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VIA OVERNIGHT AND ELECTRONIC MAIL

August 21, 2008

Honorable Jaclyn A. Brilling
Secretary
State of New York
Public Service Commission
Three Empire State Plaza, 19th Floor
Albany, New York 12223-1350

Re: Case 04-M-0159 - Proceeding on Motion of the Commission to Examine the Safety of Consolidated Edison Company of New York, Inc.'s Electric Transmission and Distribution Systems, "Notice Soliciting Comments" (July 8, 2008)

JOINT COMMENTS OF THE NEW YORK STATE UTILITIES

Dear Secretary Brilling:

I am writing on behalf of Central Hudson Gas & Electric Corporation, Consolidated Edison Company of New York, Inc., New York State Electric & Gas Corporation, Niagara Mohawk Power Corporation d/b/a National Grid, Orange and Rockland Utilities, Inc. and Rochester Gas and Electric Corporation (collectively the "New York State Utilities") to submit an original and five (5) copies of the enclosed "Joint Comments of the New York State Utilities" in response to the July 8, 2008 *Notice Soliciting Comments* in the above-referenced proceeding.

Kindly acknowledge receipt of this filing by date-stamping as received the enclosed duplicate copy of this letter and returning it in the enclosed, self-addressed envelope.

Respectfully submitted,

Jeremy J. Euto

Enclosures

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STATE OF NEW YORK
PUBLIC SERVICE COMMISSION

Proceeding on Motion of the Commission to Examine the Safety of Consolidated Edison Company of New York, Inc.'s Electric Transmission and Distribution Systems – Notice Soliciting Comments Issued July 8, 2008	**Case No. 04-M-0159**

JOINT COMMENTS OF THE NEW YORK STATE UTILITIES

CENTRAL HUDSON GAS & ELECTRIC CORPORATION,
CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.,
NEW YORK STATE ELECTRIC & GAS CORPORATION,
NIAGARA MOHAWK POWER CORPORATION,
ORANGE AND ROCKLAND UTILITIES, INC. AND
ROCHESTER GAS AND ELECTRIC CORPORATION

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Dated: August 22, 2008

STATE OF NEW YORK
PUBLIC SERVICE COMMISSION

Proceeding on Motion of the Commission to Examine the Safety of Consolidated Edison Company of New York, Inc.'s Electric Transmission and Distribution Systems – Notice Soliciting Comments Issued July 8, 2008	**Case No. 04-M-0159**

JOINT COMMENTS OF THE NEW YORK STATE UTILITIES

Background

On July 8, 2008, the New York Public Service Commission ("Commission") issued a Notice Soliciting Comments (the "Notice") in the above-referenced proceeding.[1] The Notice seeks comments on proposed changes to the Commission's electric system safety standards (the "Standards"), as set forth in a proposal presented by the Department of Public Service Staff (the "Staff Proposal"), as well as five specific questions and one item on the efficacy of utilizing mobile stray voltage testing technology on a statewide basis.[2] Central Hudson Gas & Electric Corporation, Consolidated Edison Company of New York, Inc., New York State Electric & Gas Corporation, Niagara Mohawk Power Corporation d/b/a National Grid, Orange and Rockland Utilities, Inc. and Rochester Gas and Electric Corporation (collectively the "Utilities") provide these joint comments on the Staff Proposal and present several additional recommended modifications to the

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[1] CASE 04-M-0159, Proceeding on Motion of the Commission to Examine the Safety of Consolidated Edison Company of New York, Inc.'s Transmission and Distribution Systems, Notice Soliciting Comments (July 8, 2008).

[2] The Notice (p. 2) states that the efficacy of utilizing mobile stray voltage testing technology on a statewide basis is "not included as a revision to the Safety Standards at this time."

Standards (the "Joint Comments"). The Utilities also note that the Standards included with the Staff Proposal do not appear to include revisions shown in Appendix A of the July 21, 2005 *Order on Petitions for Rehearing and Waiver* issued by the Commission in Case 04-M-0159 (the "July 2005 Order"). In the July 2005 Order, the Commission modified the initial schedule for testing, clarified the certification requirements, eliminated the need for interior inspections of fiberglass handholes and adopted additional refinements to the original safety standards. Revisions to the Standards proposed in the Staff Proposal should be based upon the revised safety standards adopted in the July 2005 Order.

