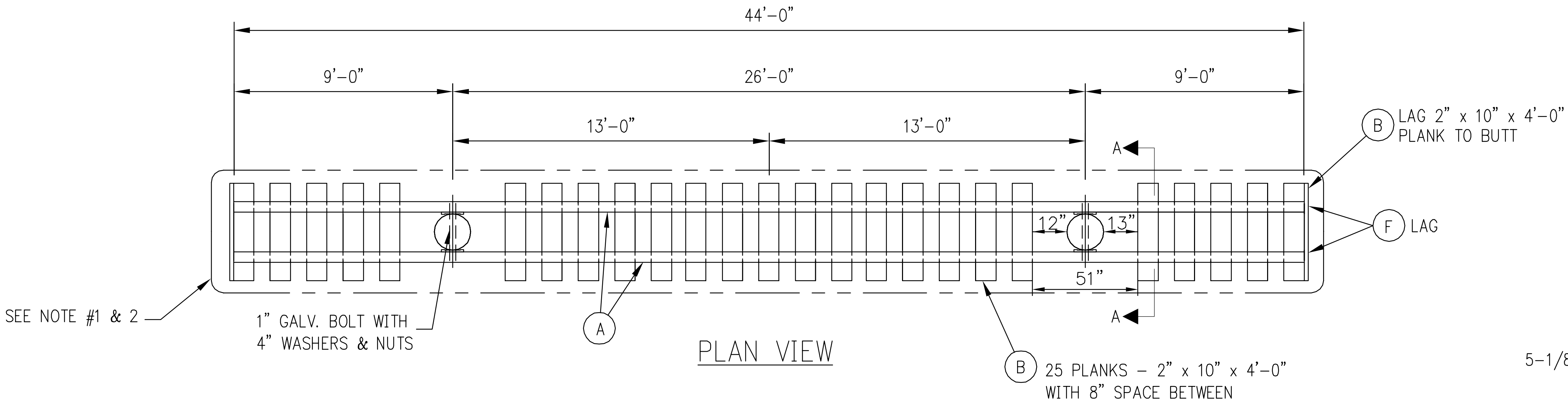
REV	DATE	DR	CK	DESCRIPTION
1	1/01/08	JAH	JRW	CONFORMED TO CONSTRUCTION RECORDS
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

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

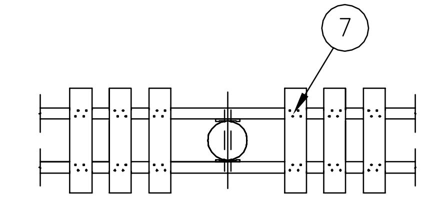
METHOD OF POLE AND GUY GROUNDING

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	
DATE: 11/05	CHECKED BY: KAW		DATE
DRAWING NUMBER: PLOT: 1=1	345–11.1		1 REV.

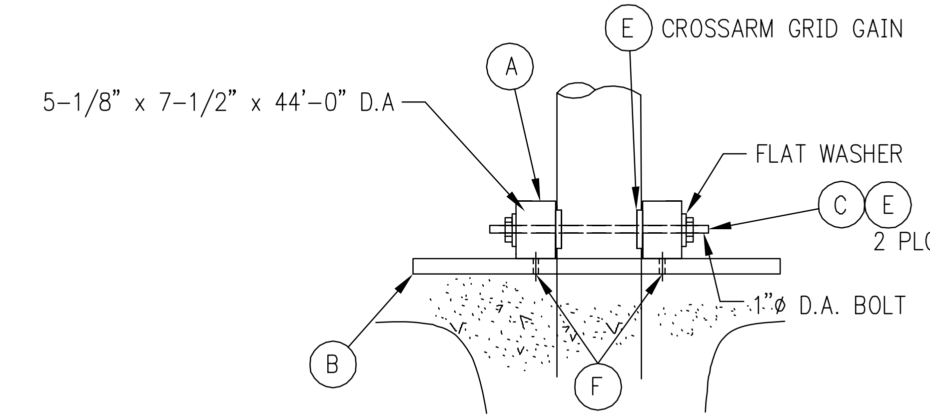
FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-11.1.dwg 02-07-2006 13:13 DSM BMcD



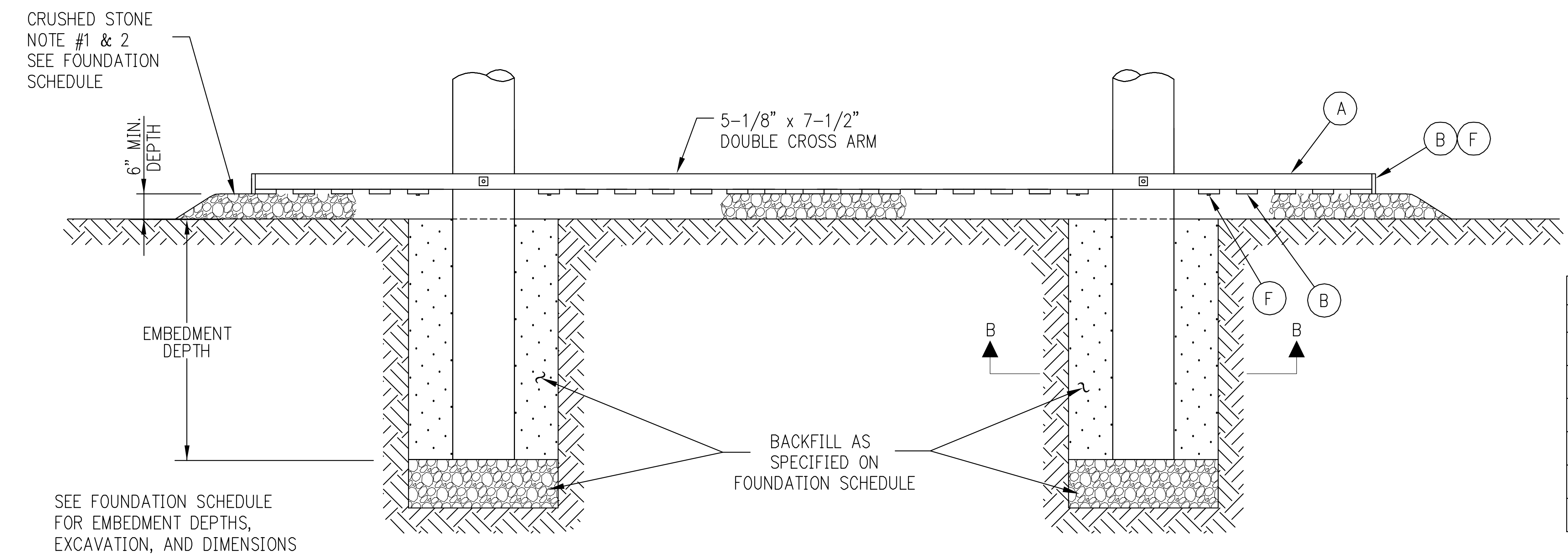
PLAN VIEW



SECTION B-B



SECT. A-A



ELEVATION VIEW

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

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

Burns & McDonnell SINCE 1898

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

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

VELCO

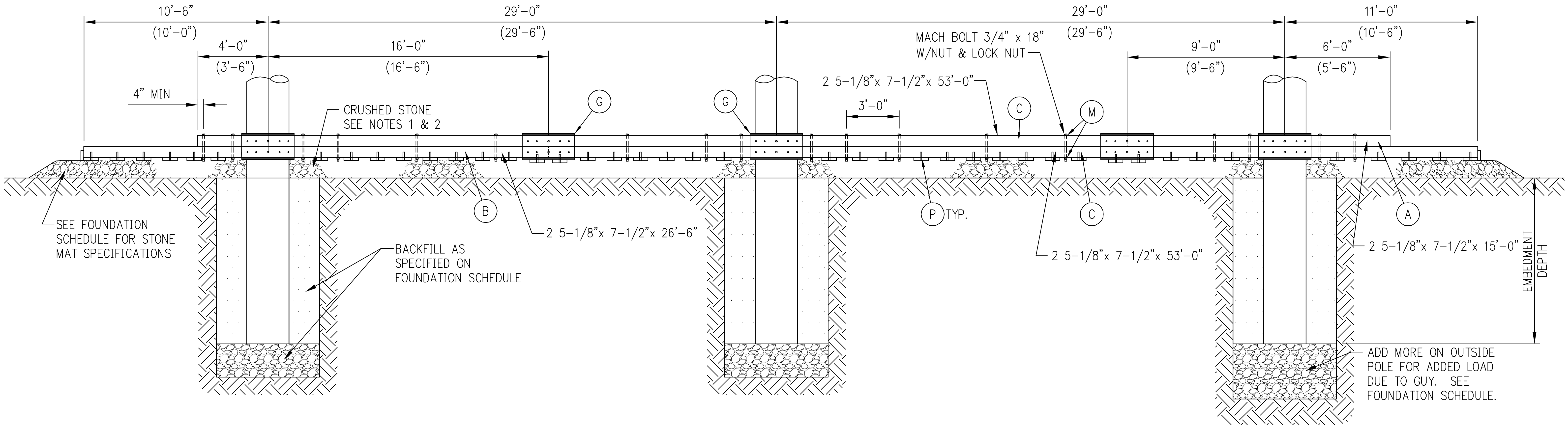
VERMONT ELECTRIC POWER CO., INC.
RUTLAND, VERMONT

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: PLOT: 1=1	345-13.0		1 REV.

FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-13.0.dwg 02-07-2006 13:13 DSM BMcD



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 SINCE 1898

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

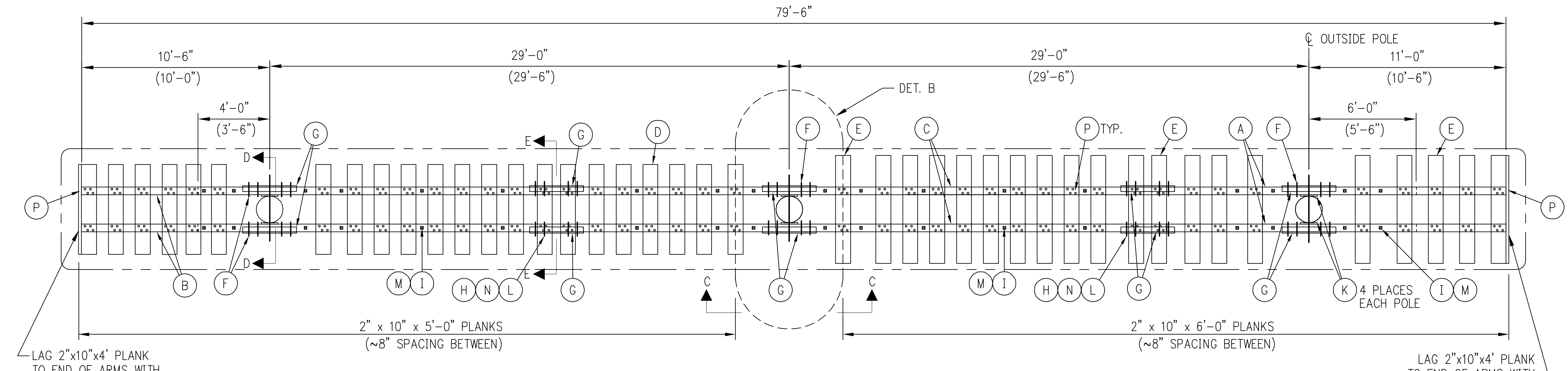
REV	DATE	DR	CK	DESCRIPTION
1	1/01/08	JAH	JRW	CONFORMED TO CONSTRUCTION RECORDS
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

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

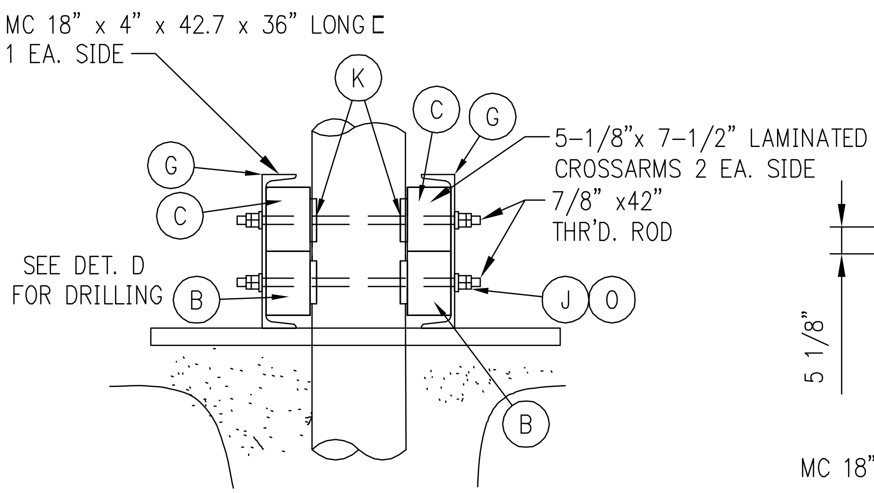
BOG SHOE PLATFORM
FOR 3 POLE STRUCTURE
29'-0" & 29'-6" POLE SPACING

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	
DATE: 11/05	CHECKED BY: KAW		DATE
DRAWING NUMBER: PLOT: 1=1	345-14.0		1 REV.

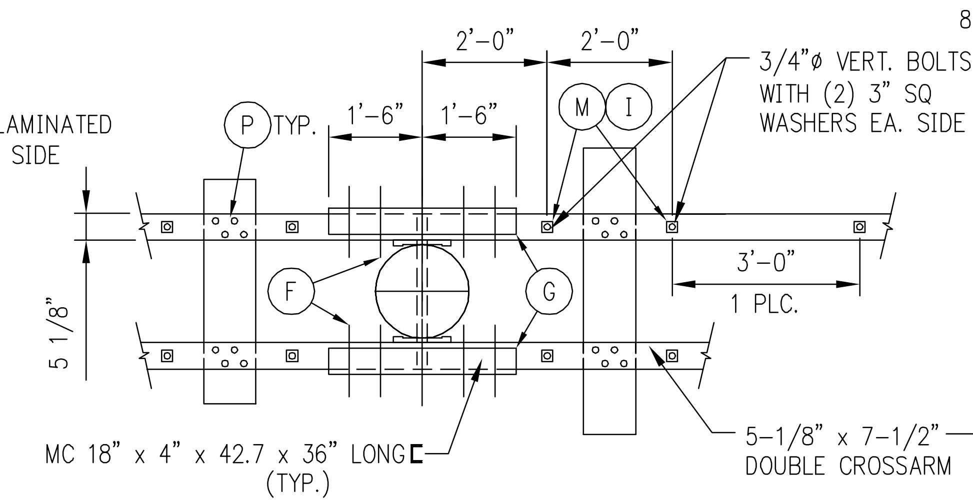
FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-14.0.dwg 02-07-2006 13:13 DSM BMcD



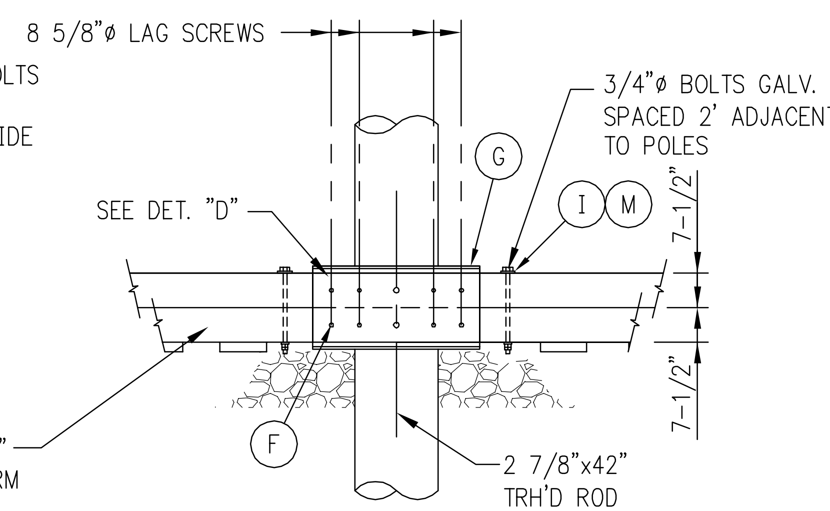
PLAN VIEW



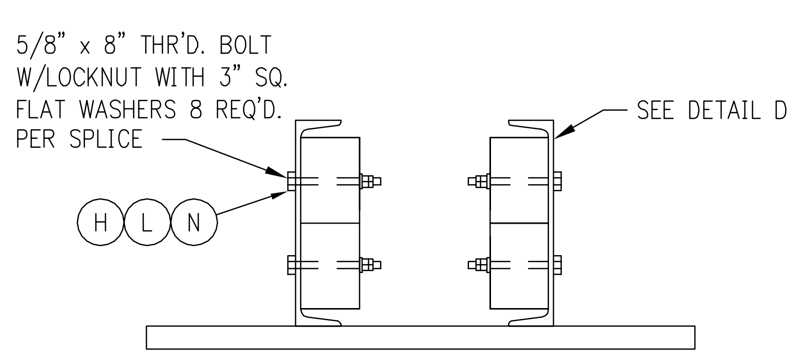
SECT. D-D



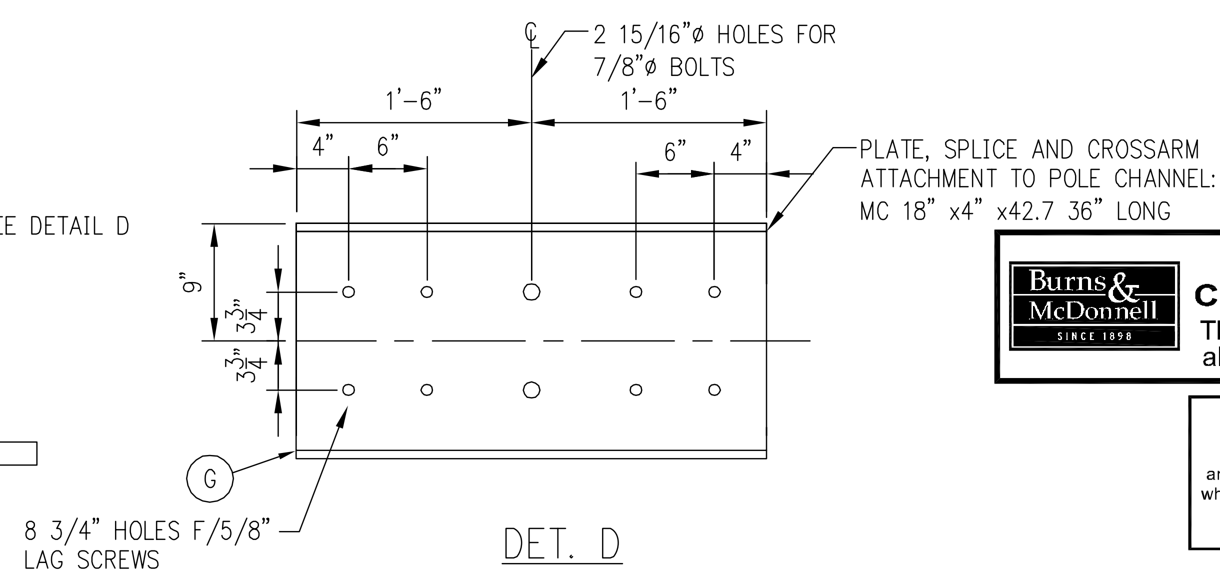
DET. B



SECT. C-C



SECT. E-E



DET. D

Burns & McDonnell SINCE 1898

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

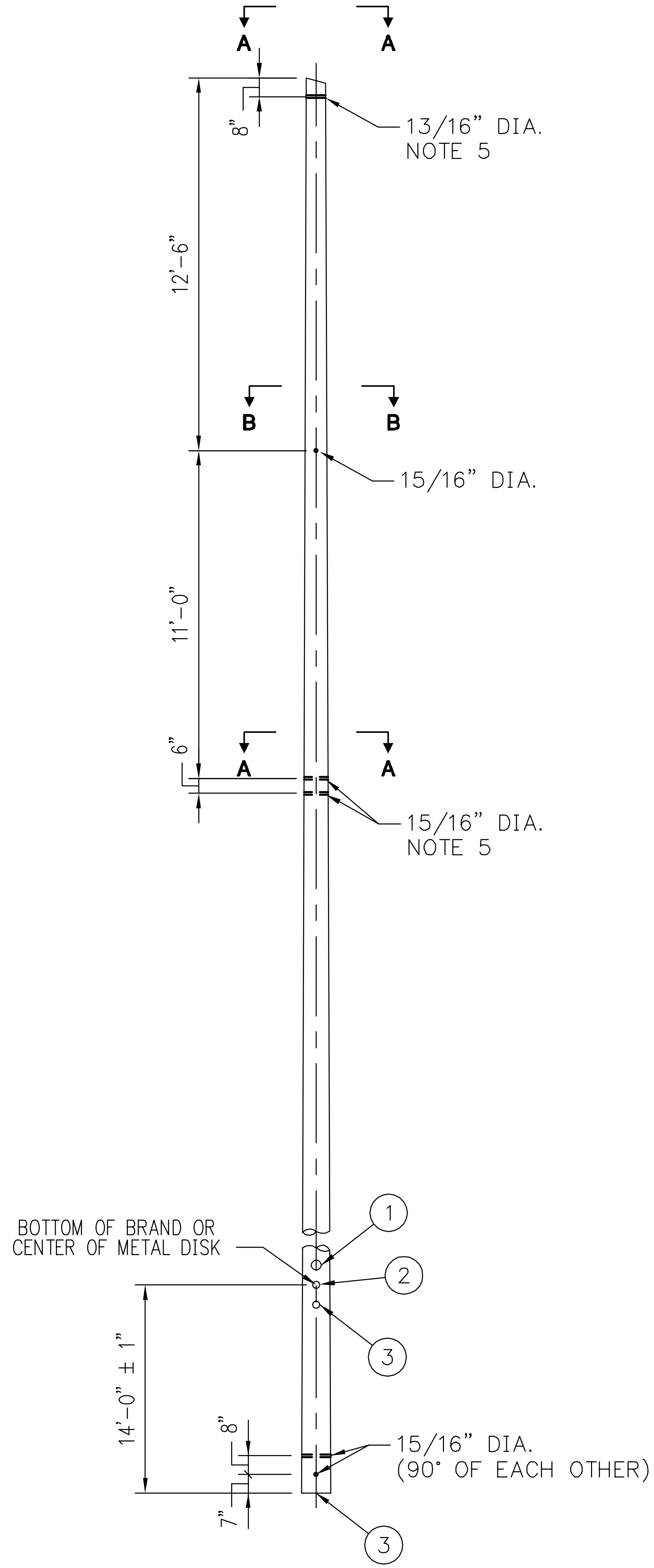
REV	DATE	DR	CK	DESCRIPTION
1	1/01/08	JAH	JRW	ISSUED FOR CONSTRUCTION
0	1/12/06	CSM	JRW	ISSUED FOR CONSTRUCTION

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

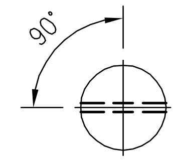
BOG SHOE PLATFORM FOR 3 POLE STRUCTURE 29'-0" & 29'-6" POLE SPACING

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	
DATE: 11/05	CHECKED BY: KAW		DATE
DRAWING NUMBER: PLOT: 1=1	345-14.1		1 REV.

