

INDUCED AC INTERFERENCE STUDY

Prepared for:

NV5 on behalf of
San Diego Gas & Electric Company
Sycamore-Peñasquitos 230 Kilovolt
Transmission Line Project

Prepared By:



Report Issued: July 13, 2018

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EXECUTIVE SUMMARY

ARK Engineering & Technical Services, Inc. was contracted by NV5 on behalf of San Diego Gas and Electric Company (SDG&E) to investigate AC touch voltage potential due to alternating current (AC) electrical interference effects on nearby metallic AT&T communication conductors resulting from the operation of SDG&E's Sycamore to Peñasquitos 230 kilovolt (kV) Transmission Line Project (Project) located in San Diego, California. This Induced AC Interference Study was prepared in accordance with Mitigation Measure (MM) Hazards-7 of the Project's Final Environmental Impact Report (FEIR) and pertains specifically to the potential AC electrical interference effects on the AT&T communication conductors from the underground portion of the 230-kV transmission line (230-kV circuit) installed as part of the Project. This Study presents the predicted AC induction potentials during projected steady state load conditions of the 230-kV circuit based on information provided by NV5, AT&T and SDG&E.

ARK Engineering, AT&T and NV5 reviewed alignment sheets, google earth files and AT&T facility maps to identify the sections where AT&T conductors and the proposed 230-kV circuit were in proximity to each other and where there was continuous parallelism for a significant distance. As a result, three (3) sections of concern were identified where continuous AT&T communication pairs are parallel and proximate to the 230-kV circuit.

Installation details, including conductor arrangement, as well as data concerning AT&T's shield grounding and system were considered as part of the modeling effort. The communication cable pairs have a metallic shield conductor that is grounded at many AT&T manholes, the specific manholes are those drawn with splice connections by AT&T within the rough hand drawn drafts found in Appendix C. As discussed with AT&T, all of the manholes within the Stonebridge Parkway area of study have splice connections.

The ATT specifications document "ATT-TP-76416-001 Grounding and Bonding for Network Facilities – Design Fundamentals", has been reviewed to verify the expected grounding along the shields. In the additional sections studied, the ATT shielding is grounded at each manhole which shows a disconnect between the hand-drawn lines. This is based on information provided by AT&T in their June 7, 2018 letter to the California Public Utilities Commission, which states, "only those with splice locations, as shown in the drawings provided by AT&T" have grounds. A break between the lines in the drawings is assumed to represent a splice location.

AT&T has provided their shield grounding resistance, to remote ground. The resistance is expected to be between 15-30 ohms. A 30-ohm resistance has been utilized, for the shield grounding, to ensure a conservative result.

The 230-kV circuit model includes installation details, per SDG&E provided information. At each vault location along the 230-kV circuit, the shield wires are directly connected to the "MCM Copper Bare Strand". This connection reduces the AC Interference effects of the 230-kV circuit.

To represent the induction potential observed along the AT&T communication conductors, the computations were completed by grounding one end of the AT&T conductor pair and utilizing the measurement on the opposite end. This is normal AT&T practice when working on the conductor and measuring the voltage on the line. During AT&T normal operation, neither end of the communication cable is grounded, which causes an AC induction phase shift along the AT&T conductor pairs. The end of the AT&T communication pairs will observe the highest AC interference potential.

For the AT&T conductors under study with one side grounded, under the steady state load conditions, a maximum induced AC conductor potential of approximately fifteen (15) Volts, with respect to remote earth, was computed on the AT&T conductor pairs at, GPS location 32.88988°N, 117.20112°W, alongside Carroll Rd. At this location, the buried conductor will be in proximity and will parallel the 230-kV transmission circuit for approximately 7,400 feet. This meets the maximum acceptable touch voltage under steady state conditions identified in MM Hazards-7.

Recommendations

Based on the study results, the modeled induced touch voltage on the AT&T communication pairs would not exceed the maximum touch voltage of 15-volts while the SDG&E 230 kilovolt (kV) Transmission Line operates at steady state conditions. Accordingly, in compliance with MM Hazards-7, no further mitigation is required.

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1. INTRODUCTION

1.1 Introduction

ARK Engineering & Technical Services, Inc. was contracted by NV5 on behalf of San Diego Gas and Electric Company (SDG&E) to investigate AC touch voltage potential due to alternating current (AC) electrical interference effects on nearby metallic AT&T communication conductors resulting from the operation of SDG&E's Sycamore to Peñasquitos 230 kilovolt (kV) Transmission Line Project (Project) located in San Diego, California. This Induced Current Touch Study (Study) was prepared in accordance with Mitigation Measure (MM) Hazards-7 of the Project's Final Environmental Impact Report (FEIR) and pertains specifically to the potential AC electrical interference effects on the AT&T communication conductors from the underground portion of the 230-kV transmission line (230-kV circuit) installed as part of the Project. The full text of MM Hazards-7 is provided below:

Mitigation Measure Hazards-7. Induced Current Touch Study. SDG&E shall identify both aboveground and underground objects (e.g., metal fences or buried metal utility lines) in the vicinity of the proposed 230-kV transmission line that may potentially present a shock hazard to the public, due to induced currents or voltages. SDG&E shall prepare an Induced Current Touch study that evaluates the conductive and inductive interference effects of the proposed 230-kV transmission line on the identified objects. The Induced Current Touch study shall model the conductive objects using the maximum anticipated voltage for the proposed 230-kV line and shall consider the construction details for the transmission line. The study shall also construct a model using fault conditions. The maximum acceptable touch voltage under steady-state conditions is 15 volts and the threshold for fault conditions is specified in ANSI/IEEE Standard 80. In the event that the modeled induced current voltage of a conductive objective exceeds maximum touch voltage thresholds, SDG&E shall install grounding or other appropriate measures to protect the public from hazardous shocks. The Induced Current Touch study shall include the model voltage results of conductive objects prior to implementation of grounding measures and after implementation of grounding measures.

Sixty days prior to commencing construction, SDG&E shall provide the Induced Current Touch study to the CPUC, for review. The Induced Current Touch study shall include the criteria and approach that was used to determine what facilities could present a shock, the results of the model prior to implementation of grounding measures, details of the grounding or other measures to be installed, and the results of the model after implementation of the grounding

When communication conductors are located in proximity to high voltage electric transmission circuits, the conductors can incur induced voltages and currents due to AC interference effects. AC interference effects decrease with increased distance between the conductor and the electric transmission circuits.

ARK Engineering, AT&T, and NV5 identified three (3) sections of AT&T conductors within the roadway that will parallel the 230-kV circuit for significant lengths. This study pertains specifically to those three (3) separate sections of the AT&T communication cables located in proximity to and in parallel with the 230-kV circuit.

Conductors incurring high induced AC voltages and currents can cause safety and communication issues

if not mitigated effectively.

This study presents the computed steady state induced AC potentials for the identified AT&T communication conductors within proximity of the 230-kV circuit. Projected load conditions, outlined in Table 3-1, were used to predict the inductive AC electrical interference effects.

AC interference simulation programs within the Current Distribution, Electromagnetic Fields, Ground and Soil Structure Analysis (CDEGS) software package were used to model the electric transmission circuit route and estimate the levels of induced AC voltage on the AT&T conductor bundles.

The conclusions in this study are based upon conductor information provided by AT&T and electric transmission circuit data provided by NV5 and SDG&E.

1.2 Joint Facility Corridor Overview

The 230-kV circuit under study is approximately eleven (11) miles long and located in San Diego, California. Three (3) primary regions of study have been determined, as outlined in Table 1-1.

Table 1-1: Regions of Influence Caused by the 230-kV Circuit

Section	Conductor GPS Range	Length (ft)
1	Parallelism from Scranton Road to Brown Deer Rd.	7,400
2	Parallelism from the intersection of Dunbrook Rd. and Trade Pl. to the middle of Miralani Drive	4,300
3	Parallelism from Pomerado Rd. on Stonebridge Parkway to Stonecroft Terrace	6,500

Appendix B includes maps for each area of concern.

ARK Engineering and NV5 identified regions of proximity between the AT&T conductors and the 230-kV circuit. AT&T identified their sections of continuous conductors along these regions. Worst-case AC interference effects can occur on metallic conductors which parallel high voltage electric transmission circuits for extended distances. Metallic conductors, such as the communication cables, which closely parallel the 230-kV circuit for extended distances, were included in the completed analysis. The results presented in this study represent the potential AC interference effects to the AT&T communication cables during steady-state and simulated fault conditions on the 230-kV circuit.

1.3 Objectives & Project Tasks

The primary objectives of this study were as follows:

- Inductive Interference Analysis - Circuit models for the existing AT&T communications conductors and the 230-kV circuit were developed and used to determine induced conductor potentials during steady state conditions on the 230-kV circuit.
- Recommendations If AC voltage levels are computed to exceed MM Hazards-7 maximum acceptable touch voltage of fifteen (15) Volts, provide mitigation options to reduce the induced AC voltage to 15 volts.

This task is described in Section 3, and detailed results are presented in Appendix A.

1.4 A Brief Perspective on Electromagnetic Interference Mechanisms

The flow of energy transmitted by electric power is not totally confined within the power conductors. A variety of factors influence the spatial density of energy in the environment surrounding underground circuits, including the distance between the phase and shield conductors, the arrangement of the phase conductors, and the method of grounding the phase conductor metallic sheaths. Additionally, this spatial density decreases sharply with an increase in distance from the conductors. Metallic conductors such as conductors 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, currents and voltages may develop along the conductors' lengths.

The AT&T communication cable sections chosen are the longest continuous sections which will parallel the 230-kV circuit.

1.5 Definitions

AC Electrical Interference (Electromagnetic Interference): A coupling of energy from an electrical source (such as an electrical power line) to a metallic conductor 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.

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 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.

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 Conductor Potential: The potential induced onto a conductor during steady state or fault

conditions that results from the mutual coupling between the energized conductor (power line) and the conductor.

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.

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 the normal operating condition where there is negligible change in the electrical power transmitted in a circuit over a long period of time.

2. FIELD DATA

2.1 AT&T Conductor Data

This model incorporates details provided by AT&T hand drawn manhole locations, wiring details, and information obtained via verbal communication.