I. INTRODUCTION

In the sections that follow, the Utilities submit specific comments on the proposed changes to the Standards detailed in the Staff Proposal, along with additional suggested revisions to clarify the Standards and improve the effectiveness of the testing and inspection programs. These additional clarifications and revisions reflect the significant additional experience gained by the Utilities since the inception of the testing and inspection programs. In Section V, the Utilities discuss reports prepared by the various utilities to evaluate the efficacy of the programs and the potential safety and other benefits of the testing and inspection activities.

The Joint Comments focus on a number of issues of particular significance, including: (i) modifying the proposed threshold for a stray voltage finding from 1 volt to a number that is, at a minimum, not below the limit of available certified handheld testing devices; (ii) revising the 30 foot radius of required testing when a stray voltage finding occurs to a more workable 10 foot radius; (iii) extending the time to perform temporary repairs to six months; (iv) removing a proposed retroactive reporting requirement that relies upon data that have not been kept or do not exist in the manner prescribed by the Staff Proposal; and (v) concerns of the Utilities regarding the imposition of state-wide requirements to perform testing using mobile stray voltage testing technology.

II. RESPONSE TO PROPOSED CHANGES

Section 1: Stray Voltage Testing, Paragraph (e)[3]

Stray Voltage Testing – The process of checking an electric facility for stray voltage using a hand-held device capable of reliably detecting and audibly and/or visually signaling voltage in the range of 4.5 to 600 volts.

This paragraph should be modified to read: "*Stray Voltage Testing – The process of checking an electric facility for stray voltage using a device capable of reliably detecting and audibly and/or visually signaling voltage in the range of 6 to 600 V_{AC}.*"

This change is proposed because the commercially available hand-held HD testers currently certified by the Commission for stray voltage testing detection are designed to detect AC Voltages of 5 Volts to 600 Volts. As noted in the manufacturer's literature for these devices, the threshold voltage is listed at 5 V_{AC} +/- 10%.[4] The proposed modification would make this provision consistent with the manufacturer's documentation for hand-held HD devices. Six volts is proposed consistent with the detection capability of the mobile test device currently used by Con Edison in its network areas. As discussed later in these comments, the value of use of mobile detection technology outside of Con Edison's network areas has not been demonstrated.

[3] Staff's suggested changes to the specified sections are presented in *italics*.

[4] Appendix 1 – HD Electric Company, LV-S-5 Stray Voltage Detector Specifications (2005).

Section 1: Definitions, Paragraph (f)
Findings – Any confirmed voltage reading on an electric facility greater than or equal to 1V measured using a volt meter and 500 ohm shunt resistor.

This paragraph should be modified to read: "*Findings - Any confirmed stray voltage reading on an electric facility greater than or equal to 8V_{AC} measured using a volt meter and 500 ohm shunt resistor.*"

This proposed modification serves a two-fold purpose. It serves to distinguish stray voltage from other types of voltages, which ordinarily exist on electric facilities, as well as to base findings and mitigation on a voltage level that is reliably detectable by certified test equipment.

Most low level voltages are due to neutral currents, induced voltages, and capacitively coupled voltages that are safe and part of a normally working electrical distribution system. Research into average primary neutral to earth voltages ("NEV"), which are naturally occurring, was performed by the Public Service Commission of Wisconsin and compiled into a report dated January 26, 2006. According to this report, based on an investigation at 7,000 farms, the average NEV in Wisconsin was determined to be 1.24 V_{AC}.[5] Due to differences in geology and soil conditions, it can be expected that New York State could have an even higher average NEV.

Induced voltage is the result of electromagnetic coupling between a current carrying conductor and an ungrounded or poorly grounded metallic object that is in the electromagnetic field of a distribution or transmission line. When this occurs, the metallic object cuts the electromagnetic lines of force, which induces a voltage onto the object.