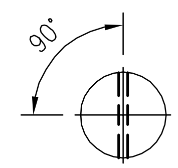
FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-14.1.dwg 02-07-2006 13:13 DSM BMcD



STRUCTURE TYPE "A"



DETAIL A



DETAIL B

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

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

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

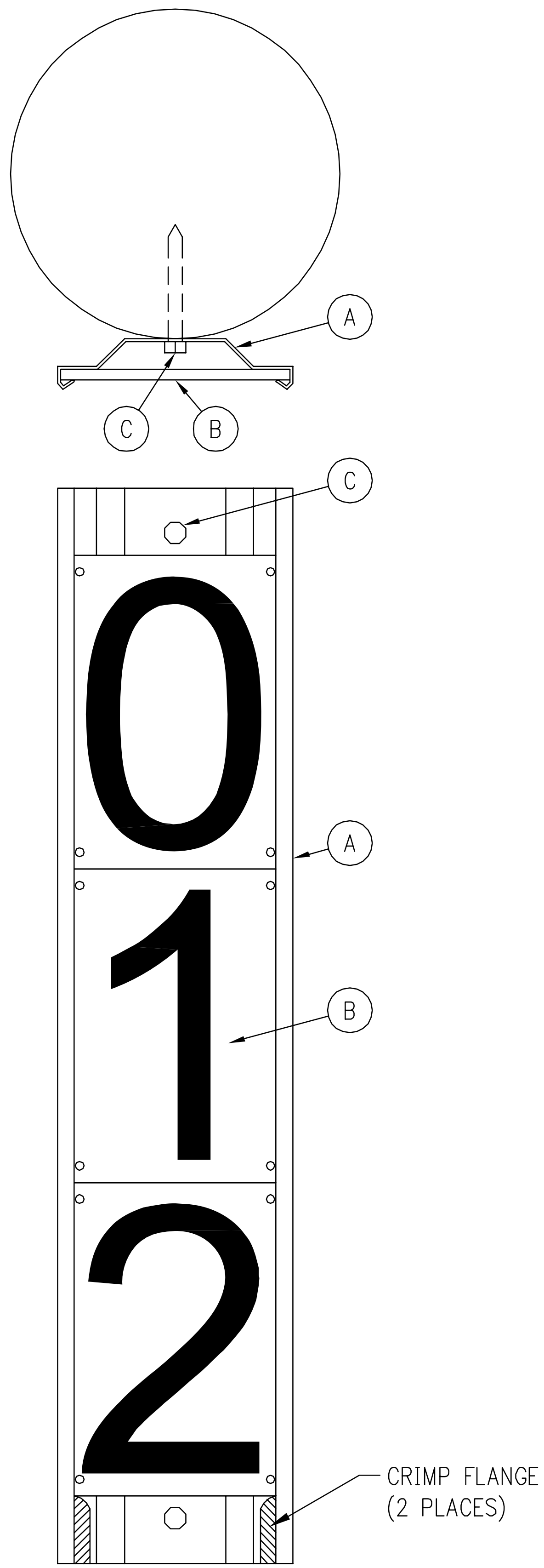
VELCO

VERMONT ELECTRIC POWER CO., INC.
RUTLAND, VERMONT
WEST RUTLAND – NEW HAVEN

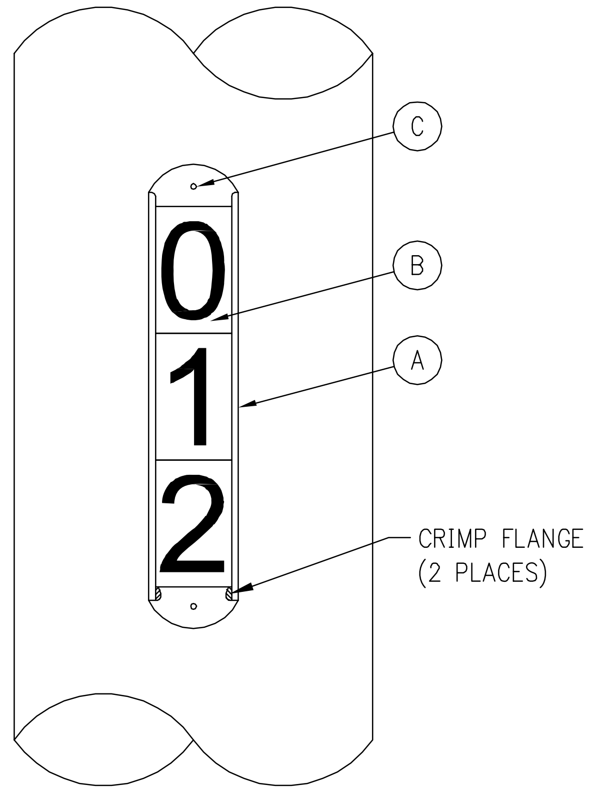
345KV STRUCTURE
POLE DRILLING GUIDE
TYPE "A"

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	
DATE:	CHECKED BY:		DATE
DRAWING NUMBER: PLOT: 1=1	345–DG		1 REV.

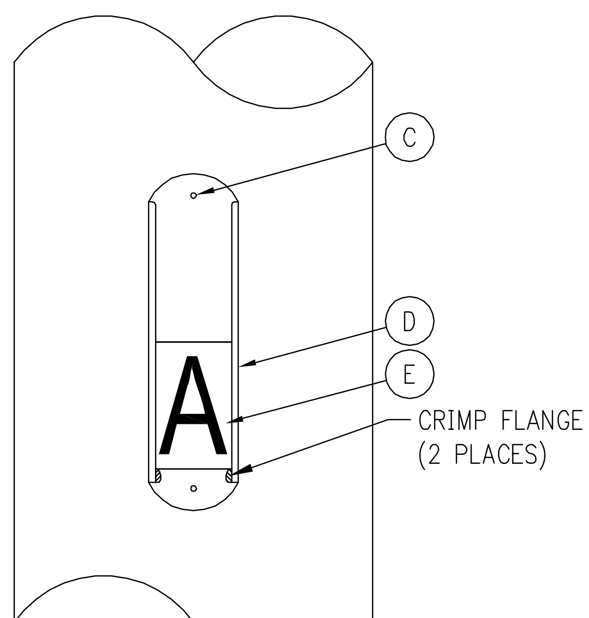
FILE: N:\Velco\36445 WR-NH EP\Cadd\STANDARD POLES\345KV\345-DG.dwg 02-07-2006 13:13 DSM BMcD



AERIAL PATROL SIGN



SN #1



SN #2

STRUCTURE NUMBER SIGNS

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

Burns & McDonnell SINCE 1898

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

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 345KV

AERIAL PATROL &
STRUCTURE NUMBER SIGNS

SCALE: NONE	DRAWN BY: BMcD	APPROVED BY:	
DATE: 1/06	CHECKED BY: JRW		DATE
DRAWING NUMBER: PLOT: 1=1	345–SIGN		1 REV.

FILE: N:\Velco\36445 WR–NH EP\Cadd\STANDARD POLES\345KV\345–SIGN.dwg 01–11–2006 09:22

VERTICAL SCALE IN FEET

HORIZONTAL SCALE IN FEET

(SCALE FOR 36 X 24 PLOT ONLY)

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

PROPRIETARY

REV	DATE	DR	CK	DESCRIPTION
G	5.30.06	PEI	PEI	ISSUE FOR PUBLIC SERVICE BOARD REVIEW
F	4.19.06	PEI	PEI	ISSUE FOR PUBLIC SERVICE BOARD REVIEW
E	2.24.06	PEI	PEI	ISSUE FOR DPS AND AFFECTED PARTY REVIEW
D	2.02.06	PEI	PEI	ISSUE FOR PRELIMINARY DPS REGULATORY REVIEW
C	12.29.05	PEI	PEI	ISSUE FOR PRELIMINARY REGULATORY REVIEW
B	12.14.05	PEI	PEI	PRELIMINARY FOR REVIEW MEETING
A	11.07.05	PEI	PEI	PRELIMINARY SPOOTING FOR FIELD REVIEW

POWER ENGINEERS
14220 LADUE ROAD
ST. LOUIS, MO 63017

VELCO
VERMONT ELECTRIC POWER CO., INC.
RUTLAND, VERMONT
NEW HAVEN – QUEEN CITY

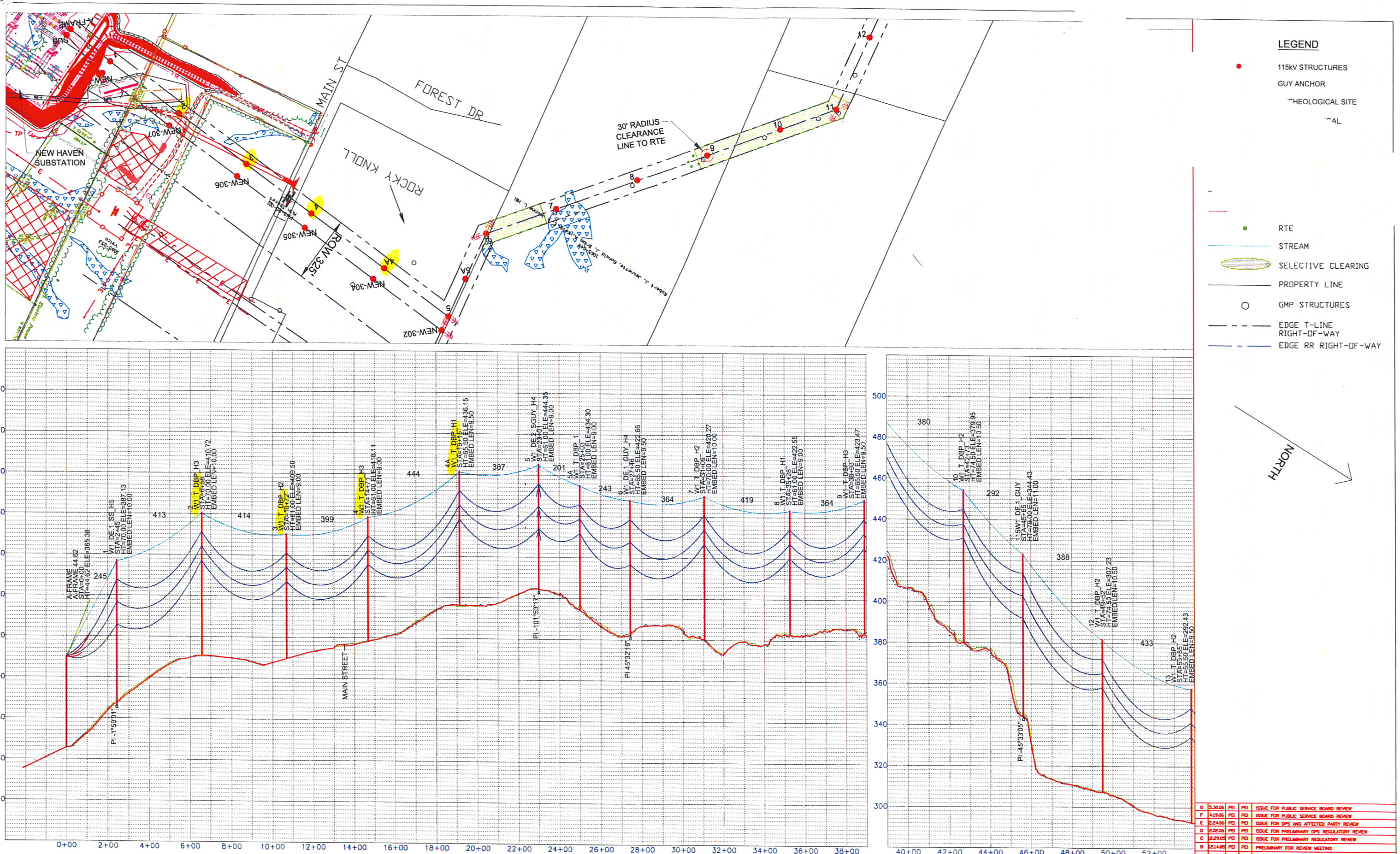
NEW HAVEN – QUEEN CITY
115kV LINE
PLAN & PROFILE

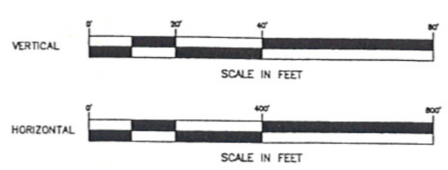
date 11/07/05 | detailed SRB (PEI)
designed BRH (PEI) | checked MAT (PEI)

SCALE: AS SHOWN | DRAWN BY: PEI | APPROVED BY: | –
DATE: 5/30/06 | CHECKED BY: PEI | DATE

DRAWING NUMBER: L023-23X
PLOT: 1=1
G REV.

FILE: NH-QC-PP.dwg





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
3) RIGHT-OF-WAY LINES ARE DISPLAYED AT 50FT RIGHT AND LEFT OF CENTERLINE, TOTALING 100FT WIDE

REV	DATE	DR	CK	DESCRIPTION
G	5.30.06	PEI	PEI	ISSUE FOR PUBLIC SERVICE BOARD REVIEW
F	4.19.06	PEI	PEI	ISSUE FOR PUBLIC SERVICE BOARD REVIEW
E	2.24.06	PEI	PEI	ISSUE FOR DPS AND AFFECTED PARTY REVIEW
D	2.02.06	PEI	PEI	ISSUE FOR PRELIMINARY DPS REGULATORY REVIEW
C	12.29.05	PEI	PEI	ISSUE FOR PRELIMINARY REGULATORY REVIEW
B	12.14.05	PEI	PEI	PRELIMINARY FOR REVIEW MEETING
A	11.07.05	PEI	PEI	PRELIMINARY SPOTTING FOR FIELD REVIEW

PROPRIETARY

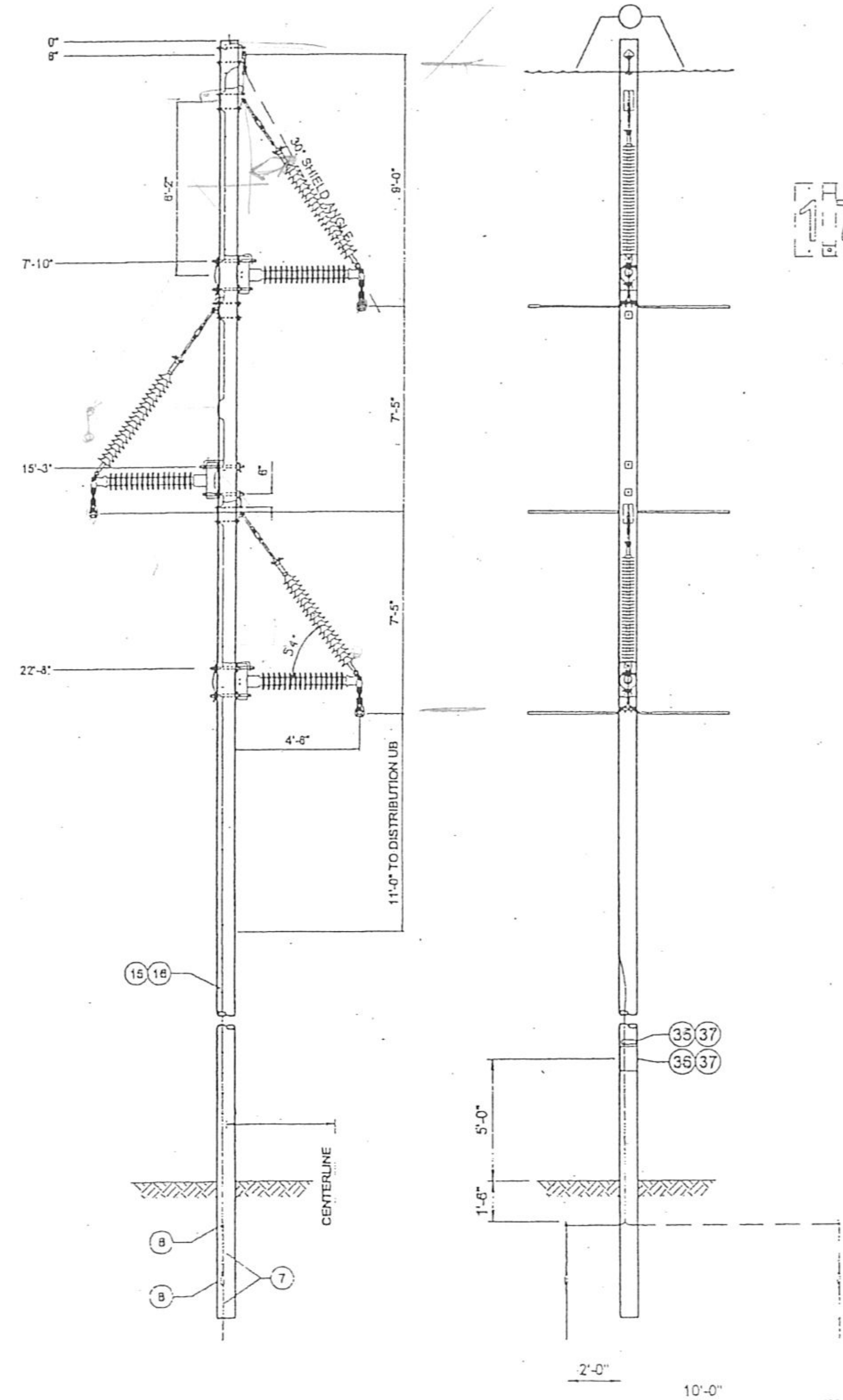
POWER ENGINEERS
14220 LAQUE ROAD
ST. LOUIS, MO 63017

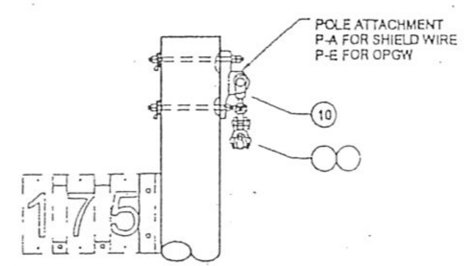
VELCO
VERMONT ELECTRIC POWER CO., INC.
RUTLAND, VERMONT
NEW HAVEN – QUEEN CITY

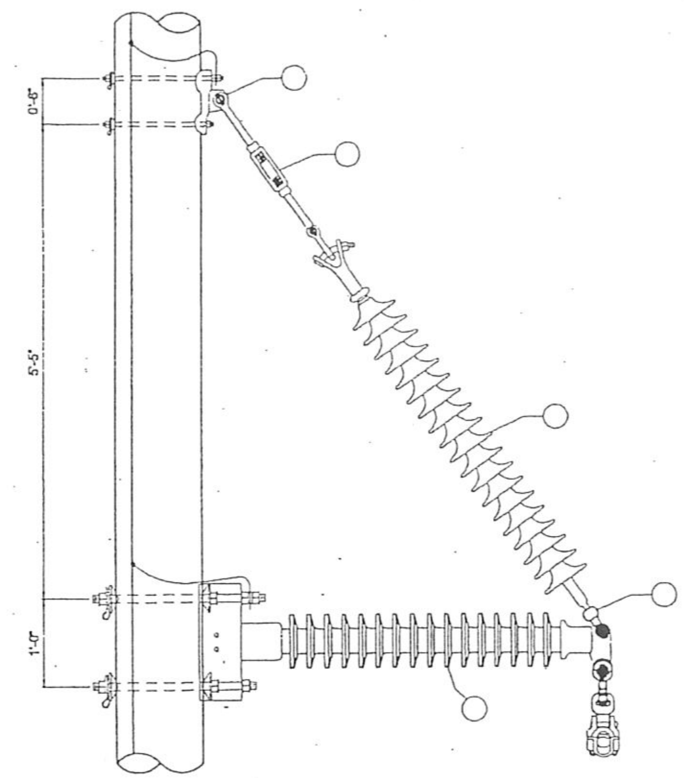
NEW HAVEN – QUEEN CITY
115kV LINE
PLAN & PROFILE

date 11/07/05 | detailed SRB (PEI)
designed BRH (PEI) | checked MAT (PEI)

SCALE: AS SHOWN | DRAWN BY: PEI | APPROVED BY:
DATE: 5/30/06 | CHECKED BY: PEI
DRAWING NUMBER: L050–1
PLOT: 1=1







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 3/8X3X6IN , 2 HOLE 15/16IN 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	CLEVIS-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	513-4063	CLIP-BONDING GRND 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" 8-1/0STR	1	1
	18	504-6461	ROD-GROUND THREADLESS 5/8"X 8'CU CLAD	2	2
	19	513-5590	COUPLING-GROUND ROD 5/8" CU CLAD	1	1
HARDWARE	20	504-3366	CLEVIS-Y BALL 30KLB BOLT, NUT, COTTER	4	3
	21	504-8053	SUPPORT-SHIELD WIRE 3/4X14"	1	-
	22	513-5961	HOOK-GUY SGL 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 H1 POLE)	5	5
	31	513-2763	BOLT-MACH 7/8X20"GALV SQ HD (FOR CL H1 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 W/AL 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

SPAN LENGTH LIMITS (FT)

GALLOPING CLEARANCE	1272 ACSR	1272 ACSR WITH U/B 477 ACSR
R-S LIMIT	440	-
MAX SPAN	440	-
INSULATOR STRENGTH (MCL)=9000 LB	-	-
WEIGHT SPAN LIMIT	-	-

* LIMITED BY SHIELD WIRE TO TOP PHASE

NOTES:

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

PRELIMINARY

ISSUED FOR REVIEW AND COMMENTS
NOT FOR CONSTRUCTION

REV	DATE	DR	CK	DESCRIPTION

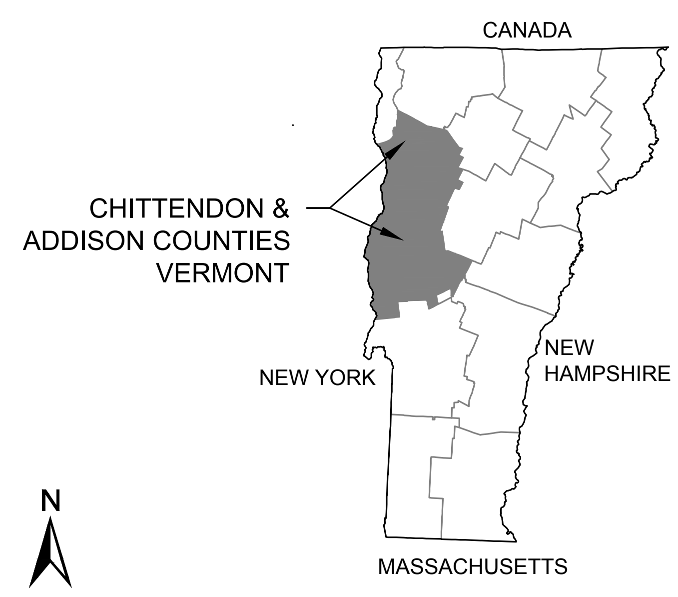
POWER ENGINEERS

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

115KV CONSTRUCTION SINGLE CIRCUIT BRACED POST TANGENT STRUCTURE (0°-3°)

date 12/12/05	detailed SRB (PEI)	SCALE: NONE	DRAWN BY: SRB	APPROVED BY:	12/05
		DATE: 12/12/05	CHECKED BY: PJH		DATE
designed PJH (PEI)	checked PJH (PEI)	DRAWING NUMBER: PLOT: 1=1	115-SPSCBP-1.0		- REV.