The characteristics used for the communication conductors, provided by AT&T, are identified below.

- Filled ASP: Direct burial wire.
- Bonded STALPETH: Congested underground duct system.
- The communication cable pairs have a metallic shield conductor that is grounded at many AT&T manholes, the specific manholes are those drawn with splice connections by AT&T in the documents found in Appendix C.
- Each section modeled is electrically insulated at the on end while grounded on the other to simulate the effects noticed in the field during AC readings.
- Insulation of the wire is set to the minimum of $1G\Omega$ mile resistance described within the STALPETH specification sheet.
- A 30-ohm resistance has been utilized for the shield grounding.

Assumptions used to complete the analysis, are as follows.

- 22 AWG wire; for both ASP and STALPETH
- Depth of AT&T conductor; minimum of two (2) feet deep.
- The quality of this ground has been modeled based on AT&T's grounding standards.

2.2 SDG&E 230-kV Circuit Design Data

The characteristics used for the 230-kV circuit, provided by SDG&E, are identified below.

- Vaults are placed along the route approximately every 1,800 feet. Actual locations were used for section 1, as alignment sheets have been provided.
- At each vault location, the shield wires, of each phase, are directly connected to the "350 MCM Copper Bare Strand". The "350 MCM Copper Bare Strand" is grounded.

Assumptions used to complete the analysis, are as follows.

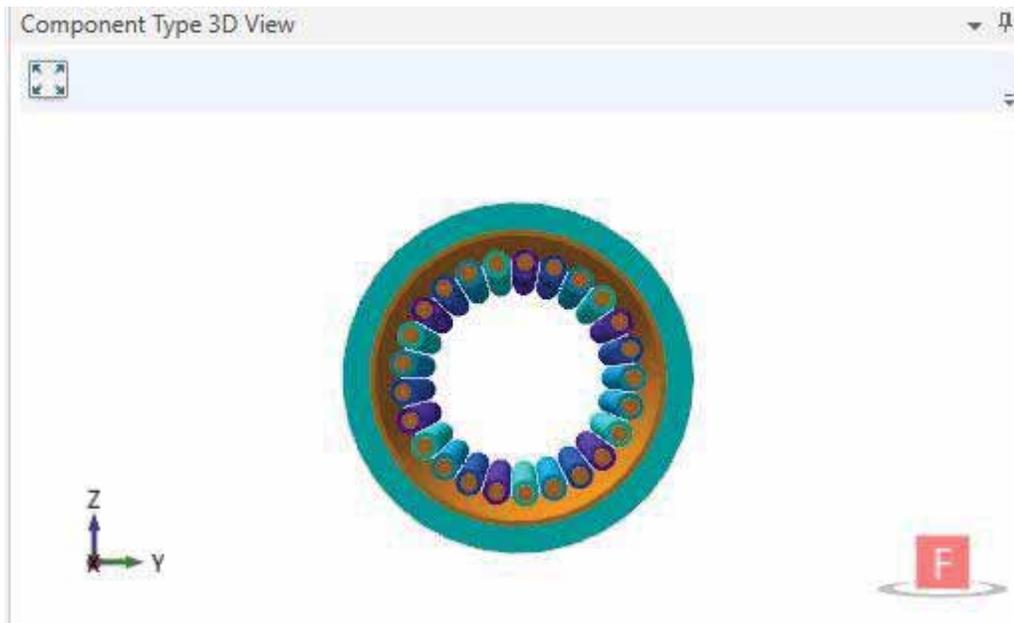
- SDG&E vault locations for section 2 and 3 have been assumed as only a KMZ has been provided

for these sections.

Multiple modeling techniques have been utilized to validate the information. During this analysis, a single conductor was originally used to represent the AT&T line. In actuality, the AT&T conductor has multiple bundled conductors, which are each insulated from one another, beneath the shielding. Extensive modeling has shown near identical values whether the AT&T conductor has multiple pairs or just one (1) conductor.

An example of how the cross section of the wire appears within the model, with multiple conductors per wire, can be seen below.

Figure 2-1: AT&T Modeled Cross Section



The above conductor was used to verify the model when a single conductor was used. This conductor has been modeled by utilizing the STALPETH data sheet provided by AT&T which states that the conductors are grouped in pair of twenty-five (25) wires and can range from twenty-five (25) wires, within a conductor, up to 2100. The inner copper core conductors are insulated from one another and all surrounded by an aluminum shield with steel armor and insulation. The center remains empty in this scenario, but the output was nearly identical regardless of the wiring orientation used. By modeling both scenarios, and obtaining very similar results, ARK Engineering concludes that adding more wire pairs will output similar values.

2.3 Soil Resistivity Measurements

This study was based on soil resistivity measurements recorded by ARK Engineering personnel for a previous analysis on an overhead portion of this electric transmission circuit project in this area. These measurements were recorded using equipment and procedures developed especially for this type of induced current touch study.

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 would during actual conditions. Resistance readings can be inflated by a factor of four (4) or more. This error can result in conservative AC mitigation designs.

2.3.1 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".

The electrode spacing varied from one point five (1.5) meters to seventy (70) 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.

2.3.2 Soil Resistivity Data

Soil resistivity measurements were used to derive an equivalent soil structure model. This -multi-layer 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 multilayer soil characteristics are used to calculate the conductive and total AC interference effects.

Table 2-3: Soil Resistivity Values Derived Using Previous Measurements

Bottom Layer Resistivity (Ω -m)	Resistivity at Conductor Depth (Ω -m)
6.8	9.8

3. MODELING DETAILS

3.1 Steady State Conditions

The -construction details of the 230-kV circuit have been considered as part of this analysis. This includes the arrangement of the electric circuit conductors and the grounding of the metallic sheaths at the vaults. The projected future load currents, provided by NV5 and SDG&E, were used to compute the maximum steady state inductive AC interference effects on the three (3) sections of the AT&T communications conductors.

The peak loads represent the possible circuit load current during peak times and demonstrate the normal operating condition of the 230-kV circuit as defined in Section 1.5 [Definitions](#).

To represent the maximum induction potential observed along the AT&T communication cables, the computations were completed by grounding one end of the AT&T communication cable and utilizing the measurement on the opposite end. This is normal AT&T practice when working on the communication cables. During AT&T normal operation, neither end of the communication cable is grounded, which causes an AC induction phase shift along the AT&T communication cable pairs. The end of each AT&T communication cable pair will observe the highest AC interference potential.

In sections of the AT&T conductors which remain continuous and close to the 230-kV circuit, beyond what has been modeled, a continuous increase of AC voltage potential should be expected. The section lengths modeled have been developed to represent the data provided by ATT and NV5 as found in Appendix B.

Table 3-1 indicates the projected future steady state load current used for this study.

Table 3-1: SDG&E 230-kV Circuit Projected Steady State Current

Projected Load Condition	Load Current in Amperes (A)
Peak	2,290

3.2 Modeled Interference Levels

ARK Engineering performed this study using the CDEGS software package. The output file plots for the steady state and simulated fault conditions on the 230-kV circuit are included in Appendix A.

3.2.1 Steady State Conditions

The induced AC conductor potentials were computed at steady state condition with the 230-kV circuit operating at projected future peak load conditions of 2,290 amperes (A).

For the three sections of AT&T conductors under study, with one side grounded and under steady state conditions, a maximum induced AC conductor potential of approximately fifteen (15) Volts, with respect to remote earth, was computed on the conductor pairs, at GPS location 32.88988°N, 117.20112°W,

along Carroll Rd. At this location, the conductor will be in close proximity and will parallel the 230-kV transmission circuit for approximately 7,400 feet.

The Carroll Road section will be the longest parallel section between a continuous AT&T conductor and the 230-kV underground transmission circuit. As this length decreases and other parameters remain similar, the AC potential decreases as well.

Table 3-2 outlines the computed induced AC conductor potentials, of each AT&T section, at projected steady state conditions on the 230-kV circuit.

Table 3-2: Computed Induced Potentials from the 230-kV Circuit at Projected Future Load Conditions

Section	230-kV Circuit Load Conditions	Grounding Conditions of the ATT Conductor	Maximum Induced AC Potential (Volts) on AT&T conductor
1	Peak	Grounded	15
2	Peak	Grounded	12
3	Peak	Grounded	14

4. CONCLUSIONS

4.1 Conclusions

In compliance with MM Hazards-7, an Induced AC Interference Study has been completed by modeling and analyzing the San Diego Gas & Electric 230-kV Sycamore to Peñasquitos underground electric transmission circuit within the three (3) parallel sections in proximity of the AT&T communication conductors for significant lengths under projected steady state conditions.

Alignment sheets and a google earth file for the 230-kV circuit provided by NV5 and facility maps provided by AT&T were utilized to represent the distance between the AT&T communication conductor and the 230-kV circuit. The alignment sheets and maps indicate that, at various locations, the 230-kV circuit will be installed between 5 to 15 feet from the existing AT&T communication conductors.

To represent the potential value observed along the AT&T communication conductors, the computations have been completed by grounding one end of the AT&T line and utilizing the measurement on the opposite end. During normal operation, neither end of the communication cable is grounded, the result changes due to a phase shift. The end of each conductor will observe the highest potential AC induction voltage.

Computer modeling and analysis, using projected steady state conditions on the 230-kV circuit and by grounding one end of the communication cable to simulate how AT&T measures voltage on their conductors, indicate that the steady state induced AC conductor voltages on the AT&T communication conductors will not exceed the MM Hazards-7 threshold of fifteen (15) Volts along any of the three sections under Study.

4.2 Assumptions

During the modeling and analysis of the potential AC induction on AT&T's communication conductors, various assumptions were required. These assumptions are outlined below:

- Additional electrical circuits were not considered in these modeling computations as this is a study on the direct effects of the 230-kV circuit on the identified objects (AT&T communication conductors) as required by MM Hazards-7.
- AT&T communication cable depth has been set to a minimum of two (2) feet.
- AT&T manhole locations were placed according to AT&T's rough hand drawn sketches thus a large deviation may exist for the modeled location.
- The quality of the AT&T shielding ground has been modeled based on AT&T's grounding standards.
- Specific soil resistivity measurements were not recorded along the 230-kV circuit right-of-way, therefore equivalent multilayer soil resistivity models were derived from measurements recorded previously by ARK Engineering in the same area of this study.