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[5] Public Service Commission of Wisconsin, Stray Voltage Phase I and Phase II, Combined Database Summary (January 26, 2006).

NEV and induced voltage are inherent to the design of an electrical system and may not be possible and/or practical to mitigate. The proposed modification to Section 1: Definitions, Paragraph (f) is consistent with the Commission's intent that testing and mitigation efforts address the safety of the public. As the Commission stated in the Safety Order, "[t]he safety standards adopted herein will take a positive, proactive step towards ensuring the safety of the public from stray voltage and enhancing electric utility reliability."[6]

The proposed finding level of 1 V_{AC} is significantly below the minimum threshold (i.e., 5 V_{AC} *+/- 10%)* achievable by the certified handheld tester currently used state-wide for stray voltage testing. The 1 V_{AC} level in Section 1: Definitions, Paragraph (f) of the Staff Proposal is approximately 78%[7] below the published minimum tolerance of the certified test equipment, assuming a 10% tolerance from specifications. Establishing a 1 V_{AC} threshold for mitigation is fundamentally inconsistent with what can be identified reliably with available technology. Mitigation should not be required at levels below what certified test equipment is capable of detecting, particularly when these low voltage levels are not hazardous and are produced by neutral currents, induced voltages, and capacitively coupled voltages that are safe and part of a normally working electrical distribution system.

In the Safety Order the Commission states that "...although the detection of eight volts may not pose an immediate safety hazard, it is an indication of a problem and potential safety hazard."[8] For the past three years, the New York State utilities have exceeded the requirements of the Safety Order, which mandates mitigation on voltages of

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[6] CASE 04-M-0159, Order Instituting Safety Standards, p. 57 (January 5, 2005).
[7] Formula: ((4.5 Volts – 1 Volts) divided by 4.5 Volts) times 100).
[8] CASE 04-M-0159, Order Instituting Safety Standards, p. 36 (January 5, 2005).

8 V_{AC} or greater. The majority of the Companies have used 4.5 V_{AC} (based on the minimum threshold of the certified handheld test equipment, with 10% tolerance) for mitigation and action levels. It has been stated by industry experts that voltage levels less than 4.5 V_{AC} pose no harmful threat to the public.[9,10] This is well below the minimum threshold that is considered dangerous by most industry experts. It is the opinion of some industry experts that voltage levels of 25 V_{AC} or less may, under certain conditions (e.g., wet, no shoes), present an uncomfortable sensation, but which is not considered lethal,[11] and is generally avoidable, even for animals.

The cost of mitigating each instance of voltage greater than 1V_{AC} far outweighs the corresponding safety benefit. Since the inception of statewide stray voltage testing in 2005, the majority of the Utilities have been mitigating to 4.5 V_{AC}, and there have been no reported instances of members of the public receiving a stray-voltage shock from utility-owned equipment due to contact voltage.

The Utilities propose maintaining the minimum threshold of 8 V_{AC} for required mitigation. However, should the Commission choose to reduce the minimum threshold, the Utilities contend that, in consideration of both naturally-occurring low-level voltages and the inability to reliably perform testing at 1 V_{AC}, the new threshold should be 4.5 V_{AC}.

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[9]A review of hazards associated with exposure to low voltages, Dr. Marom Bikson (March 2004).
[10] Burke, J.; Untiedt, C., "Stray voltage: Two different perspectives," Rural Electric Power Conference, 2008 IEEE , vol., no., pp.A2-A2-7, 27-29 (http://ieeexplore.ieee.org/iel5/4511478/4520126/04520129.pdf) (April 2008), wherein the author states at p. A2-2, "[i]f we take a more conservative approach and use 1000 ohms for the resistance of the human body (a value the author has never been able to attain), then 4.5 volts would be the limit. It would seem that a practical limit of stray voltage in the consumer environment on the order of 5 volts or even higher can be justified."
[11] OSHA Standard 1910.333 (2004).

Section 3: Stray Voltage Testing, Paragraph (g)
All equipment used for stray voltage testing must be certified by an independent test laboratory as being able to detect voltages of 4.5 to 600 volts.