APPENDIX D –
ARK ENGINEERING DESIGN DRAWINGS



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

CHA

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: CHA

SITE: VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT

PROJECT NO. 12-E-144-AC

ARK ENGINEERING & TECHNICAL SERVICES, INC.
ARK ENGINEERING & TECH. SERVICES, INC.
639 GRANITE STREET
SUITE 200
BRAINTREE, MA
02184 U.S.A.

TITLE: COVER SHEET

DRAWN BY	DATE	SIZE	DWG. NO.	REV
JRW	6/18/13	B	12144-100	C

APPROVED BY	DATE	SCALE	CAD FILE NAME	SHEET
RFA	5/16/16	NTS	12144-100-1-RC	1 OF 1

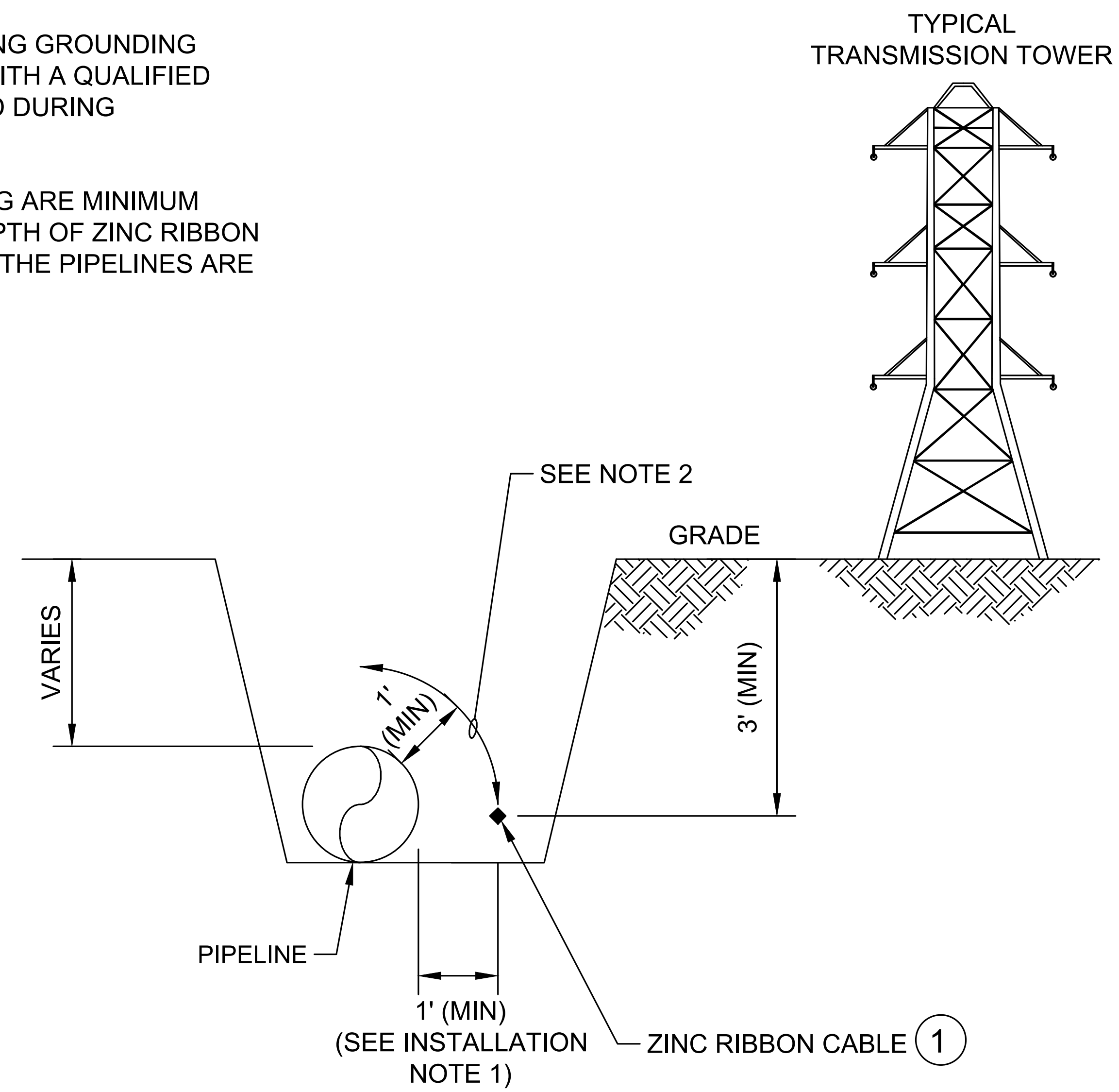
REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM
B	REVISED PER ECO 2015-017	4/1/15	RFA
C	CLIENT REVISIONS	5/16/16	RFA

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.



CROSS SECTION 'B'

ZINC RIBBON CABLE INSTALLATION
SINGLE STRAND
IN SAME TRENCH

CAUTION:
ZINC RIBBON MUST NOT TOUCH PIPE.

ISSUED FOR CONSTRUCTION

CLIENT: CHA

SITE: VERMONT GAS SYSTEMS, INC.
ADDISON NATURAL GAS PROJECT

ARK ENGINEERING & TECHNICAL SERVICES, INC.

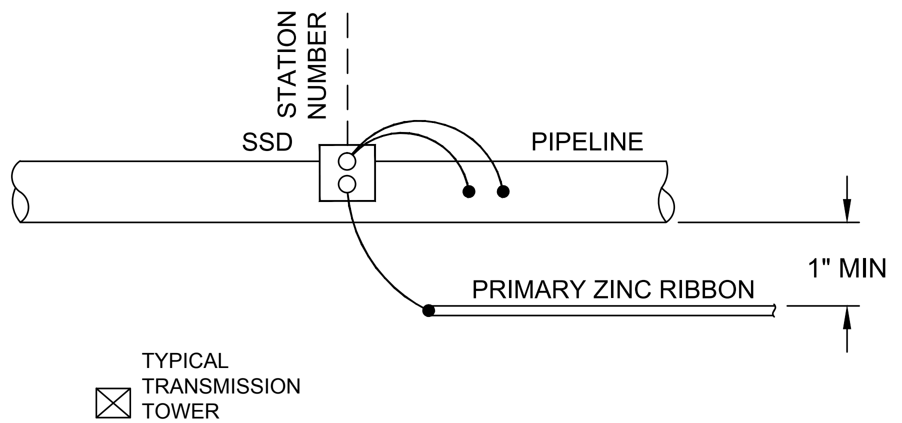
ARK ENGINEERING &
TECH. SERVICES, INC.
639 GRANITE STREET
SUITE 200
BRAINTREE, MA
02184 U.S.A.

TITLE: SINGLE STRAND ZINC RIBBON INSTALLATION SECTION VIEW

DRAWN BY	DATE	SIZE		DWG. NO.	REV
JRW	6/18/13	B		12144-200	C

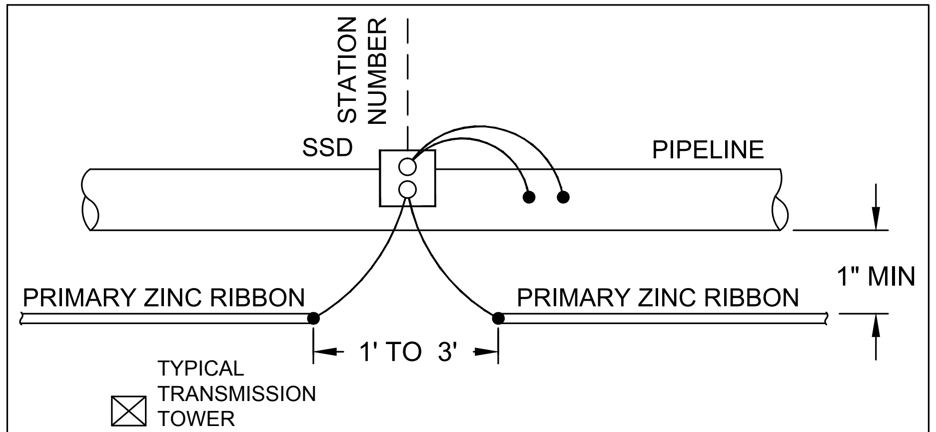
PROJECT NO.	APPROVED BY	DATE	SCALE	CAD FILE NAME	SHEET
12-E-144-AC	RFA	5/16/16	NTS	12144-200-1-RC	1 OF 1

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



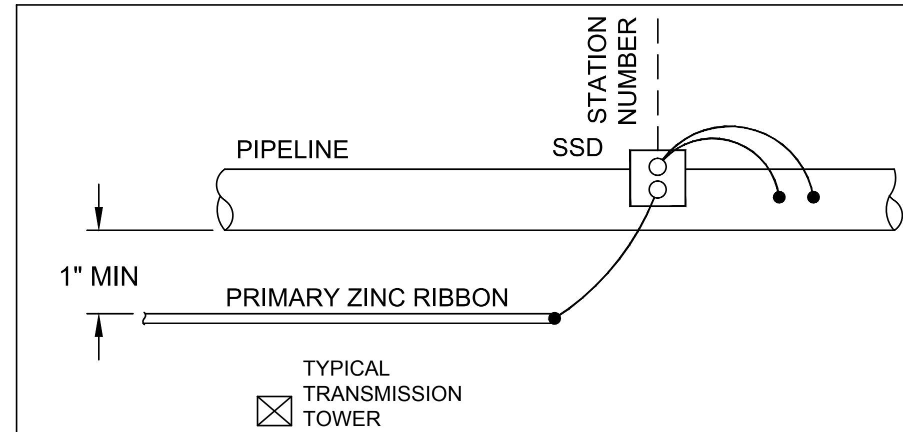
ZINC RIBBON INSTALLATION PLAN VIEW Zn-1A

SINGLE STRAND WIRING DETAIL



ZINC RIBBON INSTALLATION PLAN VIEW Zn-1B

SINGLE STRAND WIRING DETAIL



ZINC RIBBON INSTALLATION PLAN VIEW Zn-1C

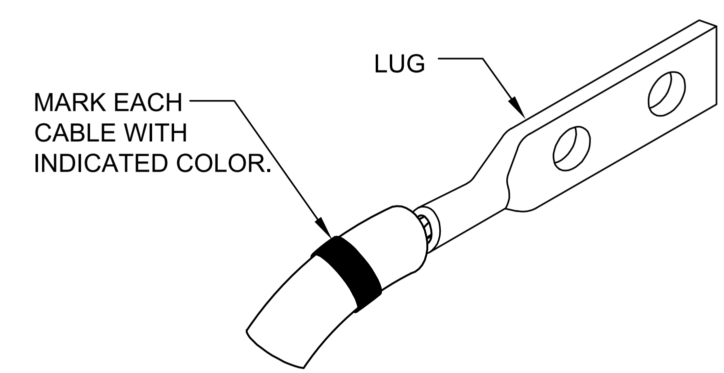
SINGLE STRAND WIRING DETAIL

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:

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



CABLE TAPE DETAIL

CAUTION:
ZINC RIBBON MUST NOT TOUCH PIPE.

ISSUED FOR CONSTRUCTION

CLIENT: CHA

SITE: VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT

PROJECT NO. 12-E-144-AC

ARK ENGINEERING & TECHNICAL SERVICES, INC.

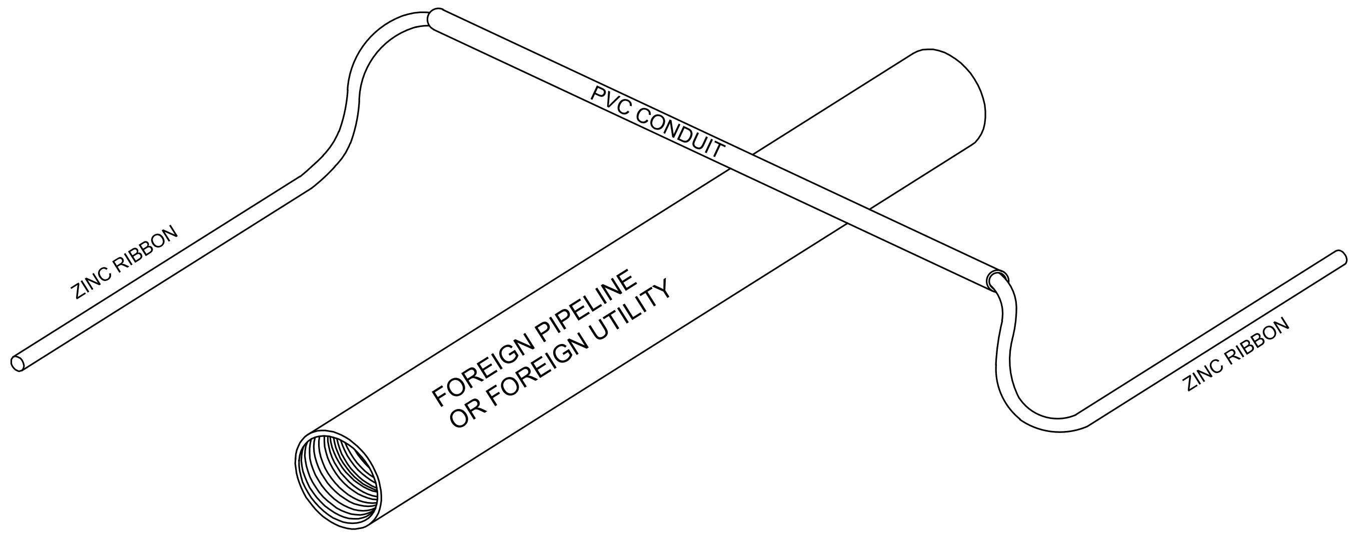
ARK ENGINEERING & TECH. SERVICES, INC.
639 GRANITE STREET
SUITE 200
BRAINTREE, MA
02184 U.S.A.

TITLE: SINGLE STRAND ZINC RIBBON AND SSD WIRING DETAILS

DRAWN BY	DATE	SIZE	DWG. NO.	REV
JRW	6/18/13	B	12144-201	C

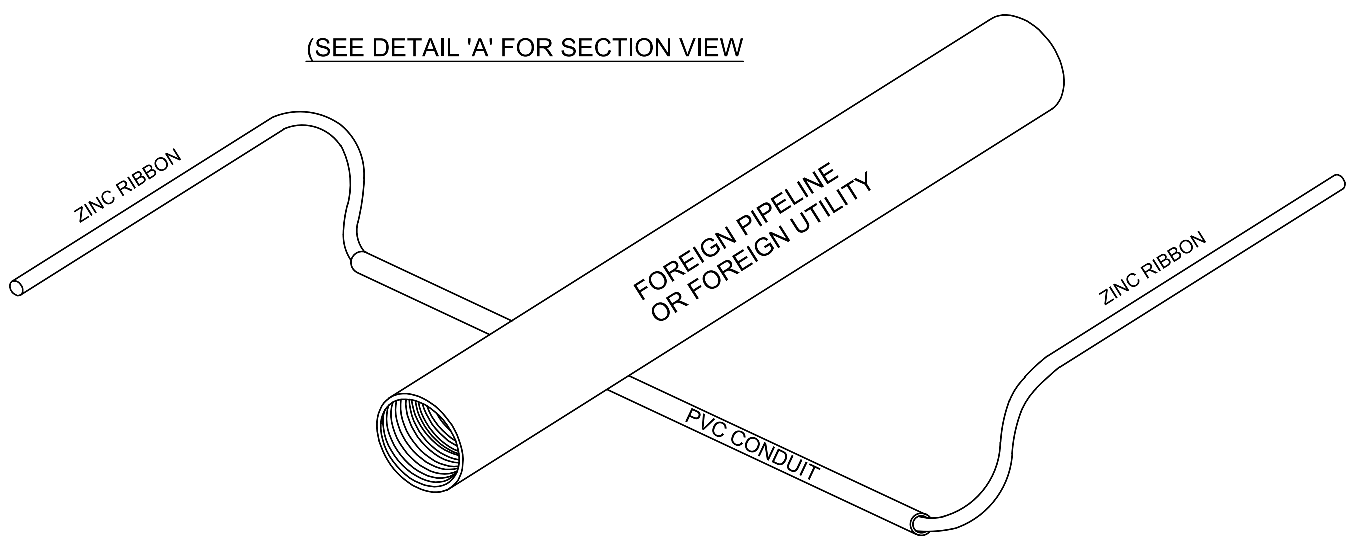
APPROVED BY	DATE	SCALE	CAD FILE NAME	SHEET
RFA	5/16/16	NTS	12144-201-1-RC	1 OF 1

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



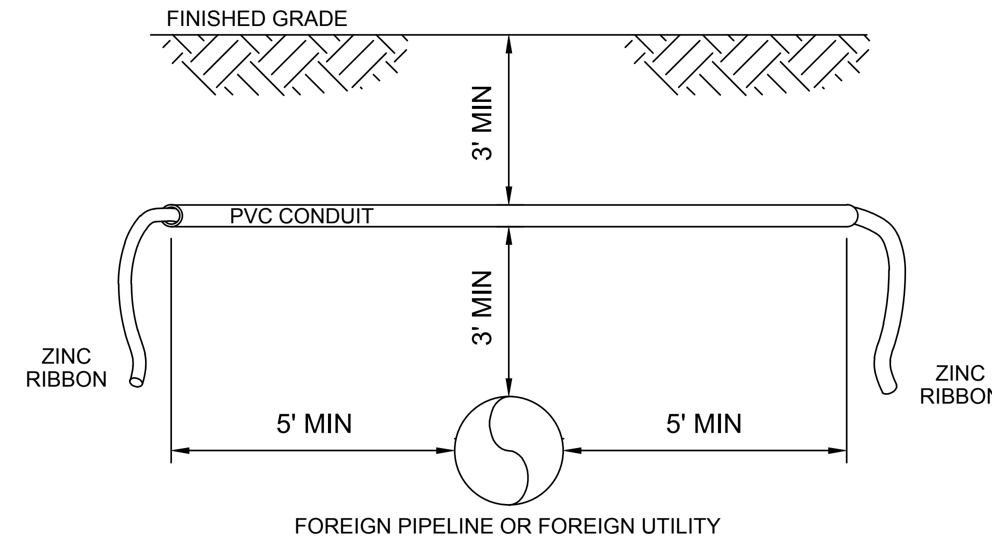
ZINC RIBBON CROSSING ABOVE
FOREIGN PIPELINE OR FOREIGN UTILITY

(SEE DETAIL 'A' FOR SECTION VIEW

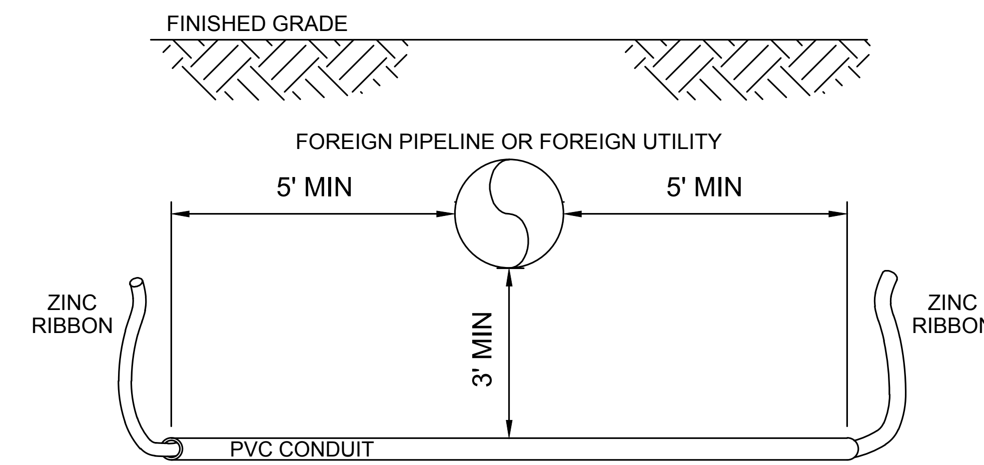


ZINC RIBBON CROSSING BELOW
FOREIGN PIPELINE OR FOREIGN UTILITY

(SEE DETAIL 'B' FOR SECTION VIEW)



DETAIL 'A'



DETAIL 'B'

NOTES:

1. 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.
2. 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.
3. PRIMARY ZINC RIBBON SHOULD BE INSTALLED BETWEEN TRANSMISSION TOWER AND PIPELINE.
4. ZINC RIBBON TO REMAIN CONTINUOUS THROUGH PVC PIPING.

CAUTION:
ZINC RIBBON MUST NOT TOUCH PIPE.

ISSUED FOR CONSTRUCTION

CLIENT: CHA

SITE: VERMONT GAS SYSTEMS, INC.
ADDISON NATURAL GAS PROJECT

PROJECT NO. 12-E-144-AC

ARK ENGINEERING & TECHNICAL SERVICES, INC.

ARK ENGINEERING & TECH. SERVICES, INC.
639 GRANITE STREET
SUITE 200
BRAINTREE, MA
02184 U.S.A.

TITLE: ZINC RIBBON CROSSING
PIPELINE DETAILS

DRAWN BY	DATE	SIZE		DWG. NO.	REV
JRW	6/18/13	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.	12144-202	C
APPROVED BY	DATE	SCALE	CAD FILE NAME		SHEET
RFA	5/16/16	NTS	12144-202-1-RC		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:

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

ISSUED FOR CONSTRUCTION

CLIENT
CHA

SITE
VERMONT GAS SYSTEMS, INC.
ADDISON NATURAL GAS PROJECT

PROJECT NO. 12-E-144-AC

ARK
ENGINEERING & TECHNICAL SERVICES, INC.

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

APPROVED BY RFA | DATE 5/16/16 | SCALE NTS

DWG. NO. 12144-203 | REV C

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

ARK ENGINEERING & TECHNICAL SERVICES, INC.

SIZE: B

DWG. NO. 12144-203 | REV C

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

REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM
B	REVISED PER ECO 2015-017	4/1/14	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: CHA

SITE: VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT

PROJECT NO. 12-E-144-AC

ARK ENGINEERING & TECHNICAL SERVICES, INC.
ARK ENGINEERING & TECH. SERVICES, INC.
639 GRANITE STREET
SUITE 200
BRAINTREE, MA
02184 U.S.A.