5. RECOMMENDATIONS

5.1 Recommendations

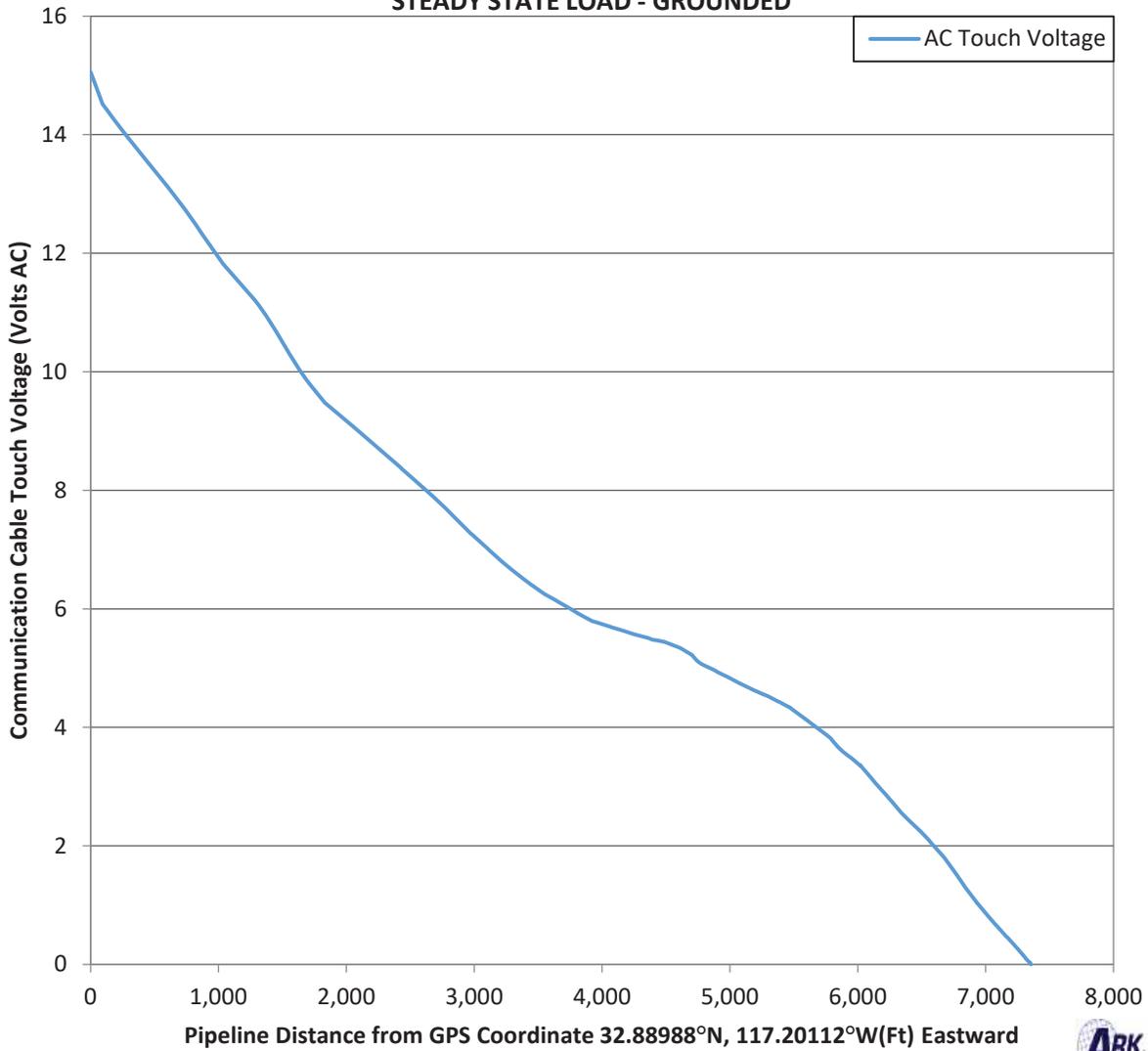
As outlined in the previous chapter, computed AC potentials and induction levels do not exceed the maximum acceptable touch voltage of 15-volts, while the SDG&E 230 kilovolt (kV) Transmission Line operates at steady state conditions, as identified in MM Hazards-7 and detailed in Table 1-1 under projected steady state conditions.

Based on the study results and in compliance with MM Hazards-7, no further AC mitigation is required.

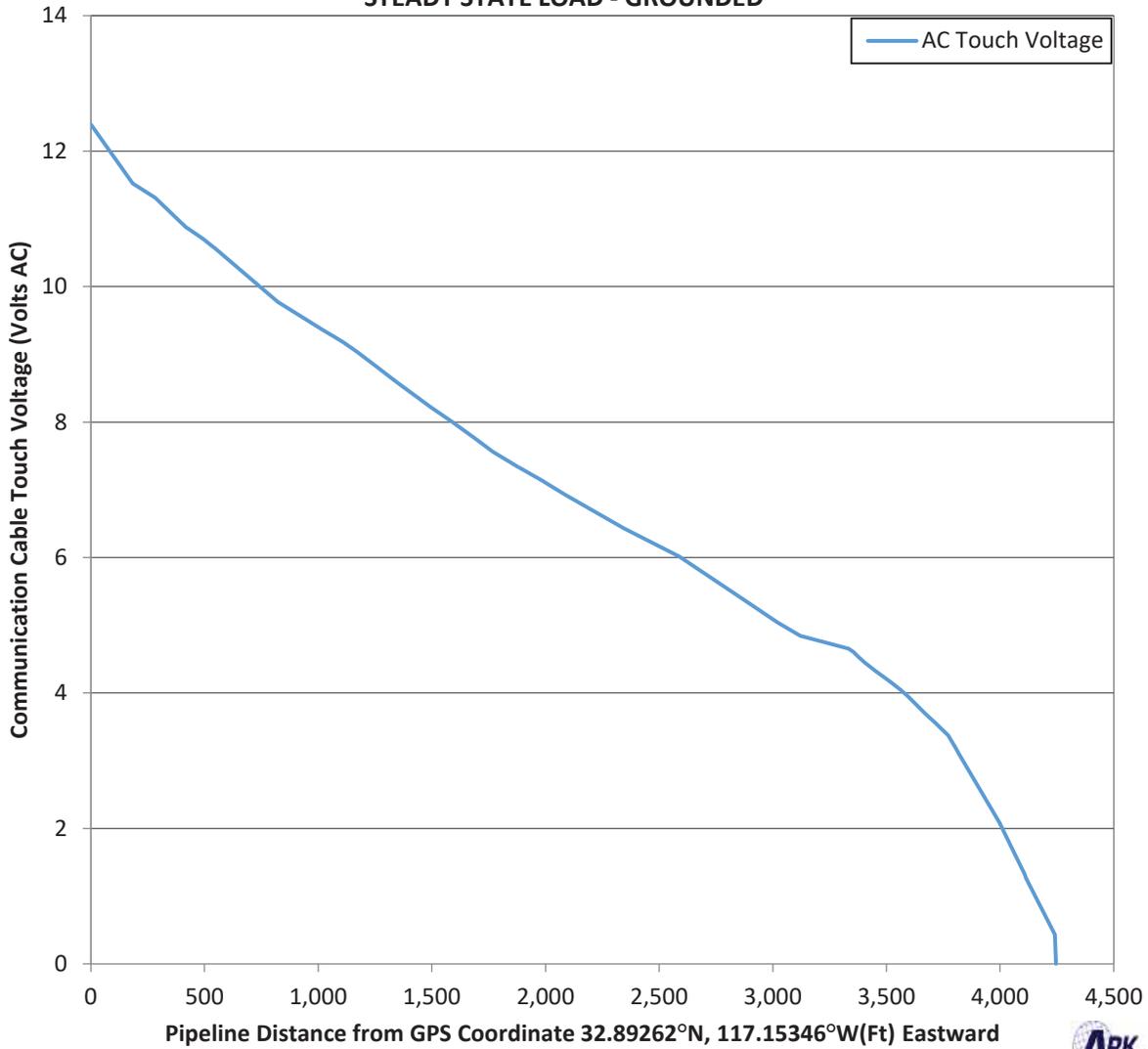
Please call the author if you have questions or require additional information regarding this report.