This paragraph should be modified to read: "*All equipment used for stray voltage testing must be certified by an independent test laboratory as being able to detect voltages of 6 to 600 V_{AC}.*"

This change is proposed because the commercially available hand-held HD testers currently certified by the Commission for stray voltage testing detection are designed to detect AC Voltages of 5 Volts to 600 Volts. As noted in the manufacturer's literature for these devices, the threshold voltage is listed at 5 V_{AC} +/- 10%.[12] The proposed modification would make this provision consistent with the manufacturer's documentation for hand-held HD devices. Six volts is proposed consistent with the detection capability of the mobile test device currently used by Con Edison in its network areas. As discussed, later in these comments the value of use of mobile detection technology outside of Con Edison's network areas has not been demonstrated.

Section 3: Stray Voltage Testing, Paragraph (h)
Any facility for which a finding is discovered shall be guarded by the utility immediately and continuously until the utility has performed mitigation and made the area safe. The utility must perform mitigation irrespective of whether the stray voltage is determined to be caused by its own or a customer-owned facility. Mitigation shall be completed on any voltage findings.

This paragraph should be modified to delete the second and third sentences. As modified, the section would read: "*Any facility for which a finding is discovered shall be guarded by the utility immediately and continuously until the utility has performed mitigation and made the area safe.*"

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[12] Appendix 1 – HD Electric Company, LV-S-5 Stray Voltage Detector Specifications (2005).

The first sentence fully addresses the required continuous guarding of stray voltage findings, rendering the following sentences redundant. In addition, utility responsibility in the event of a stray voltage finding on customer-owned equipment is fully addressed in Section 3: Stray Voltage Testing, Paragraph (k). Referring to it in this location is redundant and may cause needless confusion to any party seeking guidance from the Standards.

Section 3: Stray Voltage Testing, Paragraph (i)
In the event of a finding on an electric facility during stray voltage testing, the utility shall test for stray voltage on all metallic structures that are capable of conducting electricity within a minimum 30 foot radius of the electric facility.

This paragraph should either be stricken from the proposed changes or modified to read: "*In the event of a finding on an electric facility during stray voltage testing, the utility shall test for stray voltage on all publicly-accessible metallic structures that are capable of conducting electricity within a minimum 10 foot radius of the electric facility.*"

Testing in a 30 foot radius of an identified stray voltage finding is unnecessary and could compromise the safety of the pedestrian public and the employee charged with securing and safeguarding the location. Mandating a 30 foot radius will require testing personnel to safeguard an area in excess of 2,800 square feet.[13] Testing personnel will be forced to leave the finding unguarded while performing investigation in the surrounding area, thereby jeopardizing the intent of stray voltage testing, which is to enhance the safety of the residents of the State. The difficulty of safeguarding the identified finding is exacerbated in urban areas where the tester must seek a crosswalk in order to safely cross a street, when the devices and facilities across the street are inclusive of the 30 foot radius.

[13] Formula: $A = \pi r^2 = \pi * (30ft.)^2 = 2,827ft.^2$

If the Commission chooses to select the testing radius, the Utilities recommend that the radius from the point of stray voltage should be 10 feet. A 10 foot radius would allow testing personnel to stay within a more reasonable reach of the energized structure, in order to better safeguard the structure, while conducting stray voltage tests on other publicly-accessible structures in the surrounding area. This proposed 10-foot radius, while still requiring the tester to leave an identified stray voltage finding, would more realistically meet the Safety Order's intent to improve public safety, without compromising the objectives of the Safety Order.

The Utilities further contend that, if this requirement is adopted, it should be clarified that only publicly-accessible structures are required to be tested.[14]

Section 4: Inspections, Paragraph (k)
Utilities are expected to permanently repair deficiencies identified by the inspection program within the priority time period established during the inspection.