TITLE: SSD LOCATIONS

DRAWN BY	DATE	SIZE		DWG. NO.	REV
JRW	6/18/13	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.	12144-204	C

APPROVED BY	DATE	SCALE	CAD FILE NAME	SHEET
RFA	5/16/16	NTS	12144-204-1-RC	1 OF 1

EXOTHERMIC WELD INSTRUCTIONS:

1. FIRST DETERMINE IF THE PIPELINE IS SUITABLE FOR EXOTHERMIC WELDING BY CONDUCTING THE FOLLOWING TESTS:

   A) DETERMINE THAT THE PIPELINE SMYS (SPECIFIED MINIMUM YIELD STRENGTH) IS 80,000 PSI.
   B) DETERMINE THAT PIPELINE WALL THICKNESS IS ⅛" (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. PREPARE PIPELINE SURFACE AS SPECIFIED BY PIPELINE COATING MANUFACTURER.

4. 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.

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 MATERIALS 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.

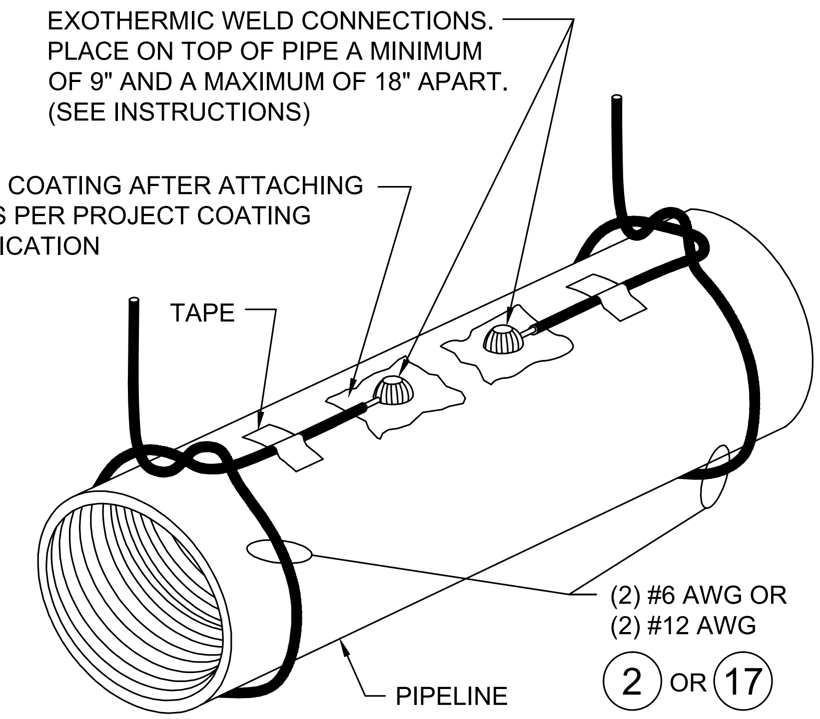
10. PLACE THE METAL RETAINER DISK IN THE SPECIFIED WELD MOLD AND DUMP (DO NOT POUR) WELD METAL POWDER ONTO THE DISK. MAKE SURE THAT ALL OF THE FINE STARTING POWDER IS IN THE MOLD. IF ANY POWDER REMAINS IN THE CARTRIDGE BOTTOM, SQUEEZE OUT INTO MOLD AND BREAK UP.

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 PREPARED 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



DETAIL 'A'
CABLE TO PIPELINE ATTACHMENT DETAIL

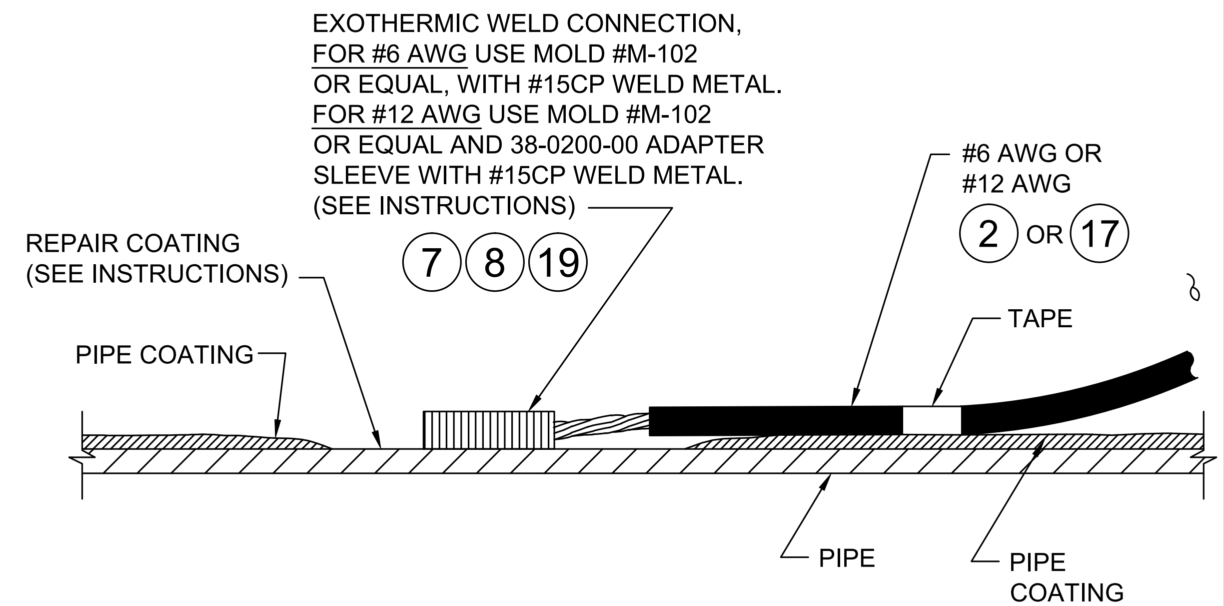
15. WHEN WELD HAS SET, REMOVE WELD MOLD AND TEST CONNECTION BY RAPPING SHARPLY WITH A SLAG HAMMER. IF THERE IS ANY INDICATION THAT A COMPLETE WELD HAS NOT BEEN ACHIEVED, REMOVE THE WELD AND RE-APPLY.

16. IF WELD IS GOOD, REMOVE ANY SLAG WITH HAMMER AND CLEAN USING A WIRE BRUSH.

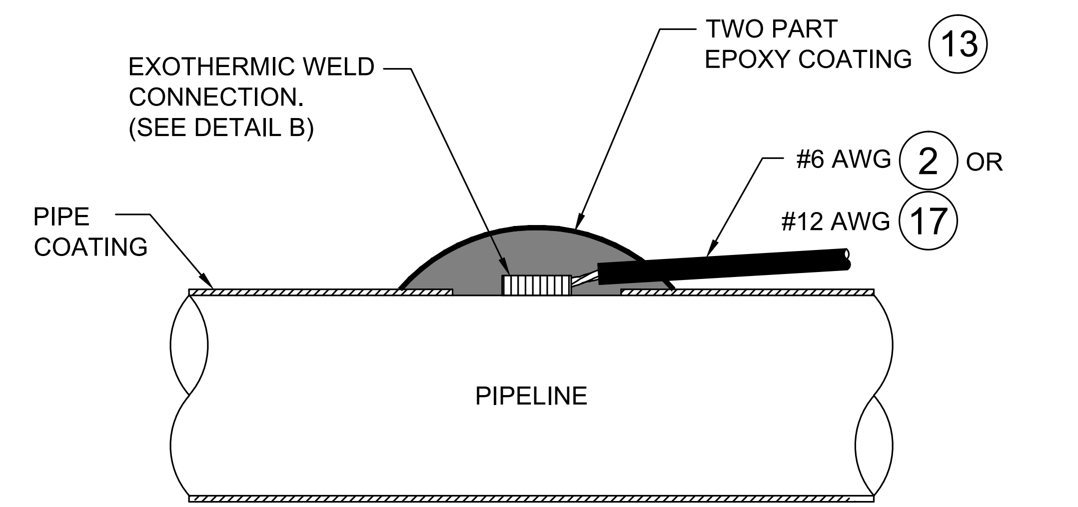
17. AFTER COMPLETING THE EXOTHERMIC WELD CONNECTION TO THE PIPELINE, ALL COATING DAMAGE IS TO BE CLEANED AND COATED WITH 20 MILS MINIMUM OF TWO PART EPOXY COATING OR VERMONT GAS APPROVED EQUAL.

18. REFER TO VERMONT GAS REPAIR SPECIFICATIONS AND PRODUCT DATA SHEET TO DETERMINE IF REPAIR IS ACCEPTABLE.

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 'B'
EXOTHERMIC WELD CONNECTION

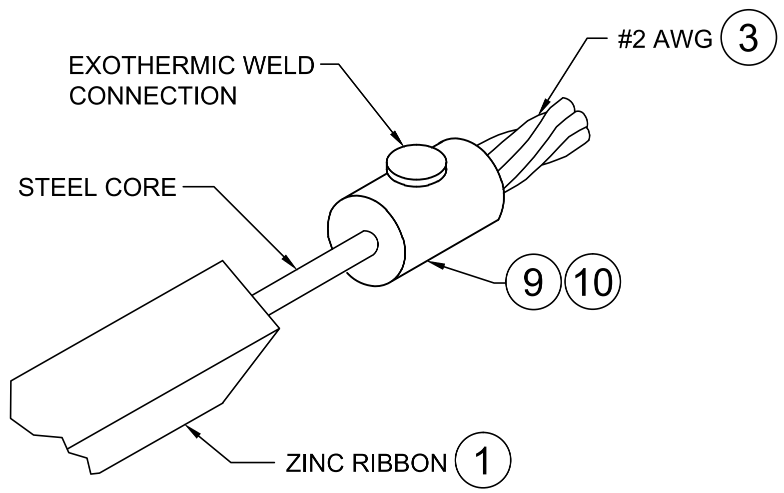


DETAIL 'C'
CORROSION PROTECTION SEAL

ISSUED FOR CONSTRUCTION

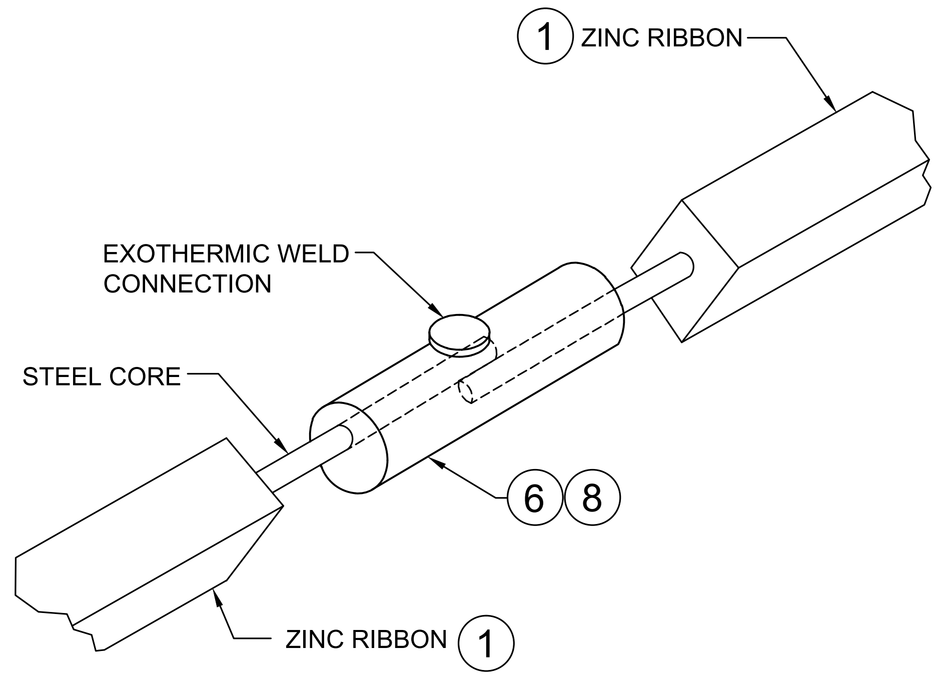
CLIENT: CHA SITE: VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT	ARK ENGINEERING & TECHNICAL SERVICES, INC. ARK ENGINEERING & TECH. SERVICES, INC. 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.	TITLE: CABLE TO PIPELINE CONNECTION DETAILS	
PROJECT NO. 12-E-144-AC	DRAWN BY JRW / DATE 6/18/13 APPROVED BY RFA / DATE 5/16/16	SIZE B / SCALE NTS	DWG. NO. 12144-300 / REV C 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



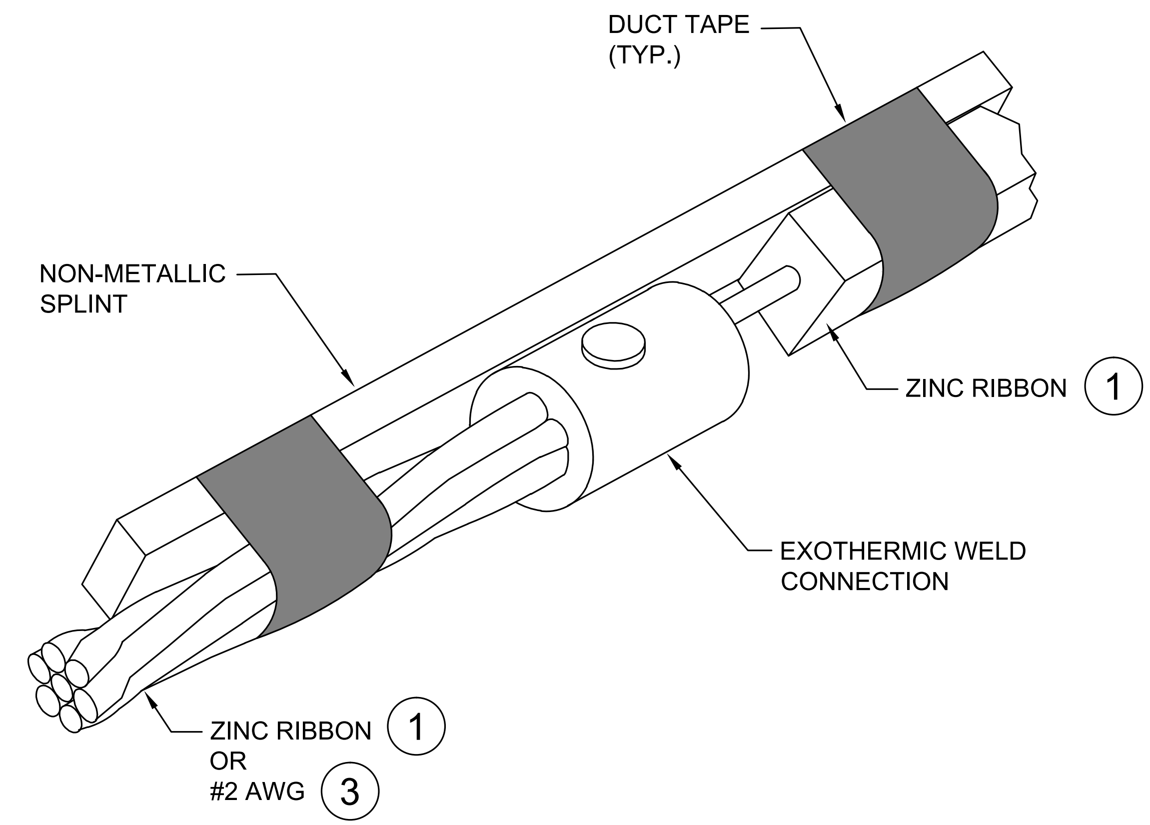
DETAIL 'A'

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



DETAIL 'B'

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



DETAIL 'C'

NON-METALLIC SPLINT INSTALLATION

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

NOTES:

1. ALL EXOTHERMIC WELD CONNECTIONS ARE TO BE SEALED WITH ROYSTON "SPLICE RIGHT" SPLICE KIT (ITEM #14), OR VERMONT GAS APPROVED ALTERNATIVE.

2. 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)

3. INSTALL ZINC RIBBON FROM STATION NO. START TO STATION NO. END, REFERENCE DRAWINGS 12144-201 FOR SSD WIRING AND TAPING DETAILS.

4. 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: CHA

SITE: VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT

PROJECT NO. 12-E-144-AC

ARK Engineering & Technical Services, Inc.

ARK ENGINEERING & TECH. SERVICES, INC. 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.

TITLE: CABLE SPLICE INSTALLATION DETAILS

DRAWN BY: JRW | DATE: 6/18/13 | SIZE: B

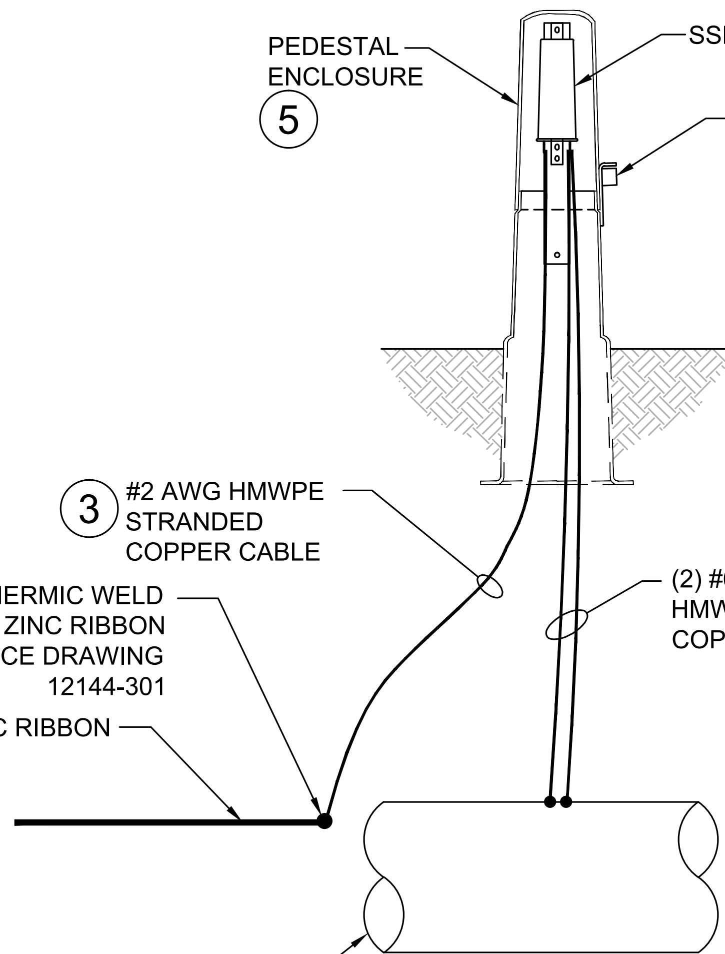
APPROVED BY: RFA | DATE: 5/16/16 | SCALE: NTS

DWG. NO. 12144-301 | REV C

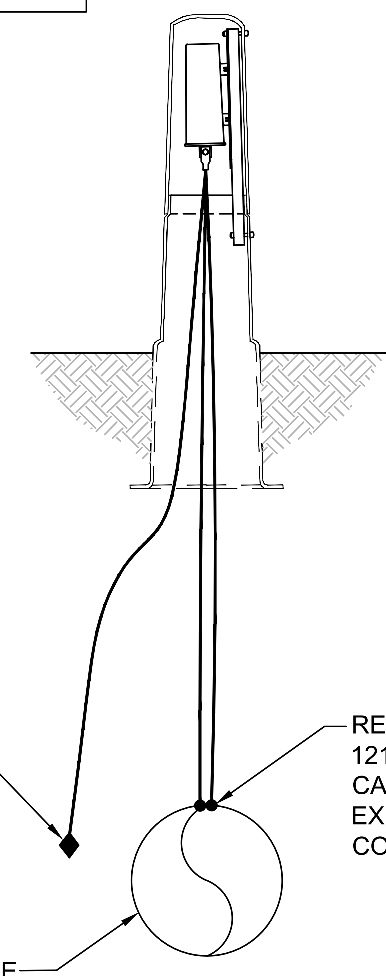
CAD FILE NAME 12144-301-1-RC | SHEET 1 OF 1

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

SSD POLARITY:
NEG: PIPELINE
POS: ZINC RIBBON

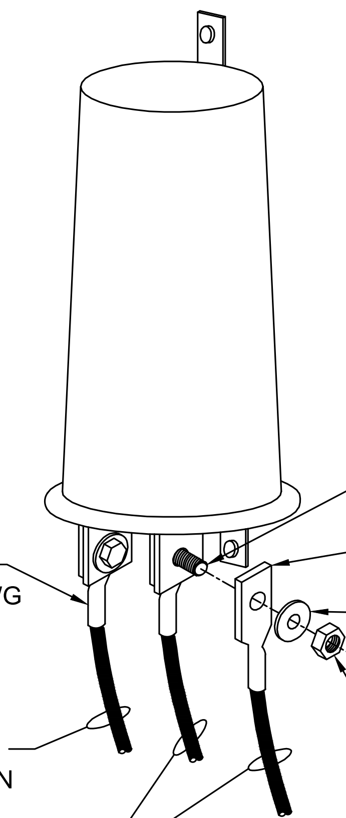


DETAIL A
FRONT VIEW



DETAIL B
SIDE VIEW

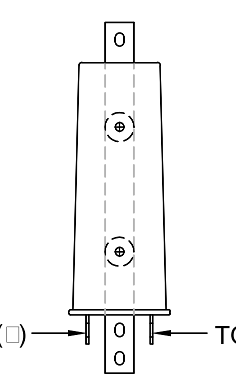
SSD INSTALLATION DETAILS



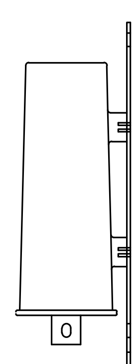
CABLE TO SSD TERMINAL CONNECTION DETAIL

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.