APPENDIX A –
COMMUNICATION CABLE STEADY STATE

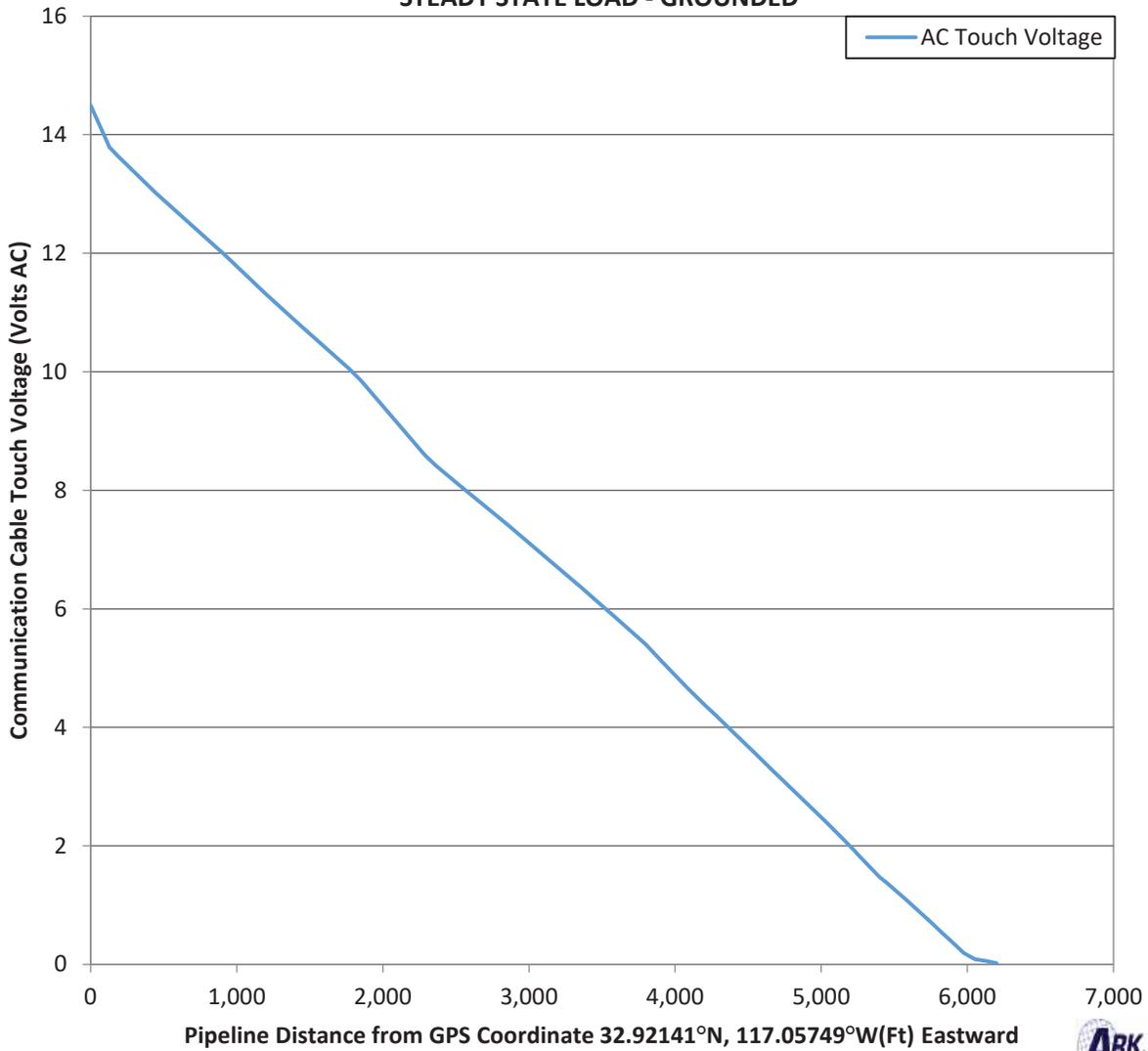
AT&T - SYCAMORE PENASQUITOS 230 KV PROPOSED CIRCUIT - AC INTERFERENCE EFFECTS
ON COMMUNICATION CONDUCTOR - AC TOUCH VOLTAGE - SECTION 1
STEADY STATE LOAD - GROUNDED



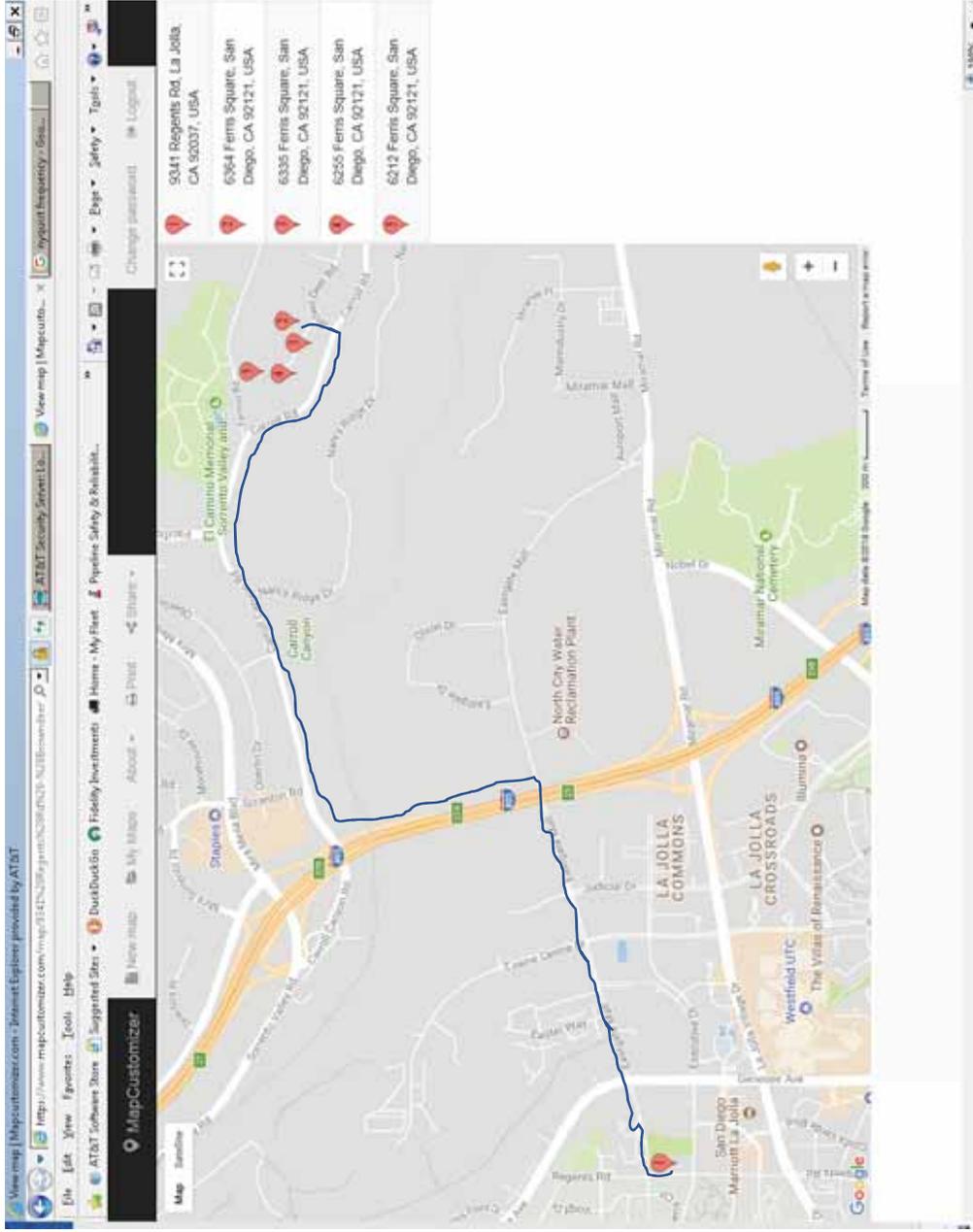
**AT&T - SYCAMORE PENASQUITOS 230 KV PROPOSED CIRCUIT - AC INTERFERENCE EFFECTS ON
COMMUNICATION CONDUCTOR - AC TOUCH VOLTAGE - SECTION 2
STEADY STATE LOAD - GROUNDED**



**AT&T - SYCAMORE PENASQUITOS 230 KV PROPOSED CIRCUIT - AC INTERFERENCE EFFECTS
ON COMMUNICATION CONDUCTOR - AC TOUCH VOLTAGE - SECTION 3
STEADY STATE LOAD - GROUNDED**



APPENDIX B – AREAS OF CONCERN MAPS



1/22/2018 Mid-day around noon

0.3vac @ 60Hz

The screenshot shows the MapCustomizer website in an Internet Explorer browser. The browser's address bar displays "http://www.mapcustomizer.com". The website's navigation menu includes "Home - My Fleet", "Pipeline Safety & Relabilit...", "My Maps", and "About". The main content area features a map of San Diego with several red location pins and a blue route. The pins are located at the following addresses:

Location	Description
7899 Arjons Dr, San Diego, CA 92126, USA	
8444 Miralaini Dr, San Diego, CA 92126, USA	
8451 Miralaini Dr, San Diego, CA 92126, USA	
8480 Miralaini Dr, San Diego, CA 92126, USA	
8510 Miralaini Dr, San Diego, CA 92126, USA	

The interface also includes a "Location" section with a text input for "Address to plot" and a "Description" section with a text input for "(Optional) enter a description for". A "Bulk Entry" button is visible in the top right corner. The map shows a blue route connecting the locations, and various landmarks like "Miramar Speed Circuit" and "Brewski's Bar & Accade" are labeled.

1/19/2018 Early afternoon

0.4vac @ 60Hz

The screenshot shows the MapCustomizer website interface. The browser address bar displays "https://www.mapcustomizer.com/#". The website header includes navigation links like "Home", "My Fleet", and "Pipeline Safety & Reliability...". The main content area features a map of Montecito, CA, with several red location pins. A blue line is drawn on the map, possibly representing a route or boundary. On the right side of the map, there is a list of addresses, each with a red pin icon and a "Bulk Entry" button. The list includes:

- 14500 Stonebridge Pkwy, San Diego, CA 92131, USA
- 12633 Westly Ln, San Diego, CA 92131, USA
- 12844 Hidesway Ln, San Diego, CA 92131, USA
- 12516 Hidesway Ln, San Diego, CA 92131, USA
- 12877 Starwood Ln, San Diego, CA 92131, USA

Below the map, there are input fields for "Location" (Address to plot) and "Description" (Optional) enter a description for. A "Save" button and a "Bulk Entry" button are also visible. The bottom of the page shows a scale bar (0 to 200 m) and a "Terms of Use" link.