This paragraph should be modified to read: *"Utilities are expected to permanently repair deficiencies identified by the inspection program within the priority time period established during the inspection, except when circumstances outside the control of the utility prevents its repair within the identified timeframe."*

The Utilities agree with the expectation that deficiencies identified by the inspection program shall be repaired within the timeframes established; however, there may be instances where the repair timeframes will be exceeded, including (but not limited to) system emergencies such as weather-related storms, permitting issues, terrain-

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[14] This is consistent with the Commission's January 5, 2005 Order Instituting Safety Standards in Case 04-M-0159, which states at p. 15, "It is not necessary or appropriate to test all electric facilities. For example, it is neither practical nor productive to test underground or aerial cables for stray voltage. Since the purpose of our safety standards is to protect the general public, it is not necessary to test facilities that are not accessible to the public."

related issues, and special material requirements. The Standards should provide for such an exception.

<u>Section 4: Inspections, Paragraph (l)</u>

When a temporary repair is located during an inspection or made by the company, best efforts shall be used to affect a permanent repair of the facility within 45 days. A temporary repair to the facility may remain in place for more than 45 days only in extraordinary circumstances, which may include major storms that require significant repair activity. In such event, the utility shall periodically perform site visits to monitor the condition of the temporary repair. All exceptions must be identified and justified as part of the reporting requirements under Section 9.

The Utilities propose extending the time frame for permanent repairs to six months. By definition, temporary repairs pose no immediate danger to the general public and service to customers. Such conditions may require extensive planning and scheduling to implement a permanent repair, such as arranging for equipment and pole replacements.

These repairs often involve equipment that is not readily available and permitting that may take several months to obtain. These repairs may also involve outages, which require careful scheduling in order to avoid a negative impact on customer reliability. In addition, there is often lag time associated with the transfer of data into the utility's database. For some utilities, the lag time could be in excess of thirty days. The 45 day requirement provides no measurable safety benefit and does not provide ample time to complete permanent repairs without negatively impacting manpower and Company resources.

In addition, compliance with this modification would require an adjustment period in order to allow for the implementation of a system that accurately and effectively tracks temporary repairs company-wide. Because this would be a company-wide initiative extending outside of the scope of inspections and stray voltage testing, considerable changes would be required in order to efficiently and effectively track temporary repairs. This would require time and planning to develop necessary interfaces within current work management systems, outage management systems, and data management systems to properly manage, record, and report this information.

Section 6: Recordkeeping, Paragraph (d)

Each utility shall develop procedures and protocols to track temporary repairs made on the system and whether these locations were permanently repaired within 45 days after making or locating a temporary repair.

As discussed in response to Section 4, par. (l) above, the Utilities propose extending the time frame for permanent repairs to six months. By definition, temporary repairs pose no immediate danger to the general public and service to customers. Such conditions may require extensive planning and scheduling to implement a permanent repair, such as arranging for equipment and pole replacements.

As discussed previously, these repairs often involve equipment that is not readily available and permitting that may take several months to obtain. These repairs may also involve outages, which require careful scheduling in order to avoid a negative impact on customer reliability. In addition, there is often lag time associated with the transfer of data into the utility's database. For some utilities, the lag time could be in excess of thirty days. The 45 day requirement provides no measurable safety benefit and does not provide ample time to complete permanent repairs without negatively impacting manpower and Company resources.

In addition, compliance with this modification would require an adjustment period in order to allow for implementation of a system that accurately and effectively tracks temporary repairs company-wide. Because this would be a company-wide initiative extending outside of the scope of inspections and stray voltage testing, considerable changes would be required in order to efficiently and effectively track temporary repairs. Information technology, operations, and engineering departments would need to work together to implement an adequate tracking system, at a considerable effort and cost by the Companies. This would require time and funding to develop necessary interfaces within the current work management systems, outage management systems, and the data management systems to properly manage, record, and report this information.

Section 9: Reporting Requirements, Paragraph (a.4)
Contains a breakdown of the voltage findings in a tabular format as detailed in Appendix B;

The Utilities propose eliminating reporting findings within the range of 1 V_{AC} to 4.4 V_{AC}. The 1 V_{AC} - 4.4 V_{AC} is below the minimum threshold achievable by the certified HD handheld tester currently used state-wide for stray voltage testing.[15] Since recording and reporting findings within the 1 V_{AC} to 4.4 V_{AC} range would not be achievable using currently available handheld technology this proposal lacks validity. As described in the Utilities' response to Section 1: Definitions, Paragraph (f), the majority of the voltages found in this range are inherent to the design of the electrical system and have been described by industry experts as non-hazardous voltages. The inclusion of this category will unnecessarily inflate the number of stray voltage findings and could adversely affect public perception regarding the safety of the electrical system.