FRONT VIEW



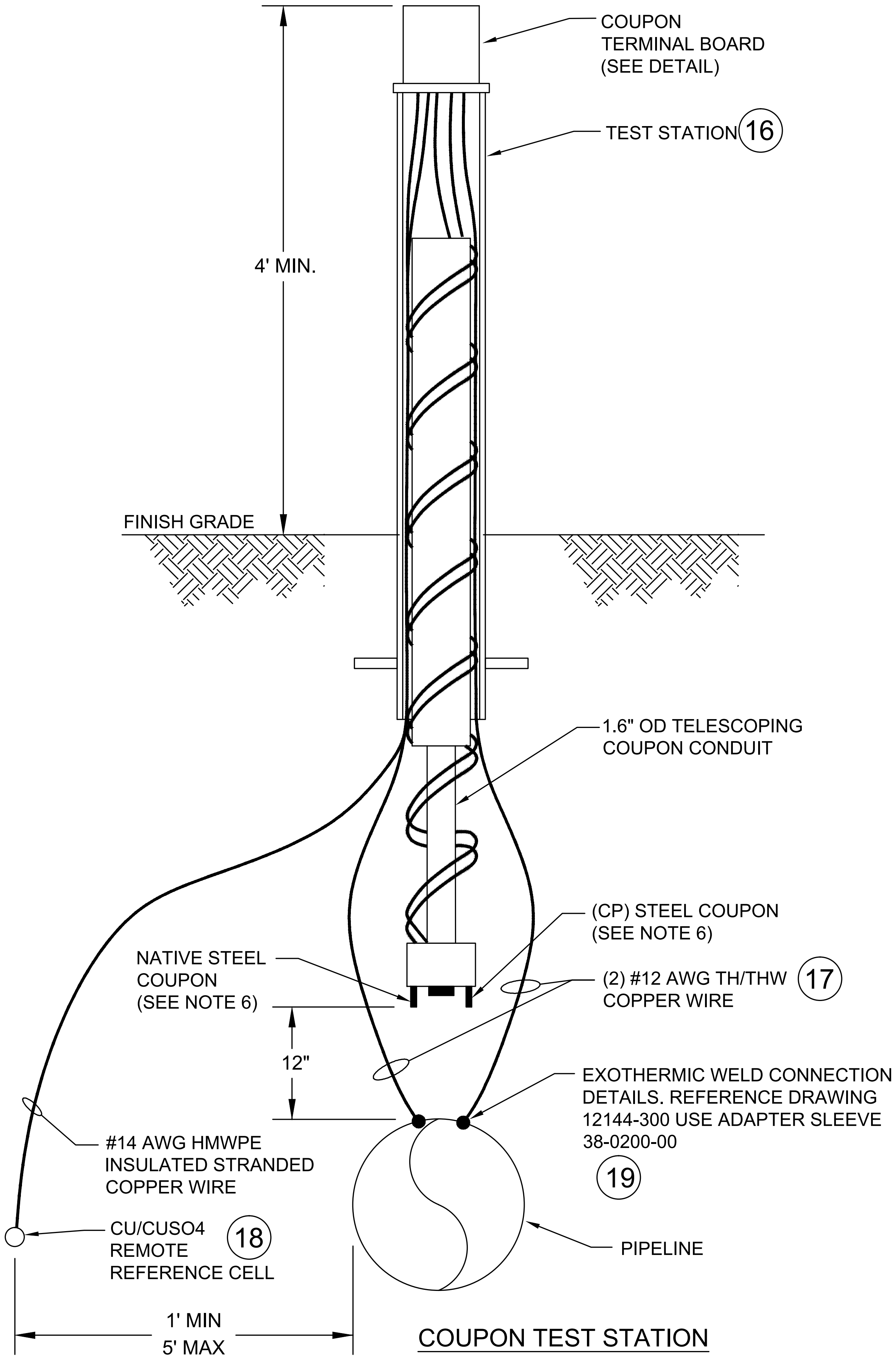
SIDE VIEW

SOLID STATE DECOUPLING DEVICE (SSD)

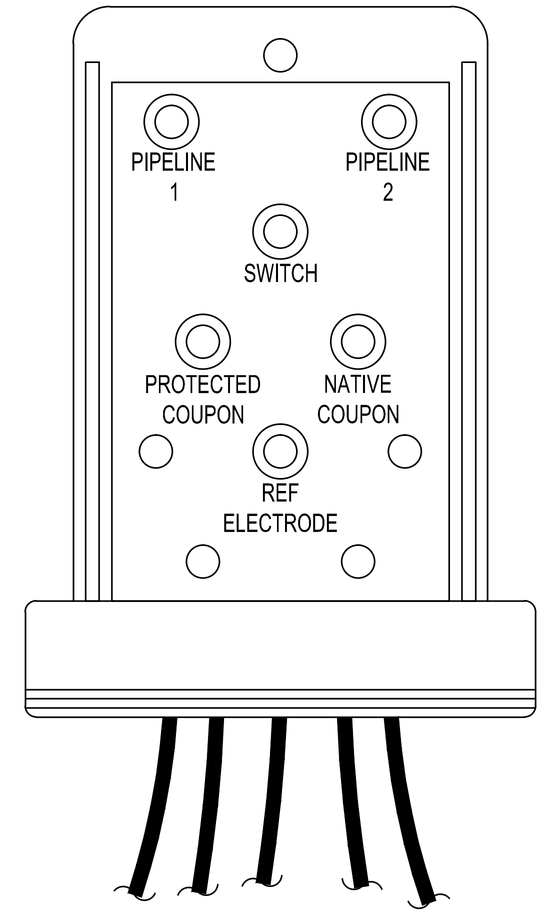
ISSUED FOR CONSTRUCTION

CLIENT: CHA	ARK ENGINEERING & TECH. SERVICES, INC. 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A. — ARK ENGINEERING & TECHNICAL SERVICES, INC.	TITLE: SOLID STATE DECOUPLER (SSD) INSTALLATION DETAILS			
SITE: VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT	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

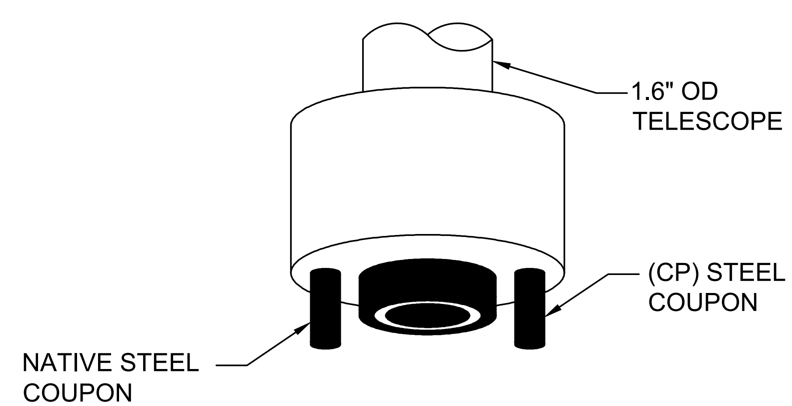
REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION - ECO 2014-025	6/27/14	JM
B	REVISED PER ECO 2015-017	4/1/15	RFA
C	CLIENT REVISIONS	5/16/16	RFA



COUPON TEST STATION INSTALLATION DETAIL



COUPON TEST STATION TERMINAL BOARD



AC COUPON DETAIL

NOTES:

1. TEST STATION TO BE INSTALLED DIRECTLY ABOVE BURIED PIPE. COUPON TO BE 12" FROM TOP OF PIPE.
2. COUPON TEST STATION INCLUDES TERMINAL BOARD, COVER, TELESCOPING BODY, TWO COUPONS AND INTERNAL WIRING. (ITEM 15)
3. 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.
4. COUPONS TO HAVE 1.44 SQUARE INCH SURFACE AREA.
5. REFERENCE DRAWING 12144-204 FOR TEST STATION LOCATIONS.
6. SOIL PLACED AROUND AND BENEATH COUPON SHOULD BE NATIVE AND FREE OF FOREIGN MATERIAL AND ROCKS.
7. 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

CLIENT: CHA

SITE: VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT

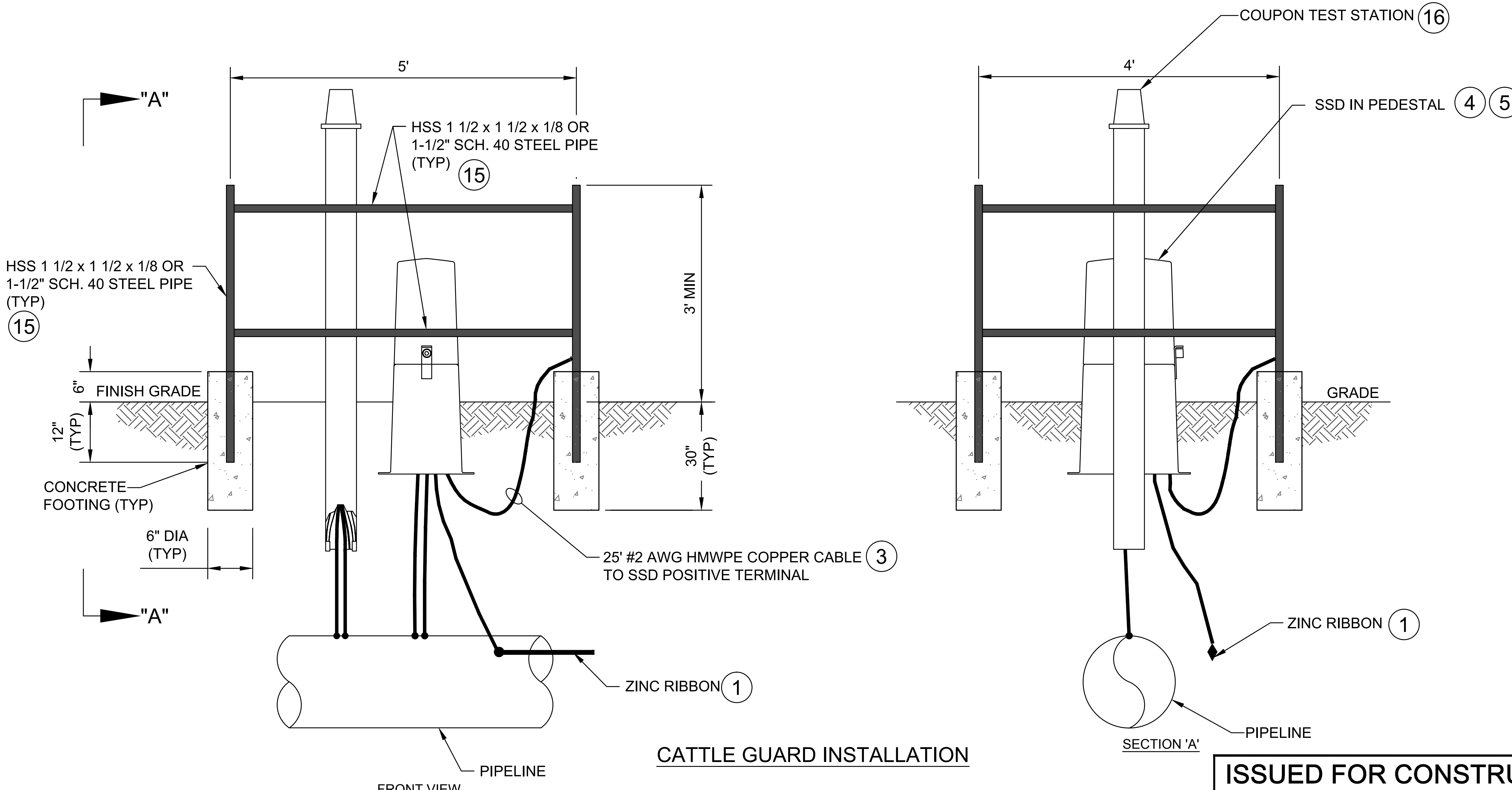
PROJECT NO. 12-E-144-AC

ARK ENGINEERING & TECHNICAL SERVICES, INC.
ARK ENGINEERING & TECH. SERVICES, INC.
639 GRANITE STREET
SUITE 200
BRAINTREE, MA
02184 U.S.A.

TITLE: COUPON TEST STATION WIRING DETAILS

DRAWN BY	DATE	SIZE		DWG. NO.	REV
JRW	6/18/13	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.	12144-303	C
APPROVED BY: RFA	DATE: 5/16/16	SCALE: NTS	CAD FILE NAME: 12144-303-1-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



CATTLE GUARD INSTALLATION

ISSUED FOR CONSTRUCTION

NOTES:

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

CLIENT: CHA

SITE: VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT

PROJECT NO. 12-E-144-AC

ARK ENGINEERING & TECHNICAL SERVICES, INC.
ARK ENGINEERING & TECH. SERVICES, INC.
639 GRANITE STREET
SUITE 200
BRAINTREE, MA
02184 U.S.A.

DRAWN BY: JRW — DATE: 6/18/13 — SIZE: B

APPROVED BY: RFA — DATE: 5/16/16 — SCALE: NTS

TITLE: CATTLE GUARD INSTALLATION DETAIL

DWG. NO. 12144-304 — REV C

CAD FILE NAME 12144-304-1-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

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 AWG HMWPE INSULATED STRANDED COPPER CABLE. SOFT-DRAWN, COMMERCIALLY PURE COPPER, ASTM B8, CLASS B STRANDING.
3	1,600'	#2 AWG HMWPE INSULATED STRANDED COPPER CABLE. SOFT-DRAWN, COMMERCIALLY 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 AWG STRANDED CABLE TO PIPE. USES 15CP WELD METAL.
8	7 BOXES	EXOTHERMIC WELD METAL, THERMOWELD P/N #15CP. BONDS #6 AND #12 AWG 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 AWG CABLE. USE #32CP WELD METAL.
10	7 BOXES	EXOTHERMIC WELD METAL, THERMOWELD P/N #32CP. USED FOR #2 AWG CABLE TO ZINC RIBBON CONNECTIONS. 10 SHOTS PER BOX.
11	116	BURNDY YAZ6C-TC38 COMPRESSION LUG. THESE LUGS WILL CONNECT THE #6 AWG COPPER CABLE TO THE SOLID STATE DECOUPLING DEVICES. TWO LUGS PER SSD.
12	64	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.
13	58 TUBES	TWO PART EPOXY: SPECIALTY POLYMER COATINGS, INC SP-2888 (OR APPROVED EQUAL). USED FOR REPAIRING PIPE COATING AT #6 AWG 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 MANUAFACTURER 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 AWG 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 AWG YELLOW HMWPE 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 AWG 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: CHA

SITE: VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT

ARK ENGINEERING & TECHNICAL SERVICES, INC.

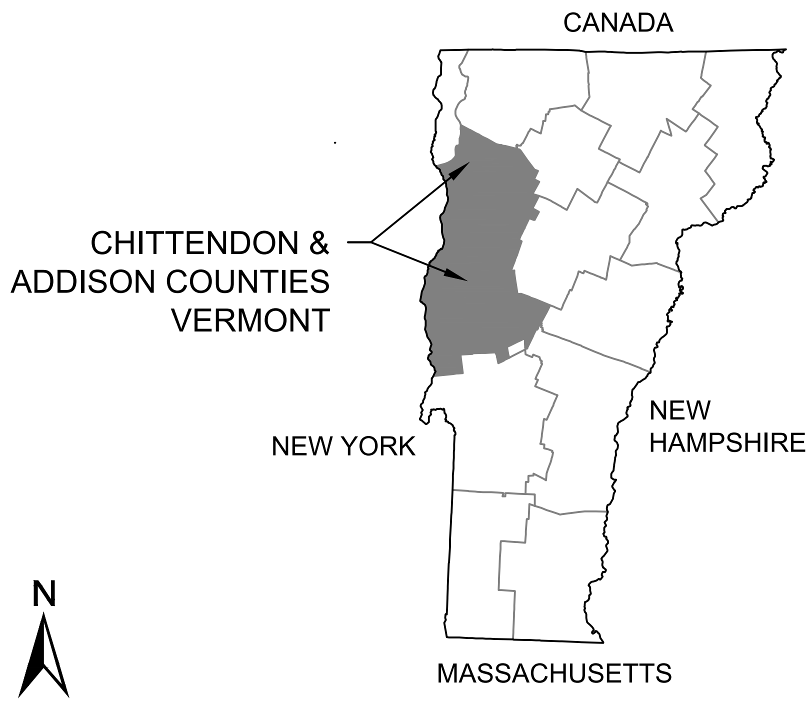
ARK ENGINEERING & TECH. SERVICES, INC.
639 GRANITE STREET
SUITE 200
BRAINTREE, MA
02184 U.S.A.

TITLE: MATERIALS LIST

DRAWN BY	DATE	SIZE		DWG. NO.	REV
JRW	6/18/13	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.	12144-400	C

PROJECT NO.	APPROVED BY	DATE	SCALE	CAD FILE NAME	SHEET
12-E-144-AC	RFA	5/16/16	NTS	12144-400-1-RC	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



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

CLIENT: CHA

SITE: VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT

PROJECT NO.: 12-E-144-AC

ARK ENGINEERING & TECHNICAL SERVICES, INC.

ARK ENGINEERING &
TECH. SERVICES, INC.
639 GRANITE STREET
SUITE 200
BRAINTREE, MA
02184 U.S.A.

DRAWN BY: JRW — DATE: 6/18/13

APPROVED BY: JM — DATE: 9/30/13

TITLE: COVER SHEET

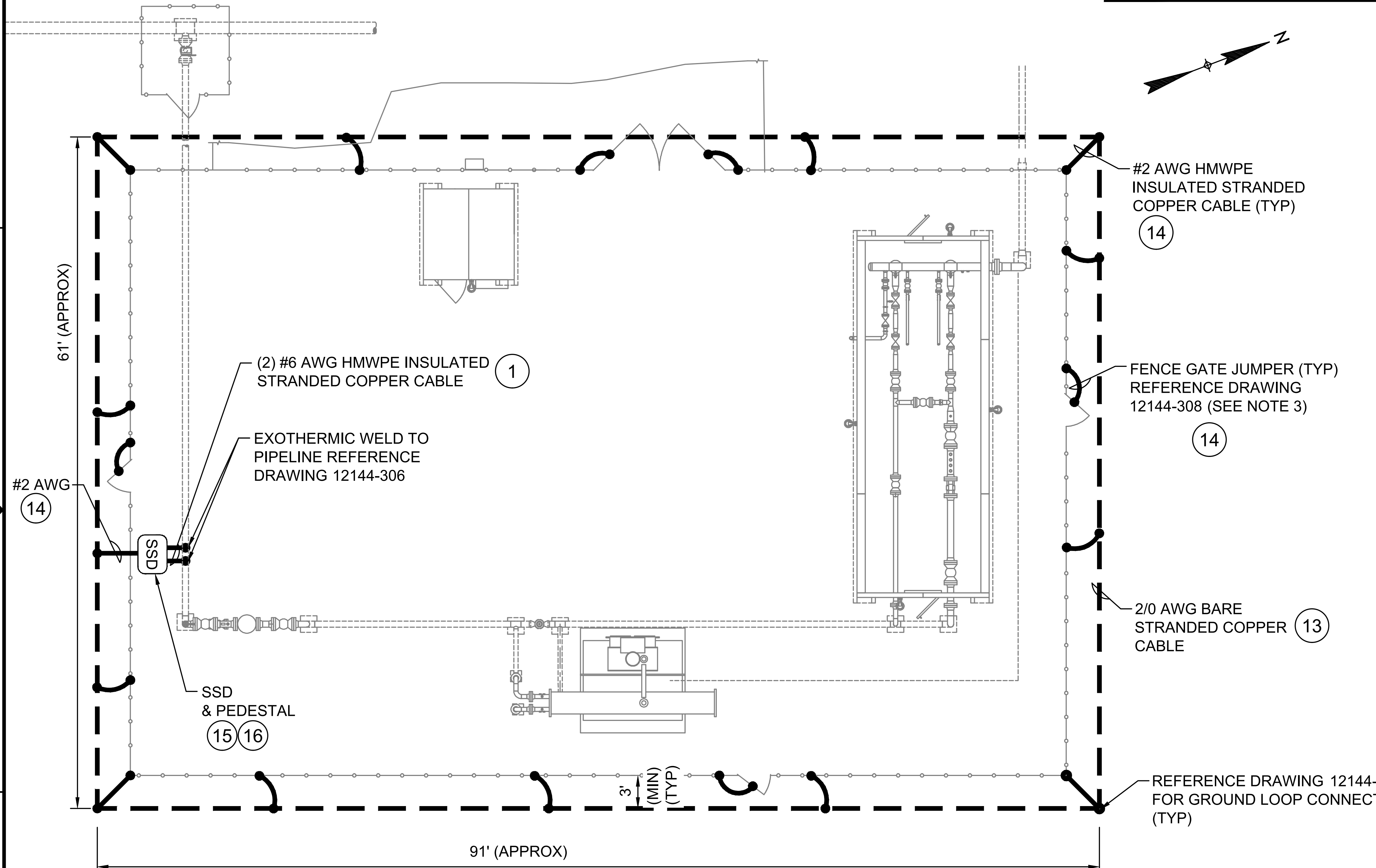
SIZE: B — SCALE: NTS

DWG. NO.: 12144-101 — REV: B

CAD FILE NAME: 12144-101-1-RB

SHEET 1 OF 1

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

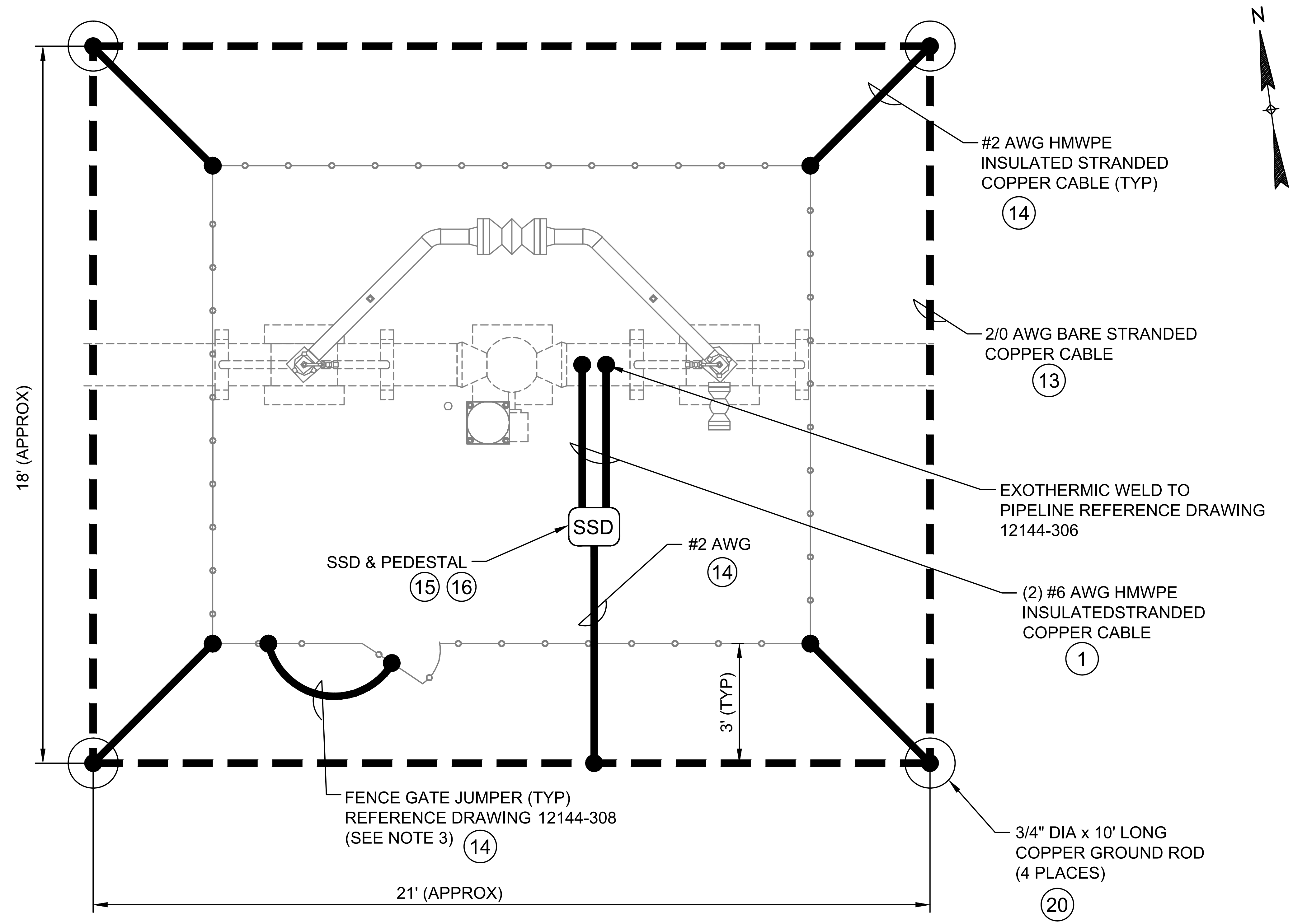


NOTES:

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" DEEP BELOW NATURAL GRADE.