1-18-2018 Early morning

4.8vac @60Hz

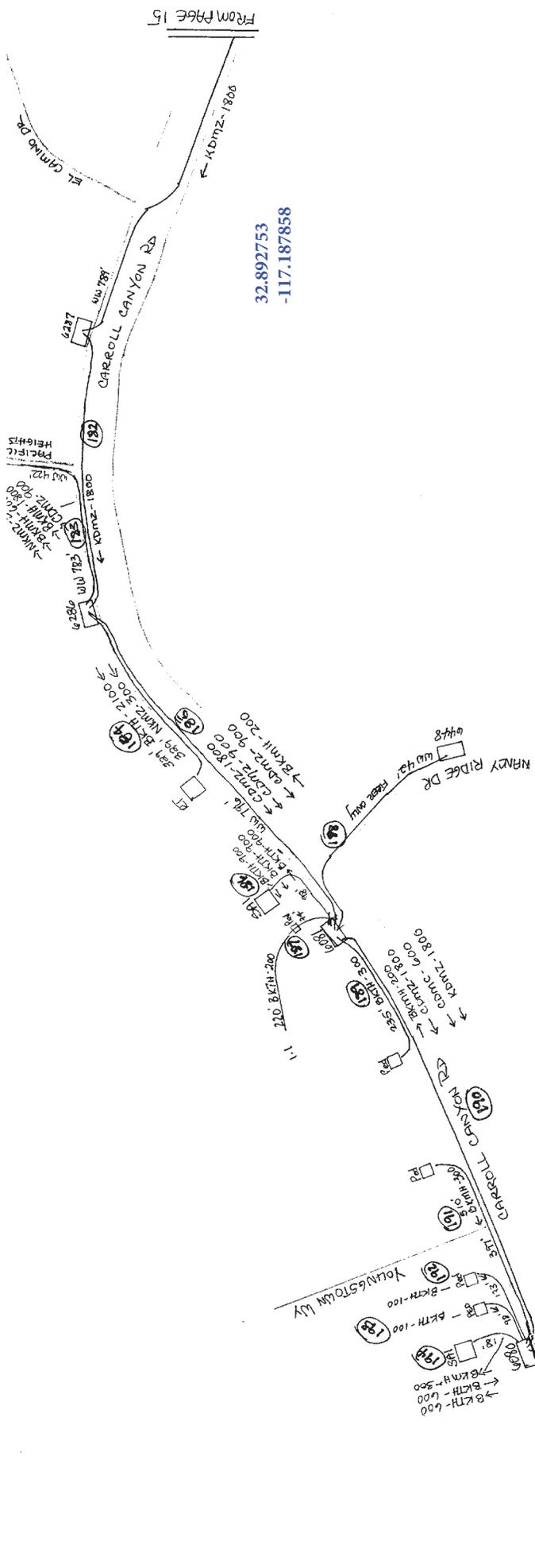
MH 1188 @SYCAMORE CANYON POWER PLANT TO MH 1178 = 10,179'

Google Maps Brown Deer Rd



Imagery ©2017 Cnes/Spot Image, DigitalGlobe, U.S. Geological Survey, USDA Farm Service Agency, Map data ©2017 Google

1000 ft 



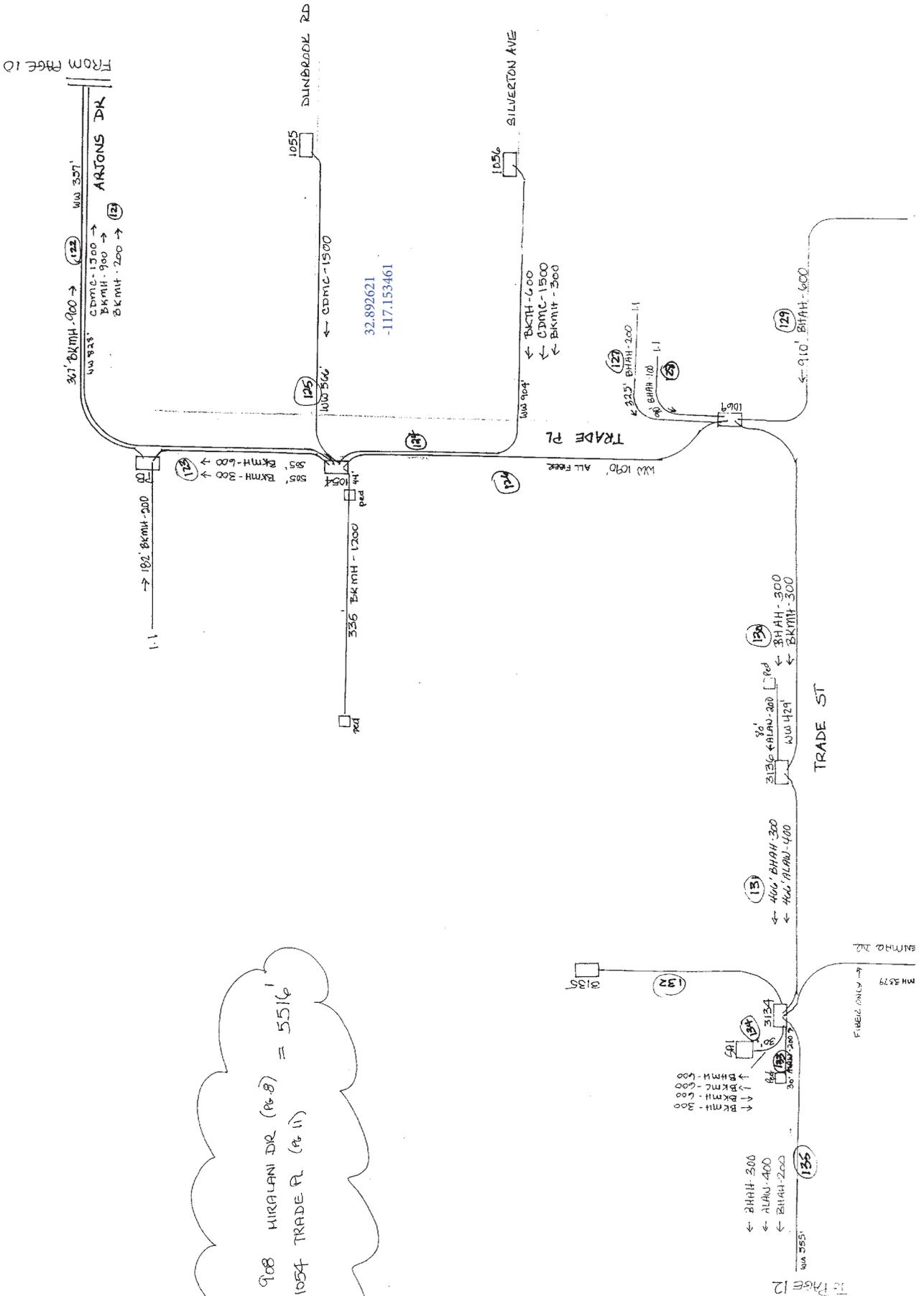
MH 6219 CARROLL RD AT BROWN DEER TO MH 6121 (END) = 8,597'

Google Maps Brown Deer Rd



Imagery ©2017 Cnes/Spot Image, DigitalGlobe, U.S. Geological Survey, USDA Farm Service Agency, Map data ©2017 Google

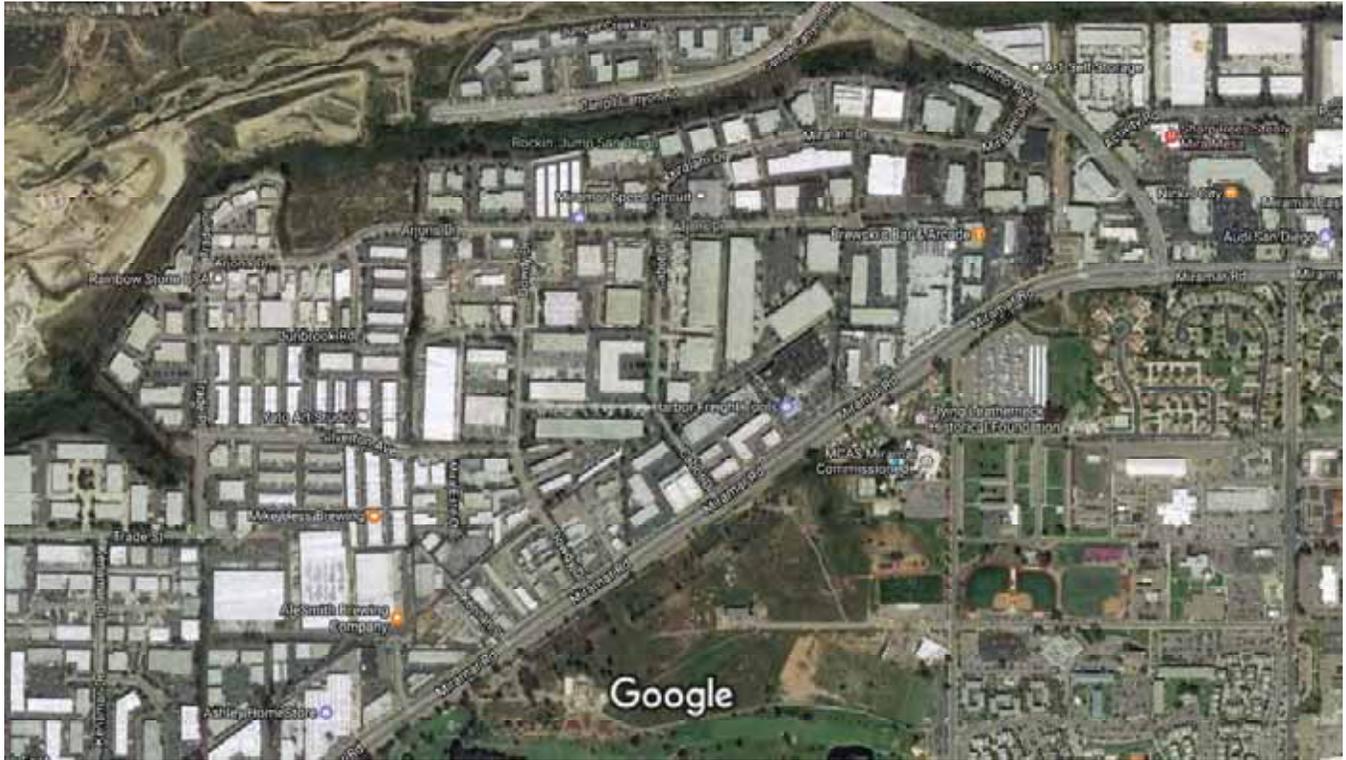
500 ft 



MH 908 HIRALANI DR (R6-B) = 5516'
 TD MH 1054 TRADE PL (R6-11)

MH 908 MIRALANI DR TO MH 1054 TRADE PL = 5516'

Google Maps Brown Deer Rd



Imagery ©2017 Cnes/Spot Image, DigitalGlobe, U.S. Geological Survey, USDA Farm Service Agency, Map data ©2017 Google