CLIENT: CHA	ARK ENGINEERING & TECHNICAL SERVICES, INC.	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
PROJECT NO.: 12-E-144-AC	APPROVED BY: JM	DATE: 9/30/13	SCALE: NTS
DWG. NO.: 12144-205	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 MINUMUM 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.

LEGEND

⊙ GROUND ROD

CLIENT: CHA

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.

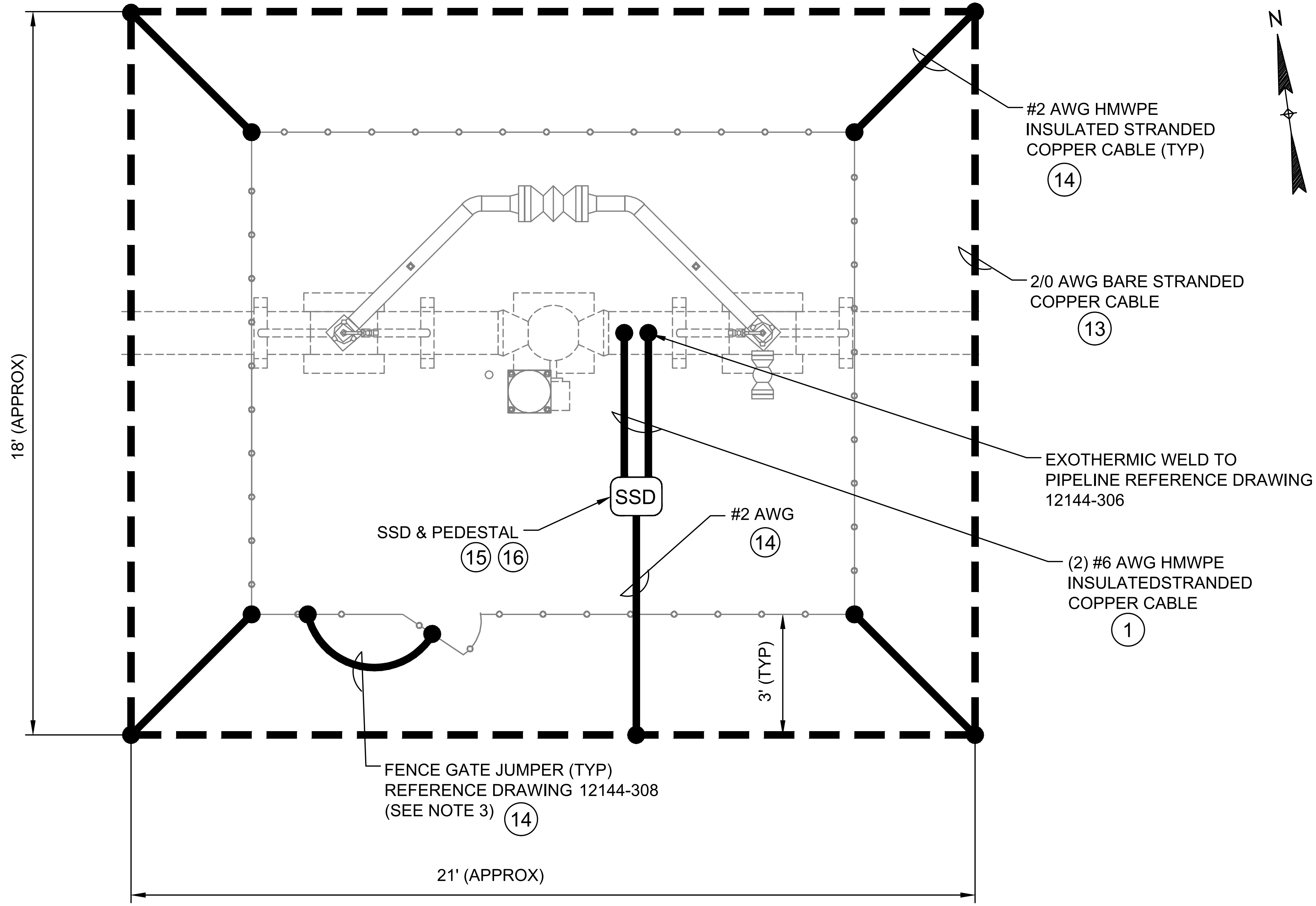
ENGINEERING & TECHNICAL SERVICES, INC.

TITLE: GROUNDING PLAN - MLV-2

DRAWN BY	DATE	SIZE		DWG. NO.	REV
JRW	6/18/13	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.	12144-206	A

PROJECT NO.	APPROVED BY	DATE	SCALE	CAD FILE NAME	SHEET
12-E-144-AC	JM	9/30/13	NTS	12144-206-1-RA	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 MINUMUM OF 18" BELOW NATURAL GRADE.

CLIENT: CHA

SITE: VERMONT GAS SYSTEMS, INC.
ADDISON NATURAL GAS PROJECT

PROJECT NO. 12-E-144-AC

ARK ENGINEERING & TECHNICAL SERVICES, INC.

ARK ENGINEERING & TECH. SERVICES, INC.
639 GRANITE STREET
SUITE 200
BRAINTREE, MA
02184 U.S.A.

DRAWN BY: JRW — DATE: 6/18/13

APPROVED BY: JM — DATE: 9/30/13

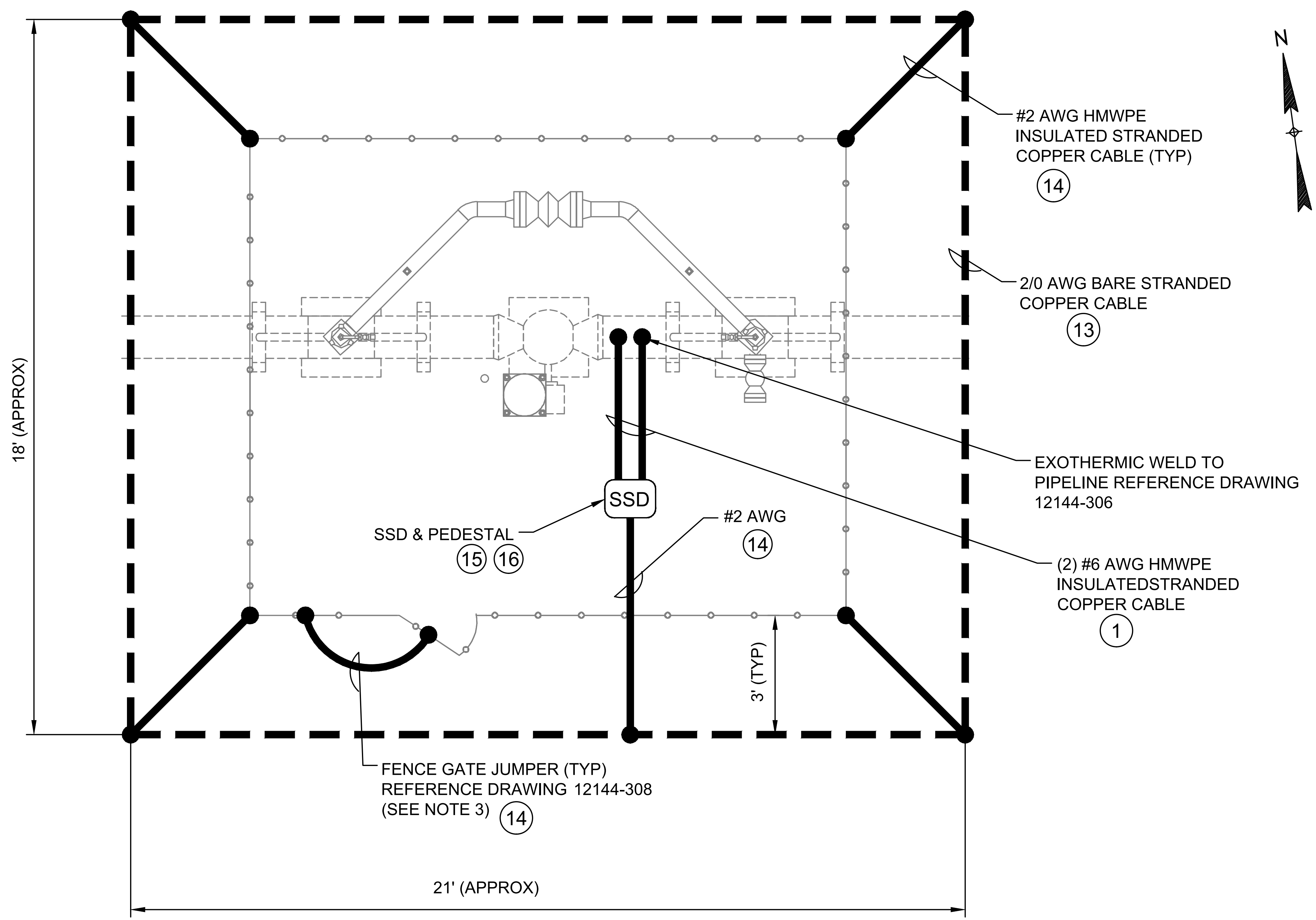
TITLE: GROUNDING PLAN - MLV-3

SIZE: B

DWG. NO. 12144-207 — REV B

SCALE: NTS — CAD FILE NAME: 12144-207-1-RB — 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 MINUMUM OF 18" BELOW NATURAL GRADE.

CLIENT: CHA

SITE: VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT

PROJECT NO. 12-E-144-AC

ARK Engineering & Technical Services, Inc.

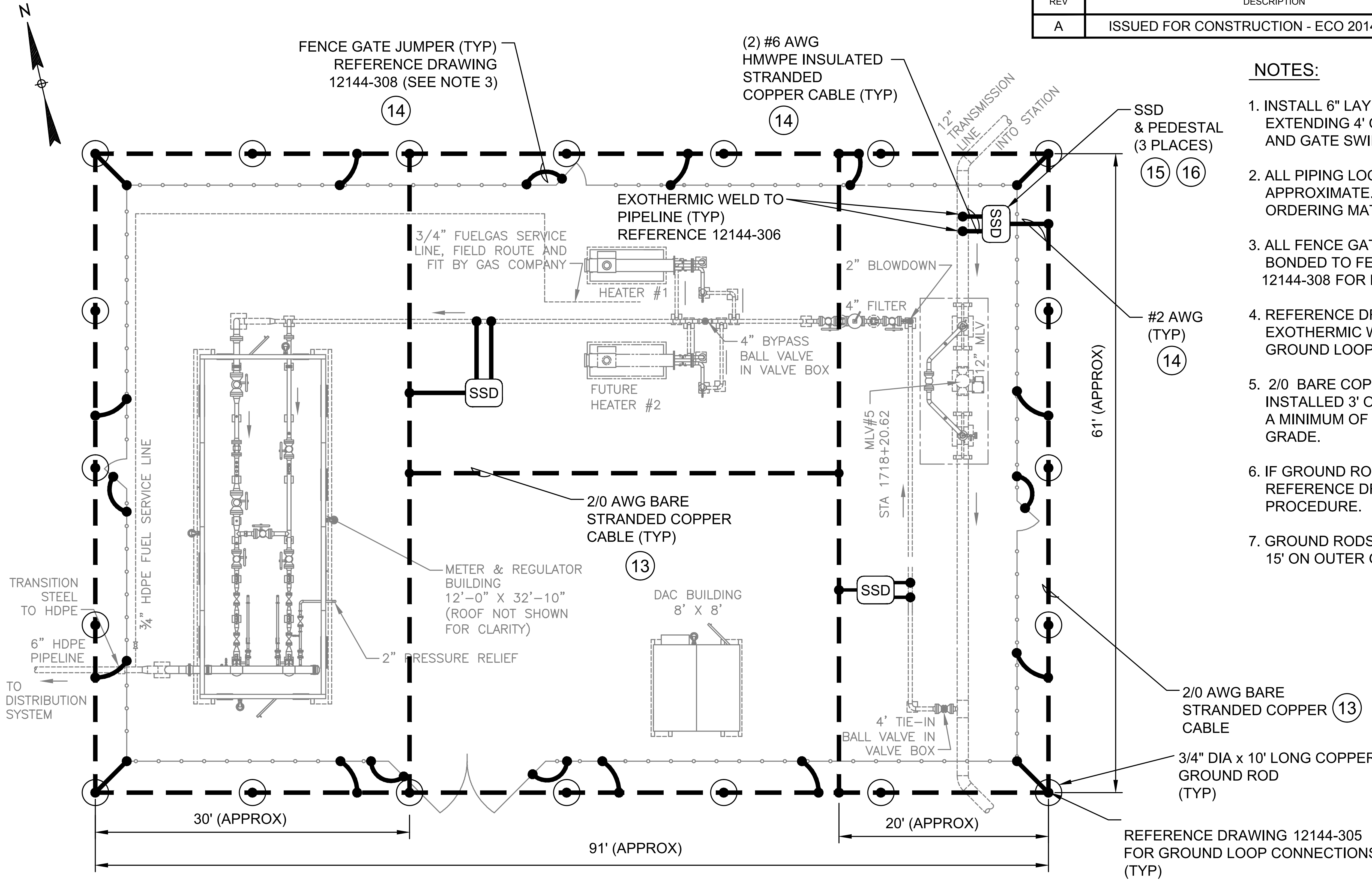
ARK ENGINEERING & TECH. SERVICES, INC.
639 GRANITE STREET
SUITE 200
BRAINTREE, MA
02184 U.S.A.

TITLE: GROUNDING PLAN - MLV-4

DRAWN BY	DATE	SIZE	DWG. NO.	REV
JRW	6/18/13	B	12144-208	A

APPROVED BY	DATE	SCALE	CAD FILE NAME	SHEET
JM	9/30/13	NTS	12144-208-1-RA	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" 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

CLIENT: CHA

SITE: VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT

ARK ENGINEERING & TECHNICAL SERVICES, INC.

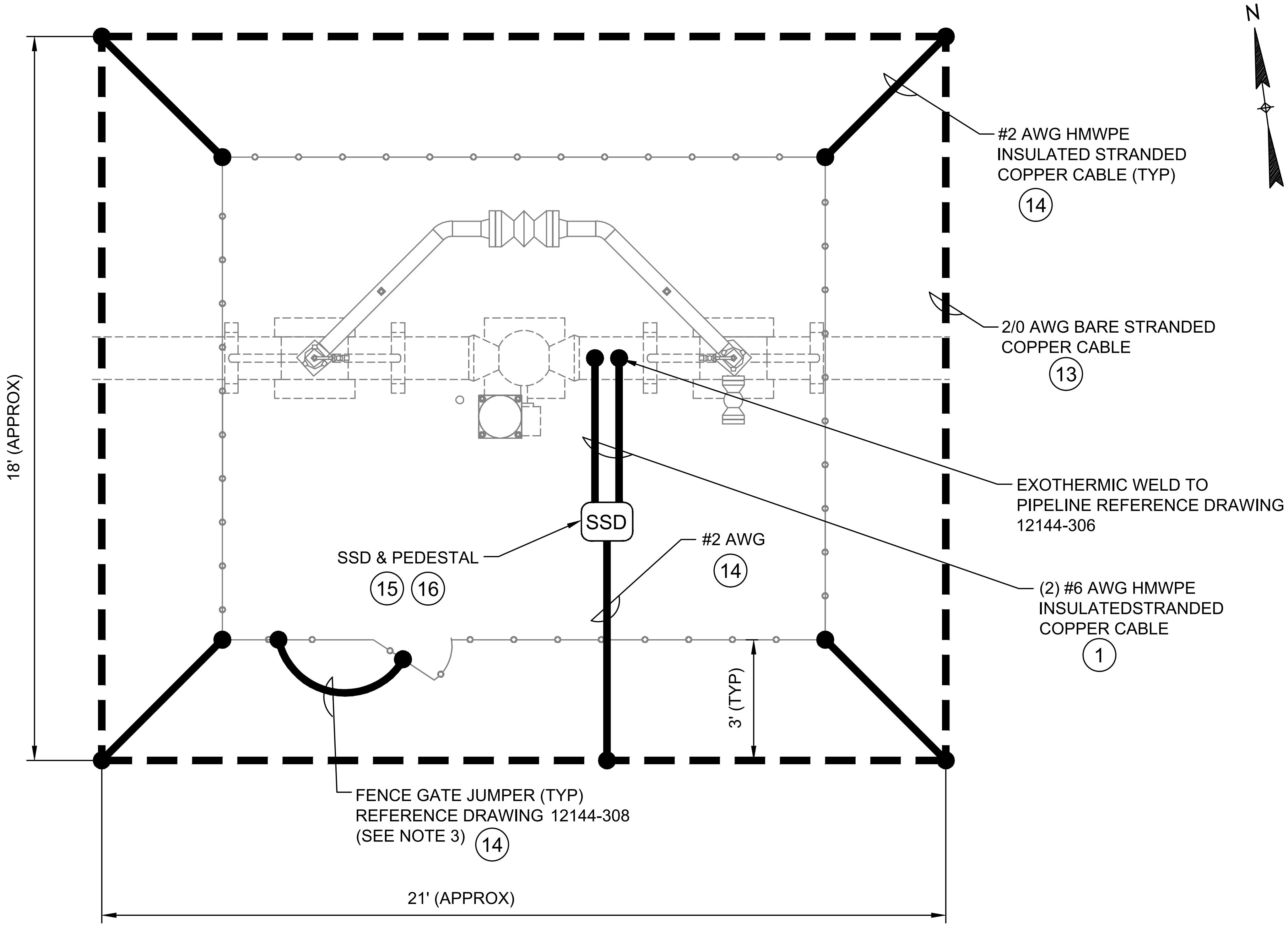
ARK ENGINEERING & TECH. SERVICES, INC.
639 GRANITE STREET
SUITE 200
BRAINTREE, MA
02184 U.S.A.

TITLE: GROUNDING PLAN - MLV-5/PLANK ROAD M & R

DRAWN BY	DATE	SIZE		DWG. NO.	REV
JRW	6/18/13	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.	12144-209	A

PROJECT NO.	APPROVED BY	DATE	SCALE	CAD FILE NAME	SHEET
12-E-144-AC	JM	9/30/13	NTS	12144-209-1-RA	1 OF 1

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

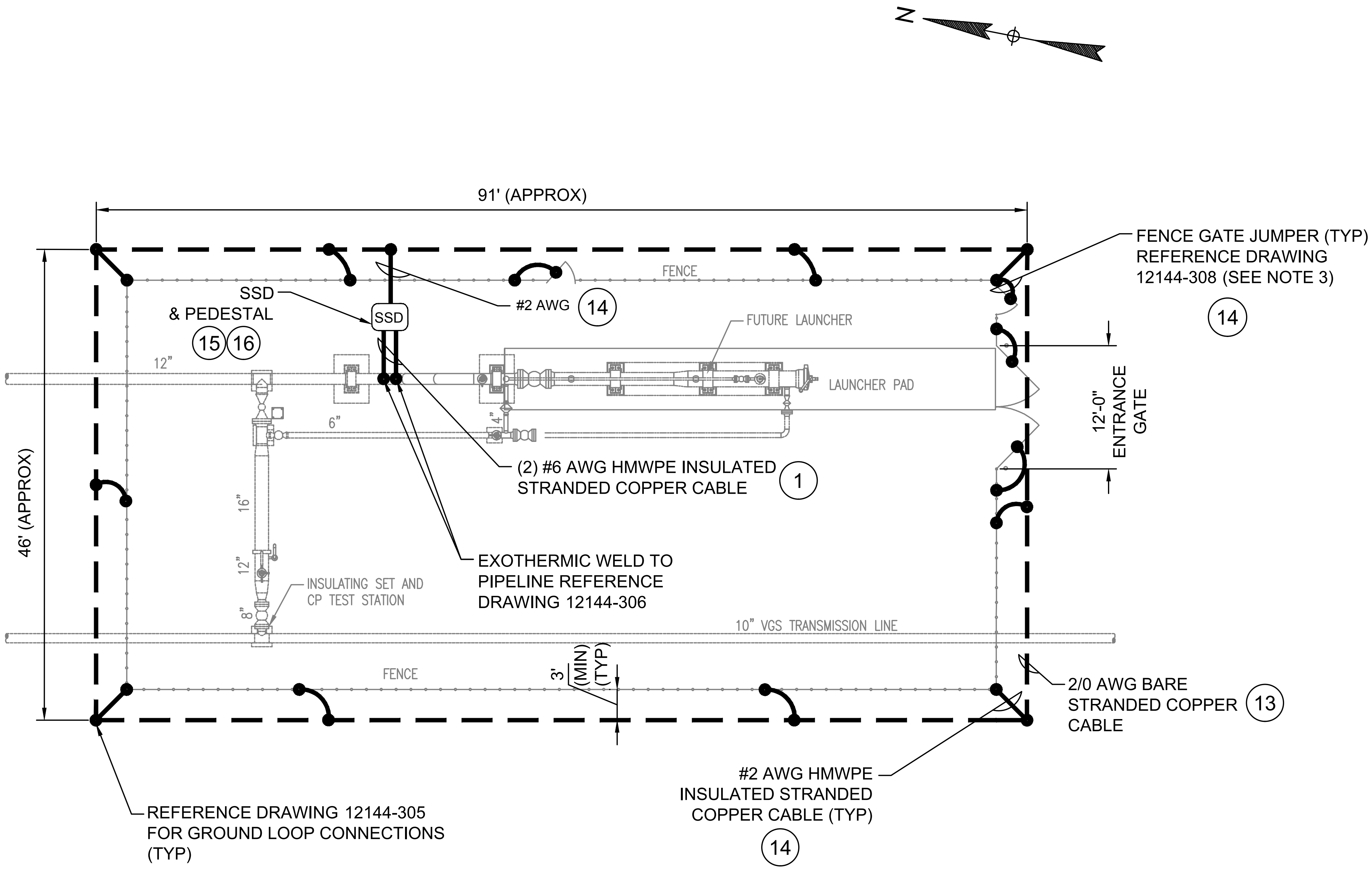


NOTES:

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 MINUMUM OF 18" BELOW NATURAL GRADE.