500 ft 

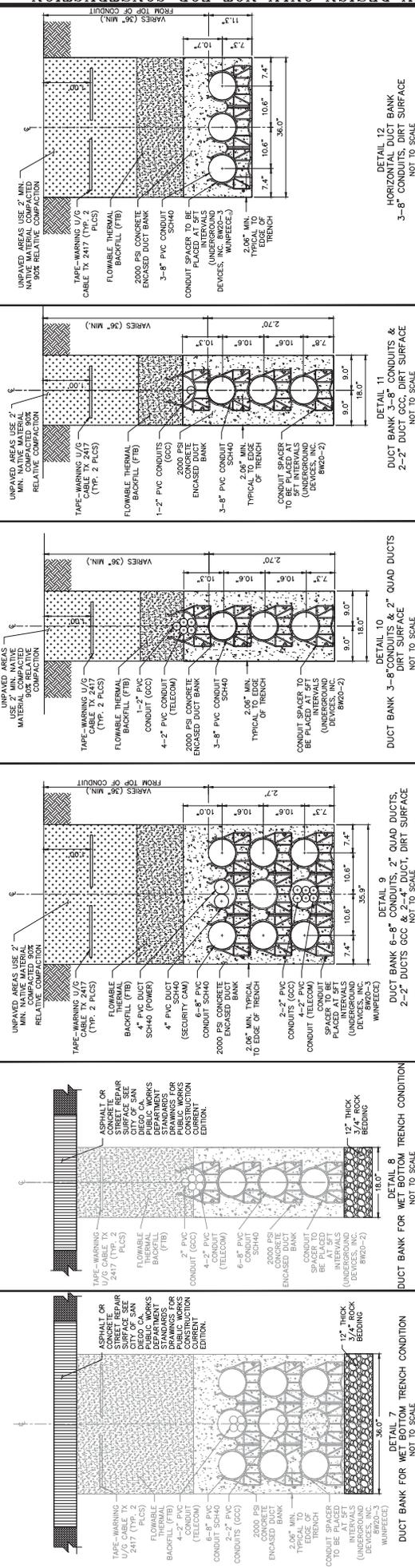
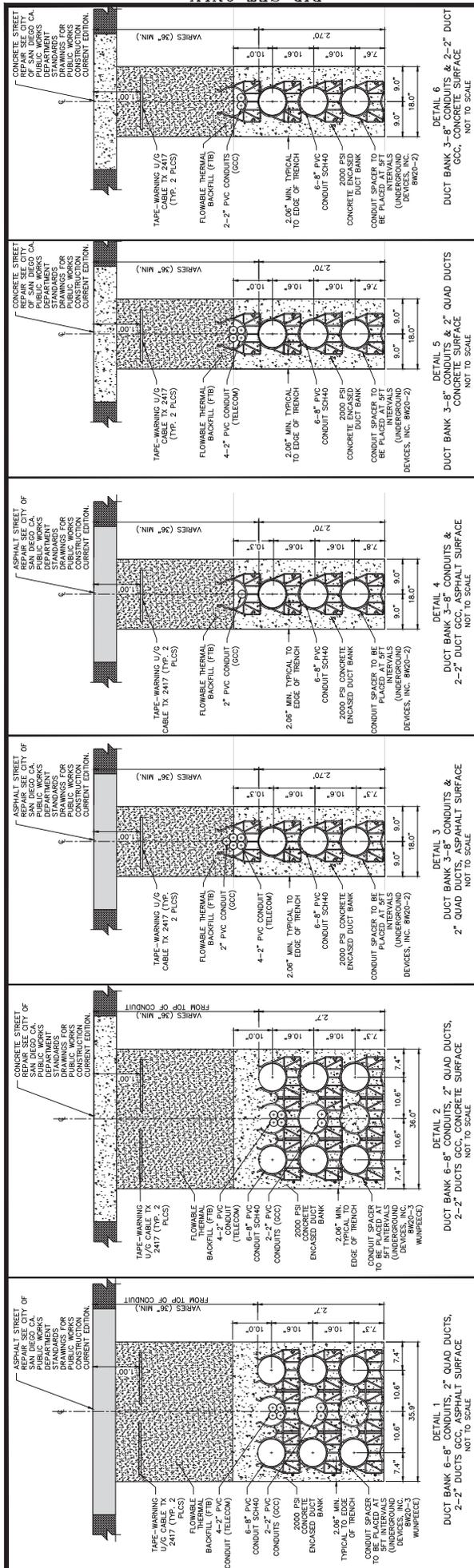
APPENDIX C – POWER & CONDUCTOR DATA



ARK Data Request

Electrical Characteristics

Circuit Information		Current Load (A)				Fault Current @ Collocation(A)															
Transmission Line	Circuit #	Voltage (kv)	Avg Summer	Avg Winter	Peak	Emergency	Pole Z519738		Mid-point			End									
23071	SX-PQ	230KV	1603	1400	2290	2950	Total	Contributed from SX	SX angle	Contributed from PQ	PQ angle	Total	Contributed from SX	SX angle	Contributed from PQ	PQ angle					
							35667	27238	-87	8459	-81	30623	15830	-84	14793	-84	34482	9351	-81	25170	-87



SDGE
SAN DIEGO GAS & ELECTRIC
TRANSMISSION ENGINEERING

NIVIS
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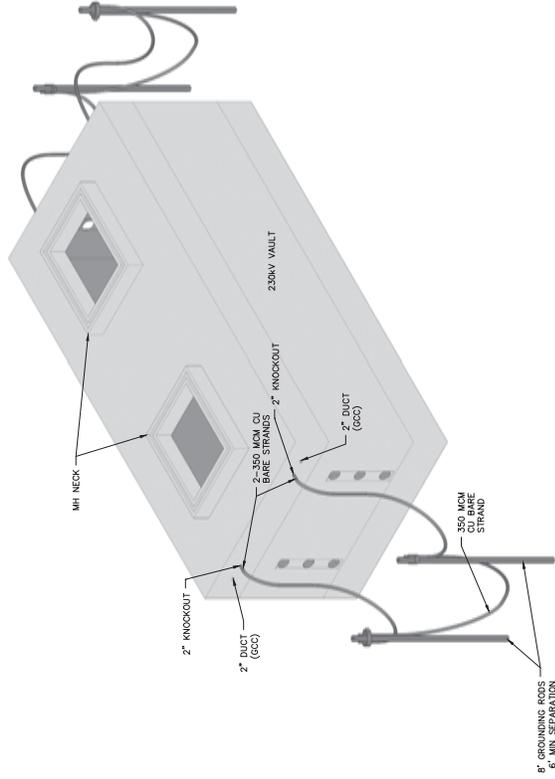
DIGALERT

SECTION DETAILS
TL23071

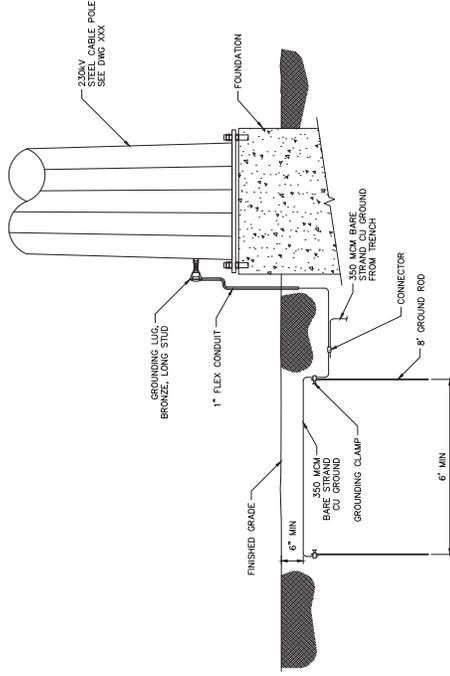
SYCAMORE CANYON SUBSTATION TO PENASQUITOS SUBSTATION
230KV UNDERGROUND SEGMENT

TL23071
DRAWING NUMBER NV5-055

DATE:	15/07/18	BY:	NVS
THRO. BY:	18/10/18	CHKD:	N/A
PROJ. NO.:	2500973	DATE:	7/9/18
CONST. NO.:		APP.:	2500975
DETAILS		TRAVEL & SUBSTRUCTURES - RID SFT. ONLY	
HORIZONTAL: N/A		SCALE:	N/A
VERTICAL: N/A		SHEET	55 OF 65



VAULT GROUNDING DETAIL
NOT TO SCALE



CABLE POLE GROUNDING
NOT TO SCALE

SAN DIEGO GAS & ELECTRIC
TRANSMISSION ENGINEERING
GROUNDING
DETAILS
TL23071

SYCAMORE CANYON SUBSTATION
TO PENASQUITOS SUBSTATION
230KV UNDERGROUND SEGMENT

TL23071
DRAWING NUMBER
NV5-057

SCALE: N/A

SHEET 57 OF 65

DATE	BY	NO.	REVISION
2016/07/28	NV5	1	ISSUE FOR BIDDING
2016/07/28	NV5	2	REVISED FOR 811
2016/07/28	NV5	3	REVISED FOR 811
2016/07/28	NV5	4	REVISED FOR 811
2016/07/28	NV5	5	REVISED FOR 811
2016/07/28	NV5	6	REVISED FOR 811
2016/07/28	NV5	7	REVISED FOR 811
2016/07/28	NV5	8	REVISED FOR 811
2016/07/28	NV5	9	REVISED FOR 811
2016/07/28	NV5	10	REVISED FOR 811
2016/07/28	NV5	11	REVISED FOR 811
2016/07/28	NV5	12	REVISED FOR 811
2016/07/28	NV5	13	REVISED FOR 811
2016/07/28	NV5	14	REVISED FOR 811
2016/07/28	NV5	15	REVISED FOR 811
2016/07/28	NV5	16	REVISED FOR 811
2016/07/28	NV5	17	REVISED FOR 811
2016/07/28	NV5	18	REVISED FOR 811
2016/07/28	NV5	19	REVISED FOR 811
2016/07/28	NV5	20	REVISED FOR 811
2016/07/28	NV5	21	REVISED FOR 811
2016/07/28	NV5	22	REVISED FOR 811
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2016/07/28	NV5	39	REVISED FOR 811
2016/07/28	NV5	40	REVISED FOR 811
2016/07/28	NV5	41	REVISED FOR 811
2016/07/28	NV5	42	REVISED FOR 811
2016/07/28	NV5	43	REVISED FOR 811
2016/07/28	NV5	44	REVISED FOR 811
2016/07/28	NV5	45	REVISED FOR 811
2016/07/28	NV5	46	REVISED FOR 811
2016/07/28	NV5	47	REVISED FOR 811
2016/07/28	NV5	48	REVISED FOR 811
2016/07/28	NV5	49	REVISED FOR 811
2016/07/28	NV5	50	REVISED FOR 811
2016/07/28	NV5	51	REVISED FOR 811
2016/07/28	NV5	52	REVISED FOR 811
2016/07/28	NV5	53	REVISED FOR 811
2016/07/28	NV5	54	REVISED FOR 811
2016/07/28	NV5	55	REVISED FOR 811
2016/07/28	NV5	56	REVISED FOR 811
2016/07/28	NV5	57	REVISED FOR 811
2016/07/28	NV5	58	REVISED FOR 811
2016/07/28	NV5	59	REVISED FOR 811
2016/07/28	NV5	60	REVISED FOR 811
2016/07/28	NV5	61	REVISED FOR 811
2016/07/28	NV5	62	REVISED FOR 811
2016/07/28	NV5	63	REVISED FOR 811
2016/07/28	NV5	64	REVISED FOR 811
2016/07/28	NV5	65	REVISED FOR 811

DIGALERT
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811

NIV5
NIV5 ENGINEERING, INC.
10000 N. 15th Street, Suite 100, Phoenix, AZ 85021
PH: 602.998.8888 FAX: 602.998.8889
WWW.NIV5.COM

Filled ASP

ANBW, ANAW, ANMW and ANTW



OSP CABLE

SPECIFICATIONS	
Conductor	Solid annealed copper
Insulation	Conductors are dual insulated with an inner layer of foamed, natural polyolefin covered by an outer layer of solid, colored polyolefin; conductor insulation is color coded in accordance with industry standard
25-Pair Core	Pairs are combined into a cylindrical core
≥ 50-Pair Core	Multiples of 25-pair groups are assembled to form the final cable core; each group is identified by color coded non-hygroscopic binders; for 1,200-pair and larger, the color code is a Mirror Image design
Filling Compound	Core assembly is completely filled with an 80°C ETPR compound, filling the air space between the insulated conductors
Core Wrap	Dielectric tape applied over the core
Shields	Corrugated bare 8 mil aluminum tape covered by a corrugated bare 6 mil steel tape applied longitudinally over the core wrap
Jacket	Black, polyethylene
Jacket Marking	Manufacturer's identification, pair count, AWG, product identification, sequential footage and a telephone handset printed at 2 foot intervals
Standards Compliance	Telcordia® GR-421-CORE Issue 2 RoHS-compliant

Telcordia is a registered trademark of Ericsson Inc

PRODUCT DESCRIPTION

FILLED ASP Cable with foam skin insulation is a single jacket, armored, filled design intended for direct burial applications in high risk areas. An ETPR compound completely coats each insulated conductor and fills the air space between conductors. The shielding, armoring and jacketing combined with the filling and flooding compounds throughout the cable, provide exceptional durability and resistance to moisture.

APPLICATIONS

- Direct burial

FEATURES

- Tightly controlled individual conductor dimensions
- Specially designed pair twist lays
- Inner and outer surfaces of both aluminum tape and steel tape are flooded
- Core wrap
- Polyethylene jacket

BENEFITS

- Limits resistance unbalance of paired conductors
- Minimizes crosstalk and meets the capacitance unbalance requirements
- Provides a barrier to moisture and inhibits corrosion
- Protects core and provides improved mechanical and electrical characteristics
- Provides a tough, flexible, protective covering that withstands exposure to sunlight, atmospheric temperatures, ground chemicals and stresses expected in standard installation

ELECTRICAL SPECIFICATIONS

Number of Pairs	Average Mutual Capacitance @ 1,000 Hz nF/mile (nF/km)	Capacitance Unbalance Pair to Pair @ 1 kHz		Capacitance Unbalance Pair to Ground @ 1 kHz	
		Maximum Individual pF @ 1 kft (pF @ 1 km)	Maximum RMS pF @ 1 kft (pF @ 1 km)	Maximum Individual pF @ 1 kft (pF @ 1 km)	Maximum Average pF @ 1 kft (pF @ 1 km)
Over 12	83 ± 4 (52 ± 2)	80 (145)	25 (45)	800 (2,625)	175 (574)

Conductor Size AWG (mm)	Minimum Insulation Resistance @ 68°F (20°C) gigohm-mile (gigohm-km)	Maximum Average Attenuation 772 kHz @ 68°F (20°C) dB/kft (dB/km)	Maximum Conductor Resistance @ 68°F (20°C) Ohms/sheath mile (km)	DC Resistance Unbalance Maximum %		Dielectric Strength DC Potential - Volts	
				Average	Individual Pair	Conductor to Conductor	Conductor to Shield
19 (0.90)	1.0 (1.6)	3.2 (10.5)	45 (29.0)	1.5	5.0	4,500	10,000
22 (0.64)	1.0 (1.6)	4.5 (14.8)	91 (56.5)	1.5	5.0	3,600	10,000
24 (0.51)	1.0 (1.6)	5.6 (18.4)	144 (89.5)	1.5	5.0	3,000	10,000
26 (0.40)	1.0 (1.6)	7.0 (23.0)	232 (144.2)	1.5	5.0	2,400	10,000

Minimum Near End Crosstalk (NEXT) @ 772 kHz

PSWUNEXT Mean (dB)	47
PSWUNEXT Worst Pair (dB)	42

Minimum Far End Crosstalk (FEXT) @ 772 kHz

Conductor Size (AWG)	19	22	24	26
PSELFEXT Mean (dB/kft)	51	49	49	47
PSELFEXT Worst Pair (dB/kft)	45	43	43	43

PART NUMBERS AND PHYSICAL CHARACTERISTICS

Part Number	Product Code	Pair Count	AWG (mm)	Nominal Diameter in (mm)	Approx. Weight lbs/kft (kg/km)	Standard Length ft (m)	Approx. Shipping Weight lbs (kg)	Steel Reel Size F x T x D in
22-031-83	ANBW	25	19 (0.90)	0.81 (21)	410 (610)	10,000 (3,048)	4,895 (2,220)	83 x 40 x 42
22-034-83	ANBW	50	19 (0.90)	1.07 (27)	735 (1,095)	5,000 (1,524)	4,470 (2,030)	83 x 40 x 42
22-038-83	ANBW	100	19 (0.90)	1.41 (36)	1,340 (1,995)	5,000 (1,524)	7,495 (3,400)	83 x 40 x 42
22-042-83	ANBW	200	19 (0.90)	1.96 (50)	2,570 (3,825)	2,000 (610)	5,935 (2,690)	83 x 40 x 42
22-044-83	ANBW	300	19 (0.90)	2.35 (60)	3,740 (5,565)	1,650 (503)	6,965 (3,160)	83 x 40 x 42
22-062-83	ANAW	25	22 (0.64)	0.63 (16)	240 (355)	18,000 (5,486)	5,115 (2,320)	83 x 40 x 42
22-065-83	ANAW	50	22 (0.64)	0.80 (20)	405 (605)	15,000 (4,572)	6,870 (3,115)	83 x 40 x 42
22-069-83	ANAW	100	22 (0.64)	1.05 (27)	730 (1,085)	7,500 (2,286)	6,270 (2,845)	83 x 40 x 42
22-073-83	ANAW	200	22 (0.64)	1.42 (36)	1,340 (1,995)	5,000 (1,524)	7,495 (3,400)	83 x 40 x 42
22-075-83	ANAW	300	22 (0.64)	1.69 (43)	1,940 (2,885)	3,300 (1,006)	7,195 (3,265)	83 x 40 x 42
22-077-83	ANAW	400	22 (0.64)	1.92 (49)	2,530 (3,765)	2,500 (762)	7,120 (3,230)	83 x 40 x 42
22-081-83	ANAW	600	22 (0.64)	2.32 (59)	3,705 (5,515)	1,650 (503)	6,910 (3,135)	83 x 40 x 42
22-083-83	ANAW	900	22 (0.64)	2.81 (71)	5,445 (8,105)	1,100 (335)	6,785 (3,075)	83 x 40 x 42
22-085-83	ANAW	1,200	22 (0.64)	3.20 (81)	7,160 (10,655)	834 (254)	6,765 (3,070)	83 x 40 x 42
22-097-83	ANMW	25	24 (0.51)	0.55 (14)	175 (260)	20,000 (6,096)	4,295 (1,950)	83 x 40 x 42
22-100-83	ANMW	50	24 (0.51)	0.69 (18)	290 (430)	20,000 (6,096)	6,595 (2,990)	83 x 40 x 42
22-104-83	ANMW	100	24 (0.51)	0.88 (22)	500 (745)	13,300 (4,054)	7,445 (3,375)	83 x 40 x 42
22-108-83	ANMW	200	24 (0.51)	1.18 (30)	900 (1,340)	6,600 (2,012)	6,735 (3,055)	83 x 40 x 42
22-110-83	ANMW	300	24 (0.51)	1.41 (36)	1,295 (1,925)	5,000 (1,524)	7,270 (3,300)	83 x 40 x 42
22-112-83	ANMW	400	24 (0.51)	1.59 (40)	1,680 (2,500)	4,000 (1,219)	7,515 (3,410)	83 x 40 x 42
22-116-83	ANMW	600	24 (0.51)	1.92 (49)	2,445 (3,640)	2,500 (762)	6,910 (3,135)	83 x 40 x 42
22-118-83	ANMW	900	24 (0.51)	2.29 (58)	3,545 (5,275)	2,000 (610)	7,885 (3,575)	83 x 40 x 42
22-120-83	ANMW	1,200	24 (0.51)	2.63 (67)	4,670 (6,950)	1,250 (381)	6,635 (3,010)	83 x 40 x 42
22-121-83	ANMW	1,500	24 (0.51)	2.92 (74)	5,775 (8,595)	1,000 (305)	6,570 (2,980)	83 x 40 x 42
22-124-83	ANMW	1,800	24 (0.51)	3.18 (81)	6,880 (10,240)	950 (290)	7,330 (3,325)	83 x 40 x 42
22-125-83	ANMW	2,100	24 (0.51)	3.45 (88)	8,045 (11,975)	940 (287)	8,960 (4,065)	83 x 40 x 42
22-145-83	ANTW	300	26 (0.40)	1.13 (29)	840 (1,250)	6,000 (1,829)	5,835 (2,645)	83 x 40 x 42
22-147-83	ANTW	400	26 (0.40)	1.29 (33)	1,100 (1,635)	6,000 (1,829)	7,395 (3,355)	83 x 40 x 42
22-151-83	ANTW	600	26 (0.40)	1.53 (39)	1,580 (2,350)	4,000 (1,219)	7,115 (3,225)	83 x 40 x 42
22-153-83	ANTW	900	26 (0.40)	1.83 (47)	2,275 (3,385)	2,500 (762)	6,485 (2,940)	83 x 40 x 42
22-155-83	ANTW	1,200	26 (0.40)	2.07 (53)	2,965 (4,415)	2,000 (610)	6,725 (3,050)	83 x 40 x 42
22-156-83	ANTW	1,500	26 (0.40)	2.33 (59)	3,695 (5,500)	1,600 (488)	6,705 (3,040)	83 x 40 x 42
22-157-83	ANTW	1,800	26 (0.40)	2.54 (65)	4,400 (6,550)	1,250 (381)	6,295 (2,855)	83 x 40 x 42
22-158-83	ANTW	2,100	26 (0.40)	2.74 (70)	5,120 (7,620)	1,200 (366)	6,940 (3,150)	83 x 40 x 42
22-159-83	ANTW	2,400	26 (0.40)	2.91 (74)	5,805 (8,640)	1,000 (305)	6,600 (2,995)	83 x 40 x 42
22-161-83	ANTW	2,700	26 (0.40)	3.08 (78)	6,485 (9,650)	740 (226)	5,595 (2,535)	83 x 40 x 42
22-162-83	ANTW	3,000	26 (0.40)	3.24 (82)	7,185 (10,695)	750 (229)	6,185 (2,805)	83 x 40 x 42