CLIENT: CHA	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	ARK ENGINEERING & TECHNICAL SERVICES, INC.			
	DRAWN BY: JRW	DATE: 6/18/13	SIZE: B	DWG. NO.: 12144-210 REV: A
PROJECT NO.: 12-E-144-AC	APPROVED BY: JM	DATE: 9/30/13	SCALE: NTS	CAD FILE NAME: 12144-210-1-RA SHEET: 1 OF 1

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

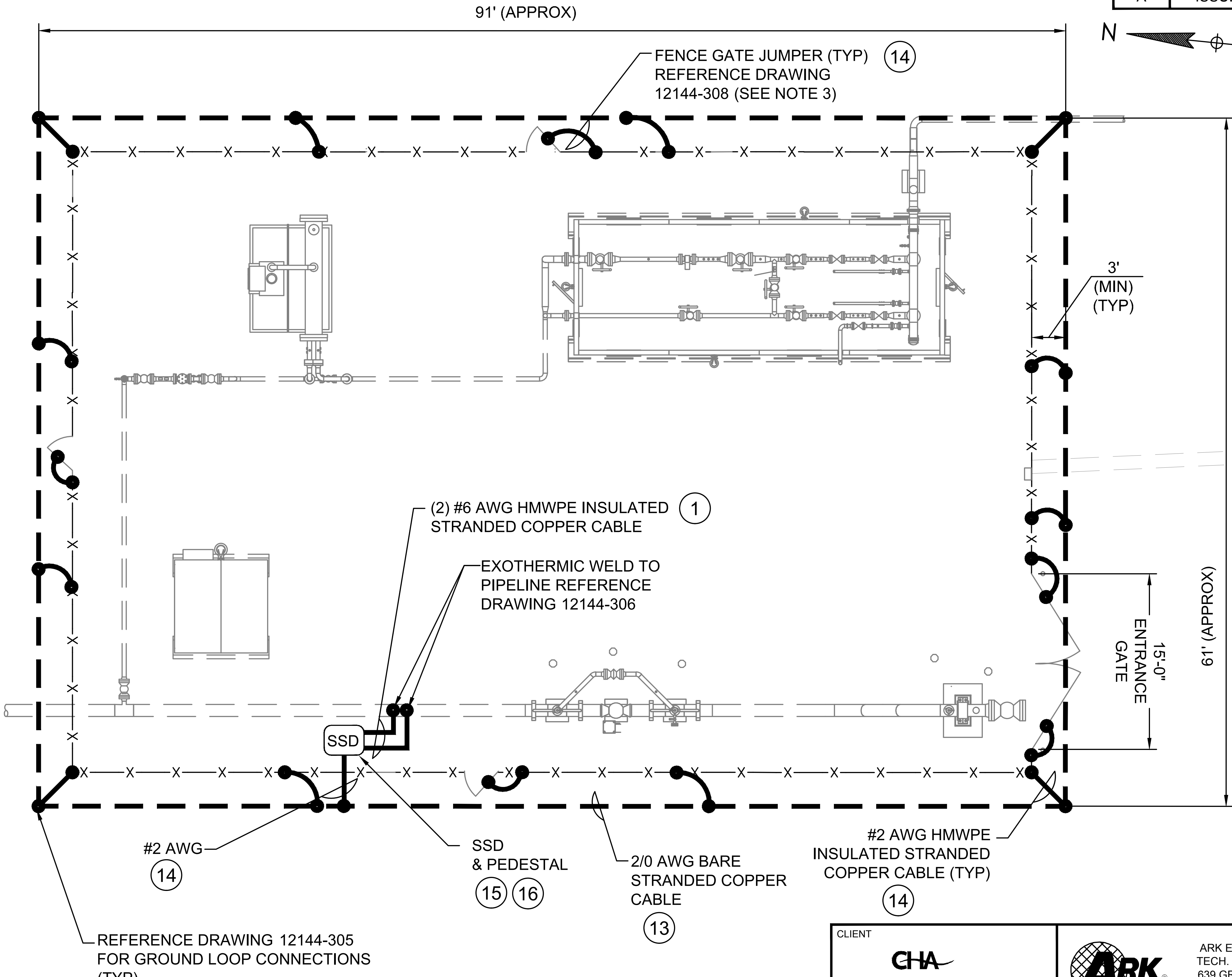


NOTES:

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" DEEP BELOW NATURAL GRADE.

CLIENT: CHA	ARK ENGINEERING & TECH. SERVICES, INC. 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.	TITLE: GROUNDING PLAN - COLCHESTER LAUNCHER
SITE: VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT	DRAWN BY: JRW; DATE: 6/18/13; SIZE: B	DWG. NO.: 12144-211; REV: A
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	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: CHA

SITE: VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT

PROJECT NO. 12-E-144-AC

ARK ENGINEERING & TECHNICAL SERVICES, INC.

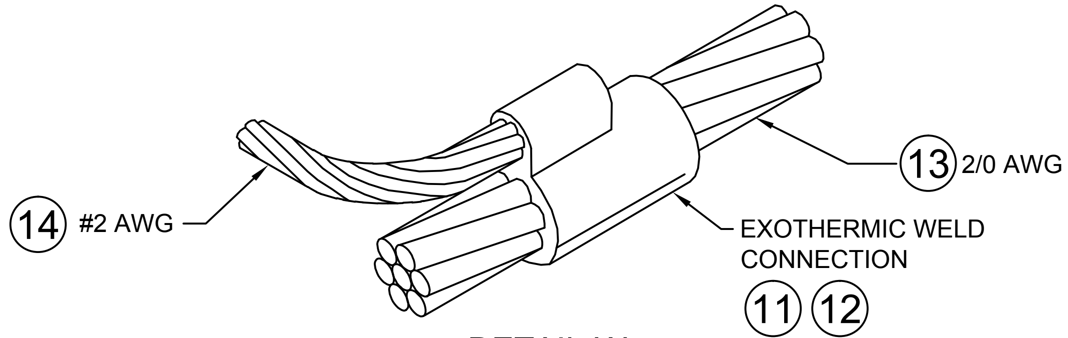
ARK ENGINEERING & TECH. SERVICES, INC.
639 GRANITE STREET
SUITE 200
BRAINTREE, MA
02184 U.S.A.

TITLE: GROUNDING PLAN - MIDDLEBURY M & R

DRAWN BY	DATE	SIZE		DWG. NO.	REV
JRW	6/18/13	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.	12144-212	A

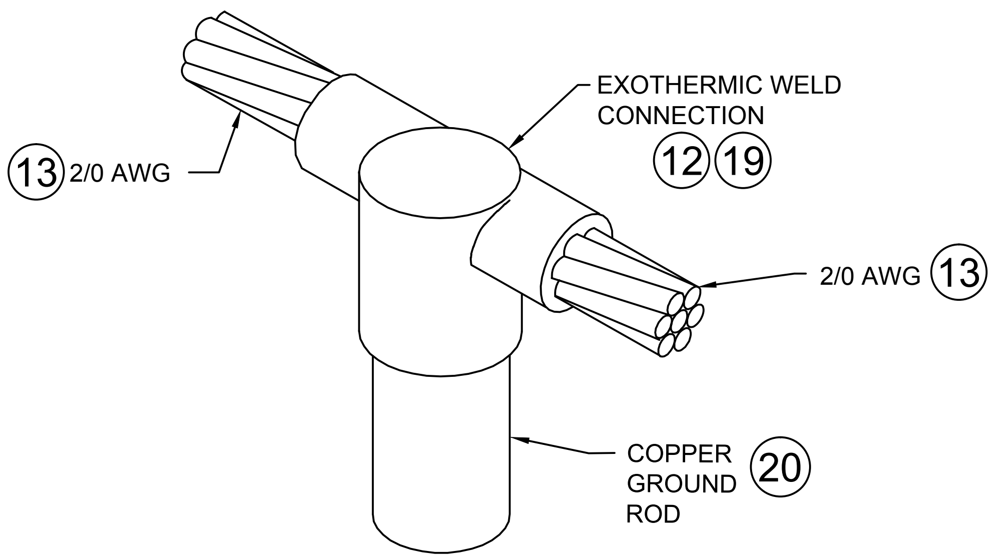
APPROVED BY	DATE	SCALE	CAD FILE NAME	SHEET
JM	9/30/13	NTS	12144-212-1-RA	1 OF 1

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



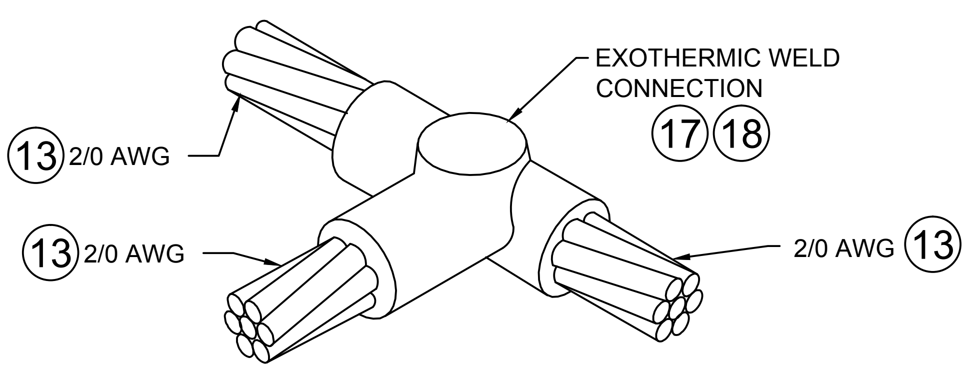
DETAIL 'A'

BARE 2/0 AWG STRANDED COPPER CABLE TO
#2 AWG STRANDED COPPER CABLE
EXOTHERMIC WELD INSTALLATION



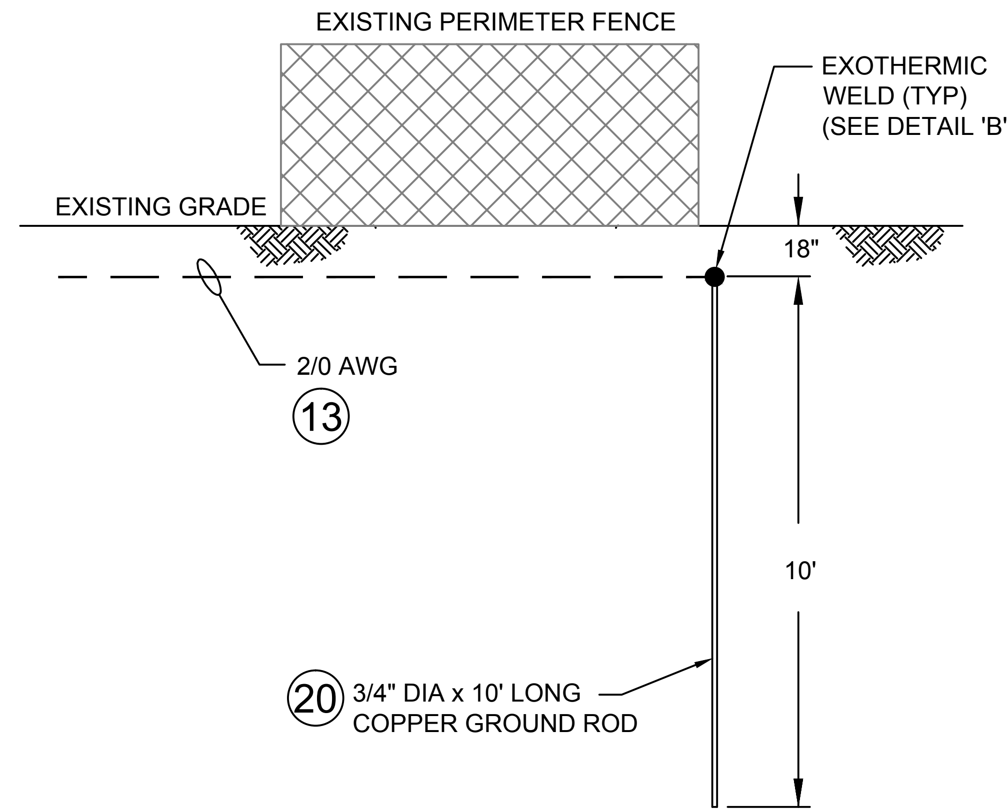
DETAIL 'B'

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

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

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.

CLIENT: CHA

SITE: VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT

PROJECT NO. 12-E-144-AC

ARK ENGINEERING & TECHNICAL SERVICES, INC.

ARK ENGINEERING & TECH. SERVICES, INC.
639 GRANITE STREET
SUITE 200
BRAINTREE, MA
02184 U.S.A.

TITLE: GROUND LOOP SPLICE CONNECTION DETAILS

DRAWN BY	DATE	SIZE		DWG. NO.	REV
JRW	6/18/13	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.	12144-305	A
APPROVED BY: JM	DATE: 9/30/13	SCALE: NTS	CAD FILE NAME: 12144-305-1-RA	SHEET: 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 □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.

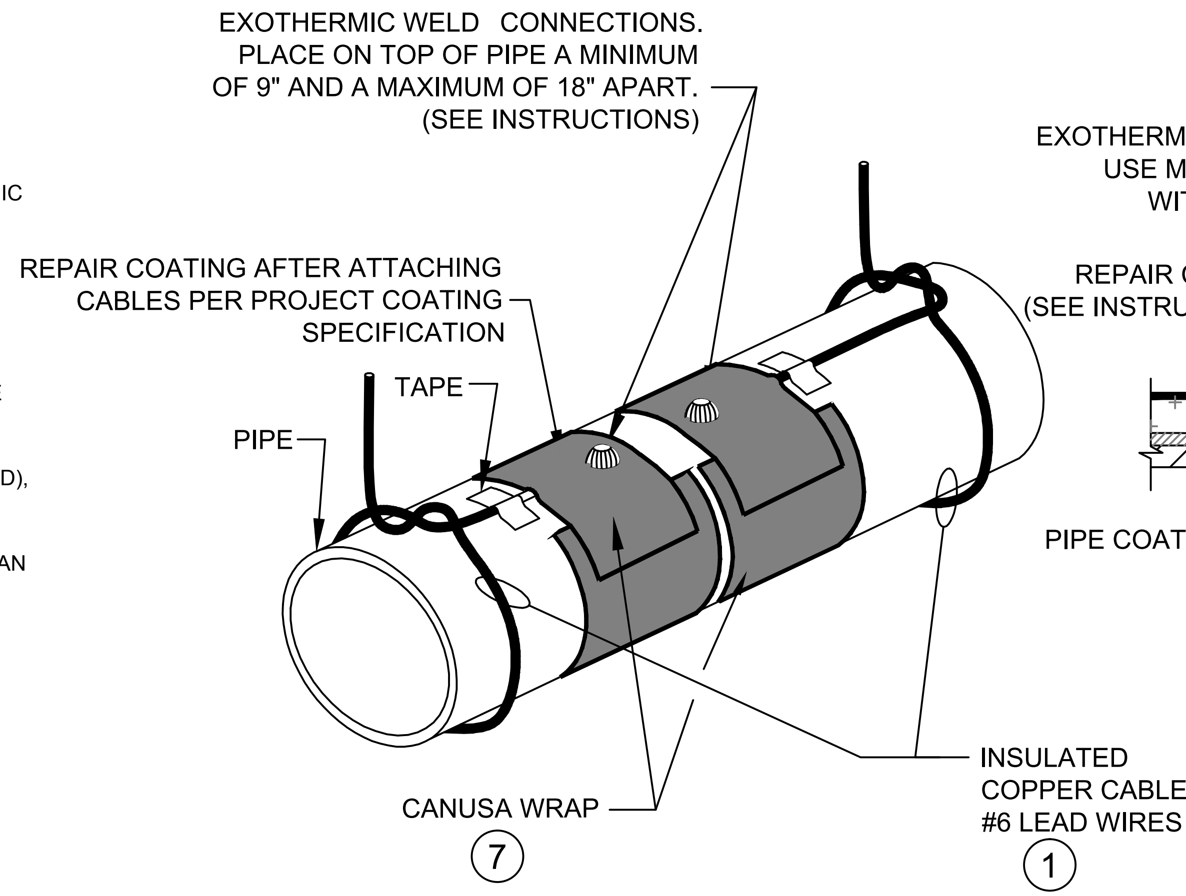
13. LAY THE CABLE END ON THE CROSSHATCHED PIPE SURFACE USING A SPRING LOADED CHAIN CLAMP TO HOLD CRUCIBLE TIGHT TO PIPELINE.

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□

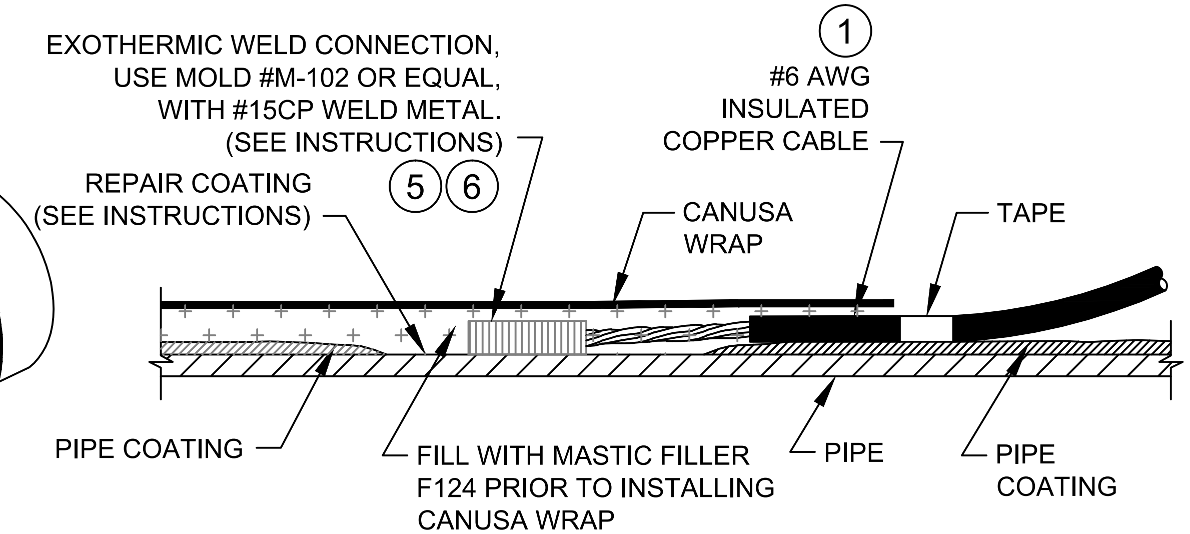
15. WHEN WELD HAS SET, REMOVE WELD MOLD AND TEST CONNECTION BY RAPPING SHARPLY WITH A SLAG HAMMER. IF THERE IS ANY INDICATION THAT A COMPLETE WELD HAS NOT BEEN ACHIEVED, REMOVE THE WELD AND RE-APPLY.

16. IF WELD IS GOOD, REMOVE ANY SLAG WITH HAMMER AND CLEAN USING A WIRE BRUSH.

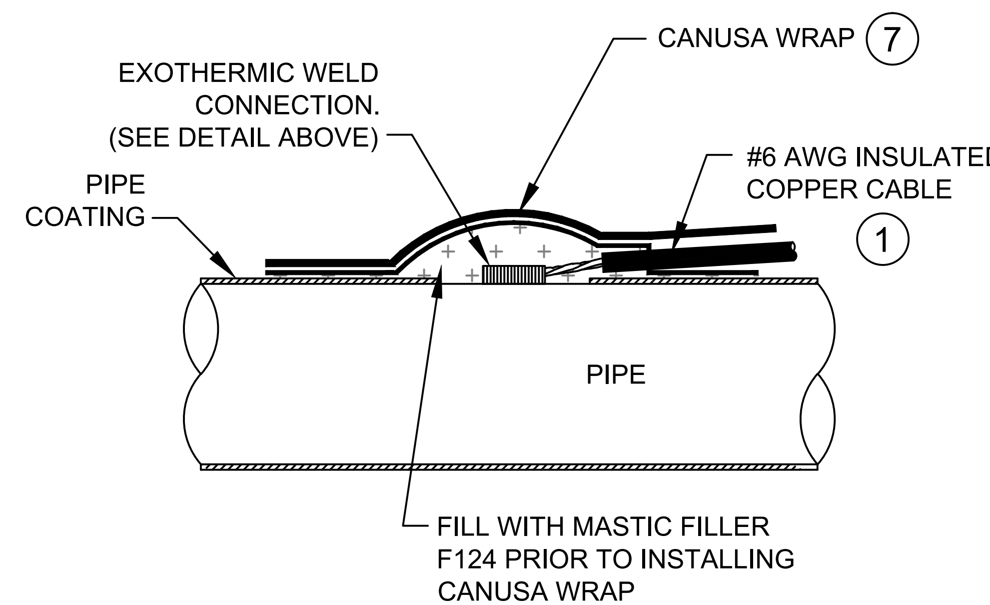
17. ONCE THE WELD CONNECTION AND AREA HAVE BEEN CLEANED, REPAIR WITH FULL CIRCUMFERENCE CUNUSA WRAP REFER TO VERMONT GAS SPECIFICATIONS TO DETERMINE IF REPAIR IS ACCEPTABLE.



CABLE TO PIPELINE ATTACHMENT DETAIL



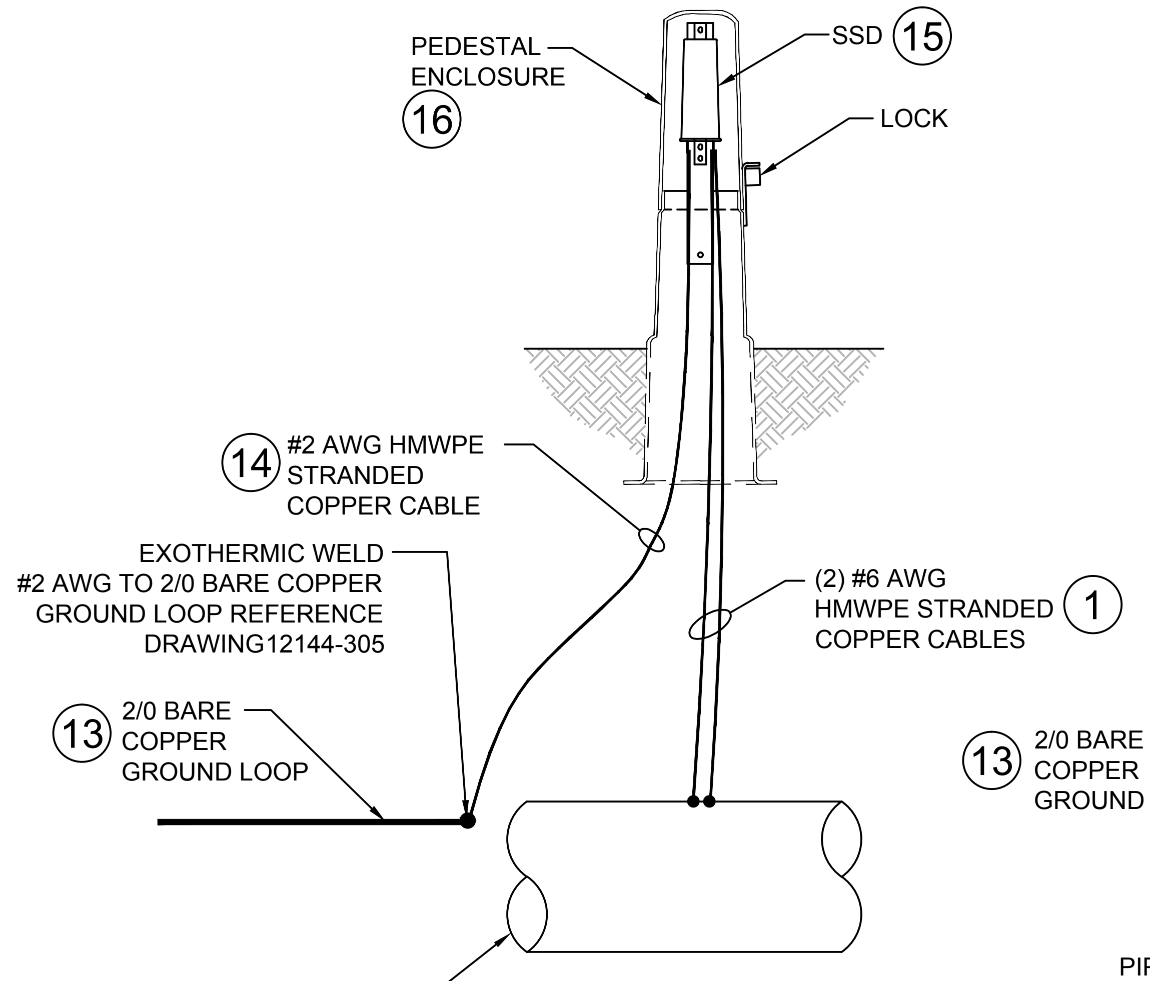
EXOTHERMIC WELD CONNECTION



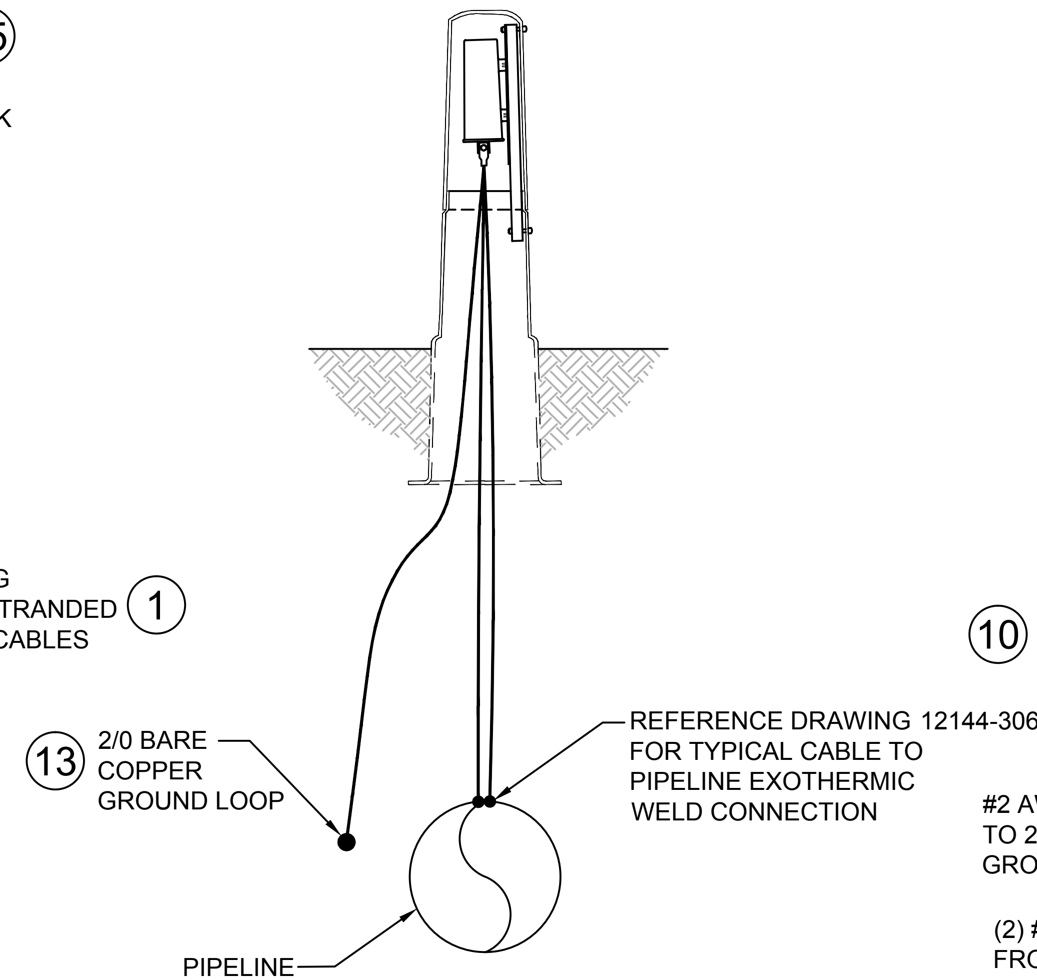
CORROSION PROTECTION SEAL

CLIENT CHA SITE VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT	ARK Engineering & Technical Services, Inc. ARK ENGINEERING & TECH. SERVICES, INC. 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.		TITLE CABLE TO PIPELINE CONNECTION DETAILS		
	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. 12144-306 — REV A
PROJECT NO. 12-E-144-AC	APPROVED BY JM	DATE 9/30/13	SCALE NTS	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

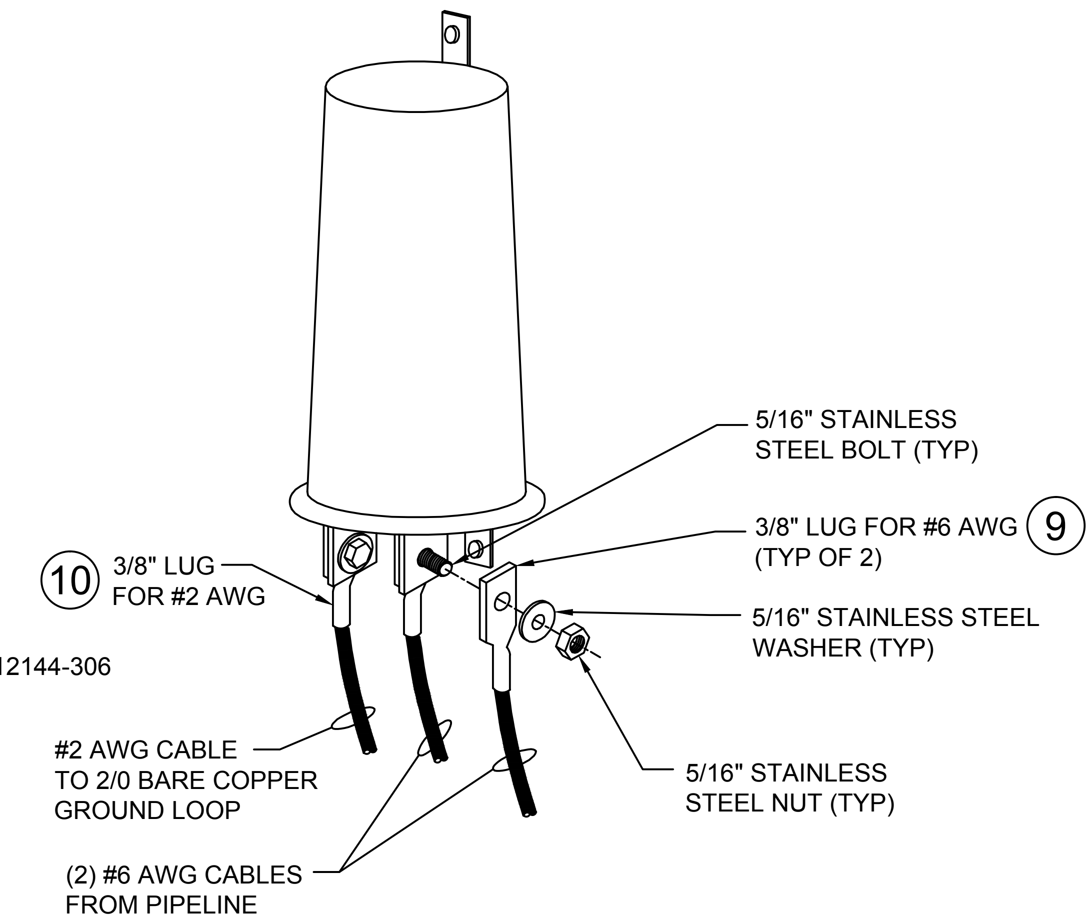


DETAIL A
FRONT VIEW



DETAIL B
SIDE VIEW

SSD INSTALLATION DETAILS



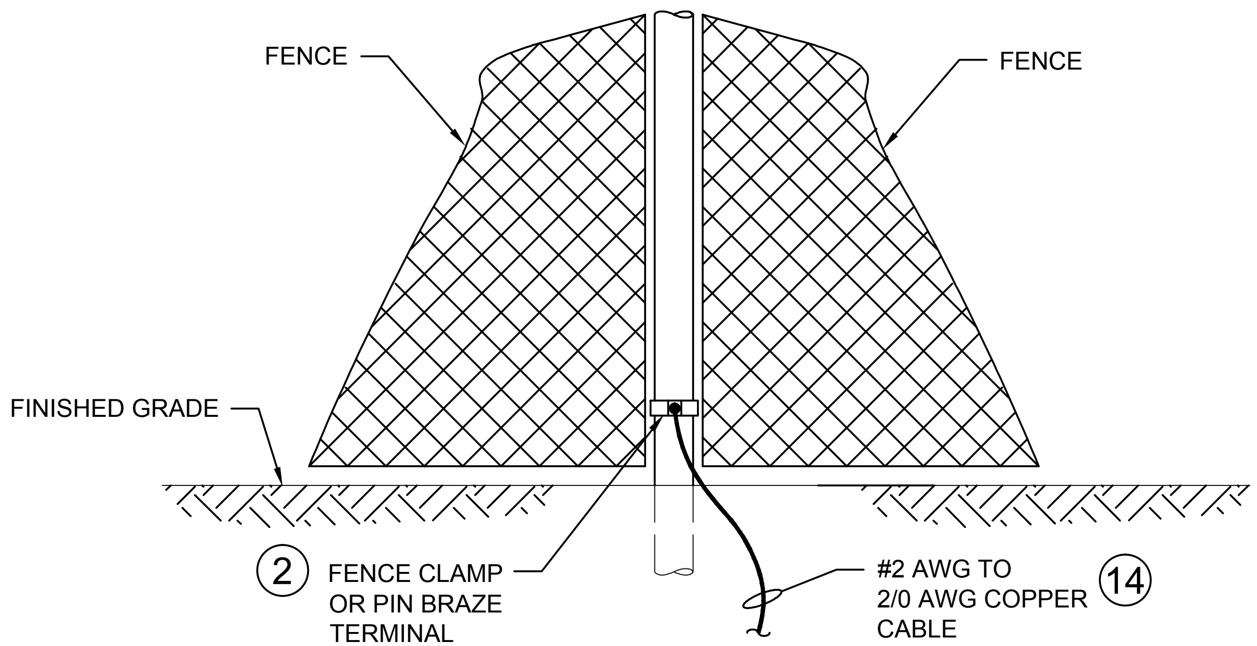
CABLE TO SSD TERMINAL CONNECTION DETAIL

NOTES:

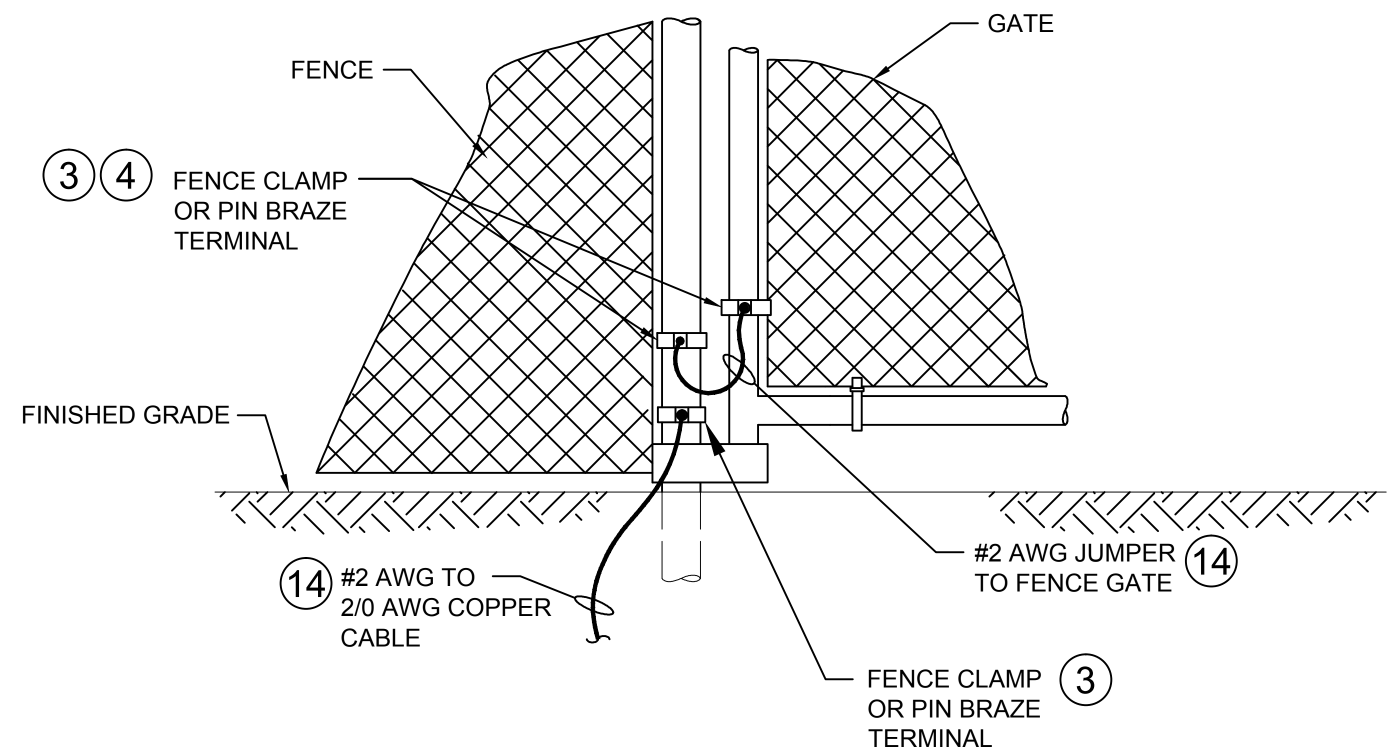
1. SSD IS TO BE MOUNTED INSIDE THE FIBERGLASS PEDESTAL. ALL COPPER CABLES ARE TO PASS THROUGH BOTTOM OF PEDESTAL.
2. INSTALL PEDESTAL AS CLOSE AS POSSIBLE TO PIPING CONNECTIONS TO REDUCE LEAD LENGTHS.
3. LOCATE SSD & PEDESTAL IN A SERVICEABLE LOCATION. COORDINATE WITH VERMONT GAS PERSONNEL.

CLIENT: CHA SITE: VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT	ARK ENGINEERING & TECHNICAL SERVICES, INC. ARK ENGINEERING & TECH. SERVICES, INC. 639 GRANITE STREET SUITE 200 BRAINTREE, MA 02184 U.S.A.			TITLE: SOLID STATE DECOUPLER (SSD) INSTALLATION DETAILS
	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.: 12144-307 / REV: A
PROJECT NO.: 12-E-144-AC	APPROVED BY: JM	DATE: 9/30/13	SCALE: NTS	CAD FILE NAME: 12144-307-1-RA / SHEET: 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

CLIENT: CHA

SITE: VERMONT GAS SYSTEMS, INC.
ADDISON NATURAL GAS PROJECT

ARK ENGINEERING & TECHNICAL SERVICES, INC.

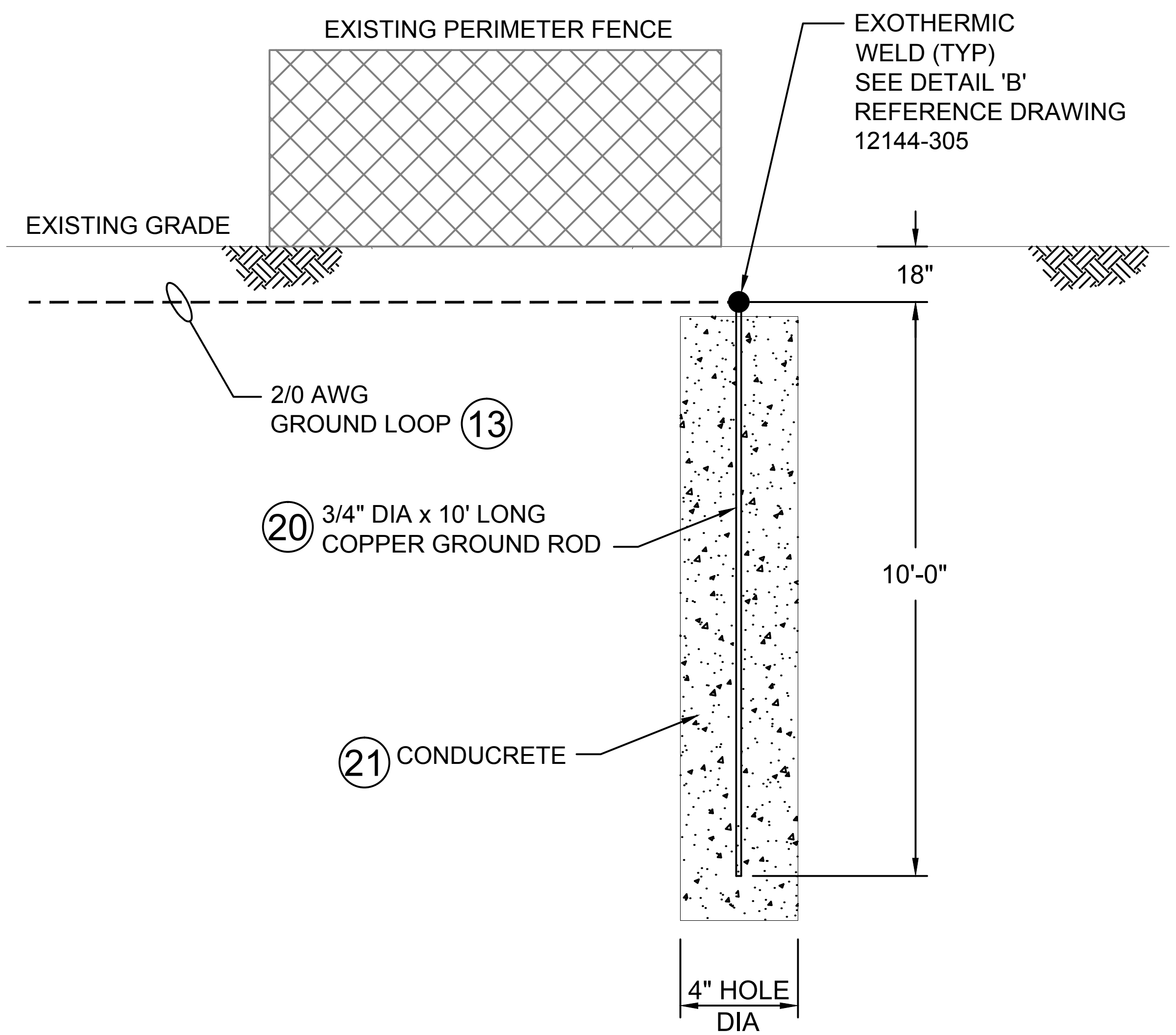
ARK ENGINEERING &
TECH. SERVICES, INC.
639 GRANITE STREET
SUITE 200
BRAINTREE, MA
02184 U.S.A.

TITLE: FENCE AND GATE CLAMP
CONNECTION DETAILS

DRAWN BY	DATE	SIZE		DWG. NO.	REV
JRW	6/18/13	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.	12144-308	A

PROJECT NO.	APPROVED BY	DATE	SCALE	CAD FILE NAME	SHEET
12-E-144-AC	JM	9/30/13	NTS	12144-308-1-RA	1 OF 1

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



ALTERNATE GROUND ROD INSTALLATION - DRILL PROCEDURE SIDE VIEW

BARE 2/0 AWG STRANDED COPPER GROUND LOOP &
10' COPPER GROUND ROD CONNECTIONS

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.

CLIENT: CHA

SITE: VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT

ARK ENGINEERING & TECHNICAL SERVICES, INC.

ARK ENGINEERING & TECH. SERVICES, INC.
639 GRANITE STREET
SUITE 200
BRAINTREE, MA
02184 U.S.A.

TITLE: GROUND ROD INSTALLATION DETAILS DRILL PROCEDURE

DRAWN BY: JRW	DATE: 6/18/13	SIZE: B		DWG. NO.: 12144-309		REV: A
PROJECT NO.: 12-E-144-AC	APPROVED BY: JM	DATE: 9/30/13	SCALE: NTS	CAD FILE NAME: 12144-309-1-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

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, COMMERCIALLY 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: CHA

SITE: VERMONT GAS SYSTEMS, INC. ADDISON NATURAL GAS PROJECT

ARK ENGINEERING & TECHNICAL SERVICES, INC.
ARK ENGINEERING & TECH. SERVICES, INC.
639 GRANITE STREET
SUITE 200
BRAINTREE, MA
02184 U.S.A.

TITLE: MATERIALS LIST

DRAWN BY	DATE	SIZE	DWG. NO.	REV
JRW	6/18/13	B	12144-401	B

PROJECT NO.	APPROVED BY	DATE	SCALE	CAD FILE NAME	SHEET
12-E-144-AC	JM	9/30/13	NTS	12144-401-1-RB	1 OF 2

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

ARK ENGINEERING & TECHNICAL SERVICES, INC.

SIZE		DWG. NO.	REV
B		12144-401	B
SCALE NTS	CAD FILE NAME 12144-401-2-RB		SHEET 2 OF 2