OSP CABLE

Bonded STALPETH

DCAZ, DCMZ and DCTZ



SPECIFICATIONS	
Conductor	Solid annealed copper
Insulation	Conductors are dual insulated with an inner layer of foamed, natural polyolefin covered by an outer layer of solid, colored polyolefin; conductor insulation is color coded in accordance with industry standard
≥ 50-Pair Core	Multiples of 25-pair groups are assembled to form the final cable core; each group is identified by color coded non-hygroscopic binders; for 1,200-pair and larger, the color code is Mirror Image design
Core Wrap	Non-hygroscopic dielectric material
Shield	Corrugated bare 8 mil aluminum tape applied longitudinally over the core wrap
Armor	Corrugated, copolymer coated, 6 mil steel tape applied over the aluminum shield and bonded to the outer jacket
Jacket	Black polyethylene
Jacket Marking	Manufacturer's identification, pair count, AWG, product identification and a telephone handset printed at 2 foot intervals; sequential footage markings are printed at alternate 2 foot intervals
Standards Compliance	Telcordia - GR-421-CORE Issue 2 RoHS-compliant

Telcordia is a registered trademark of Ericsson Inc.

PRODUCT DESCRIPTION

Bonded STALPETH Cable is a foam skin insulated, single jacket, armored air core design intended for use in ducts to provide more efficient duct utilization than standard PIC designs

APPLICATIONS

- Congested underground duct systems

FEATURES

- Tightly controlled individual conductor dimensions
- Specially designed pair twist lays
- Core wrap
- Aluminum tape shield
- Steel tape armor bonded to outer jacket
- Polyethylene jacket

BENEFITS

- Limits resistance unbalance of paired conductors
- Minimizes crosstalk and meets the capacitance unbalance requirements
- Protects the core and helps provide core-to-shield dielectric strength
- Assures good electrical contact with non-piercing bonding clamps
- Protects the core from mechanical damage and reduces the possibility of tape buckling during installation, ingress of water to the aluminum shield and of water along the cable between the armor and outer jacket
- Provides a tough, flexible, protective covering that withstands exposure to sunlight, atmospheric temperatures, ground chemicals and stresses expected in standard installations

ELECTRICAL SPECIFICATIONS

Number of Pairs	Average Mutual Capacitance @ 1,000 Hz nF/mile (nF/km)	Capacitance Unbalance Pair to Pair @ 1 kHz		Capacitance Unbalance Pair to Ground @ 1 kHz	
		Maximum Individual pF @ 1 kft (pF @ 1 km)	Maximum RMS pF @ 1 kft (pF @ 1 km)	Maximum Individual pF @ 1 kft (pF @ 1 km)	Maximum Average pF @ 1 kft (pF @ 1 km)
All pairs	83 ± 4 (52 ± 2)	80 (145)	25 (45)	800 (2,625)	175 (574)

Conductor Size AWG (mm)	Minimum Insulation Resistance @ 68°F (20°C) gigohm-mile (gigohm-km)	Maximum Average Attenuation 772 kHz @ 68°F (20°C) dB/kft (dB/km)	Maximum Conductor Resistance @ 68°F (20°C) Ohms/sheath mile (km)	DC Resistance Unbalance Maximum %		Dielectric Strength DC Potential - Volts	
				Average	Individual Pair	Conductor to Conductor	Conductor to Shield
22 (0.64)	1.0 (1.6)	5.0 (16.4)	91 (56.5)	1.5	5.0	1,400	5,000
24 (0.51)	1.0 (1.6)	6.3 (20.7)	144 (89.5)	1.5	5.0	1,200	5,000
26 (0.40)	1.0 (1.6)	7.9 (25.9)	232 (144.2)	1.5	5.0	1,000	5,000

Minimum Near End Crosstalk (NEXT) @ 772 kHz

PSWUNEXT Mean (dB)	47
PSWUNEXT Worst Pair (dB)	42

Minimum Far End Crosstalk (FEXT) @ 772 kHz

Conductor Size (AWG)	22	24	26
PSELFEXT Mean (dB/kft)	49	49	47
PSELFEXT Worst Pair (dB/kft)	43	43	43

Bonded STALPETH DCAZ, DCMZ and DCTZ

PART NUMBERS AND PHYSICAL CHARACTERISTICS

Part Number	Product Code	Pair Count	AWG (mm)	Nominal Diameter in (mm)	Approx. Weight lbs/kft (kg/km)	Standard Length ft (m)	Approx. Shipping Weight lbs (kg)	Steel Reel Size F x T x D in
19-083-01	DCAZ	900	22 (0.64)	2.49 (63)	4,375 (6,510)	1,600 (488)	7,795 (3,535)	83 x 40 x 42
19-085-01	DCAZ	1,200	22 (0.64)	2.85 (72)	5,770 (8,585)	1,200 (366)	7,720 (3,500)	83 x 40 x 42
19-116-01	DCMZ	600	24 (0.51)	1.70 (43)	1,960 (2,915)	3,900 (1,189)	8,440 (3,830)	83 x 40 x 42
19-118-01	DCMZ	900	24 (0.51)	2.02 (51)	2,860 (4,255)	1,500 (458)	8,275 (3,755)	83 x 40 x 42
19-120-01	DCMZ	1,200	24 (0.51)	2.30 (58)	3,755 (5,590)	2,000 (610)	8,305 (3,765)	83 x 40 x 42
19-121-01	DCMZ	1,500	24 (0.51)	2.57 (65)	4,660 (6,935)	1,600 (488)	8,250 (3,745)	83 x 40 x 42
19-124-01	DCMZ	1,800	24 (0.51)	2.81 (71)	5,545 (8,250)	1,250 (381)	7,725 (3,505)	83 x 40 x 42
19-125-01	DCMZ	2,100	24 (0.51)	3.04 (77)	6,440 (9,585)	1,150 (351)	8,200 (3,720)	83 x 40 x 42
19-126-01	DCMZ	2,400	24 (0.51)	3.22 (82)	7,320 (10,895)	876 (267)	7,205 (3,270)	83 x 40 x 42
19-151-01	DCTZ	600	26 (0.40)	1.38 (35)	1,285 (1,910)	5,700 (1,737)	8,120 (3,685)	83 x 40 x 42
19-153-01	DCTZ	900	26 (0.40)	1.62 (41)	1,850 (2,755)	3,900 (1,189)	8,010 (3,635)	83 x 40 x 42
19-155-01	DCTZ	1,200	26 (0.40)	1.84 (47)	2,420 (3,600)	3,200 (975)	8,540 (3,875)	83 x 40 x 42
19-156-01	DCTZ	1,500	26 (0.40)	2.08 (53)	2,995 (4,455)	2,500 (762)	8,285 (3,755)	83 x 40 x 42
19-157-01	DCTZ	1,800	26 (0.40)	2.26 (57)	3,560 (5,300)	2,080 (634)	8,200 (3,720)	83 x 40 x 42
19-158-01	DCTZ	2,100	26 (0.40)	2.41 (61)	4,115 (6,125)	1,250 (381)	5,940 (2,695)	83 x 40 x 42
19-159-01	DCTZ	2,400	26 (0.40)	2.58 (66)	4,685 (6,970)	1,600 (488)	8,290 (3,760)	83 x 40 x 42
19-161-01	DCTZ	2,700	26 (0.40)	2.71 (69)	5,240 (7,800)	1,250 (381)	7,345 (3,330)	83 x 40 x 42
19-162-01	DCTZ	3,000	26 (0.40)	2.86 (73)	5,800 (8,630)	1,200 (366)	7,755 (3,520)	83 x 40 x 42
19-164-01	DCTZ	3,600	26 (0.40)	3.03 (77)	6,885 (10,245)	1,150 (351)	8,715 (3,950)	83 x 40 x 42
19-167-01	DCTZ	4,200	26 (0.40)	3.26 (83)	7,995 (11,900)	900 (274)	7,990 (3,625)	83 x 40 x 42

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