[15] Appendix 1 – HD Electric Company, LV-S-5 Stray Voltage Detector specifications (2005).

In addition, the Utilities propose that the following modifications be made to categories listed in the Summary of Voltage Findings. The category called Street Lights/Traffic Signals should be modified to read "Utility/Non-Utility Street Lights/Traffic Signals" and Miscellaneous Facilities should be modified to read "Non-Utility Owned Facilities." These changes will clarify who is the owner responsible for facilities reported with stray voltage. See Appendix 2 for proposed changes.

<u>Section 9: Reporting Requirements, Paragraph (a.8)</u>
Contains a breakdown of facilities to be inspected, unique inspection conducted per year, and the cumulative number of unique inspections conducted to meet the five year requirement;

Reporting should not be required retroactively to the inception of the program. The reporting mechanism has not been in place to date, and conversion from previous years' reporting mechanisms could engender inconsistencies in the data.

<u>Section 9: Reporting Requirements, Paragraph (a.9)</u>
Contains a breakdown of the deficiencies found, permanent repair actions taken by year, whether the repair was completed within the required timeframe, and the number of deficiencies awaiting repair. The information should be provided on a yearly basis by priority level and by equipment groupings as detailed in Appendix D;

Reporting should not be required retroactively to the inception of the program. The reporting mechanism has not been in place to date, and conversion from previous year's reporting mechanisms could engender inconsistencies in the data. See Appendix 3 for proposed changes.

III. ADDITIONAL SUGGESTED REVISIONS TO THE SAFETY STANDARDS

Change with Regard to AC Voltage designation

The designation of AC should be added to all voltages presented in the proposed revised Standards. This modification is proposed in order to clarify that the utilities are testing for AC voltage and not DC Voltage. Failure to clarify this may cause confusion for people who consult electric safety and design standards.

General Change with Regard to Voltage Terminology

The Utilities propose removing the term "Stray Voltage" from the text of the Standards and replacing it throughout with the more correct term "Contact Voltage."

At the IEEE Working Group on Voltages at Publicly and Privately Accessible Locations in January 2008, IEEE agreed to definitions on the subject of stray voltage that will soon be distributed for comments from a wider audience.[16] IEEE defines stray voltage as follows: "[a] voltage resulting from the normal delivery and use of electricity which may be present between two conductive surfaces that can be simultaneously contacted by members of the general public or their animals. Stray voltage is not related to power system faults, and is generally not considered hazardous."

IEEE also has a clear definition to the term contact voltage: "[a] voltage resulting from power system faults that may be present between two conductive surfaces that can be simultaneously contacted by members of the general public or their animals. Contact

[16] IEEE Meeting Minutes Working Group on Voltages at Publically and Privately Accessible Locations P1695, January 7, 2008

voltage is not related to the normal delivery or use of electricity, and can exist at levels that may be hazardous."[17]

The testing that has been performed by New York utilities since 2005 seeks to identify "Contact Voltage" as that term is defined by IEEE. Utilizing IEEE's definition of contact voltage to describe hazardous voltage that is not related to the normal delivery or use of electricity more accurately describes the situation and will avoid confusion by other states, utilities, and organizations who consult the Standards.

Suggested Revision to Section 1: Definitions, Paragraph (d)

Streetlights – The term "streetlights" means and includes utility– and municipal owned streetlights located on, along, or adjacent to public thoroughfares and areas and traffic signal poles and devices; it does not include privately-owned light fixtures, such as those located in private parking lots.

This paragraph should be revised to read: "*The term "streetlights" means and includes utility- and municipal owned metal pole streetlights located on, along, or adjacent to public thoroughfares and areas and metal pole traffic signal poles and metallic* devices*; it does not include privately-owned light fixtures, such as those located in private parking lots.*"

This clarification, to include the "metal pole" specification, is proposed in order to formalize current testing practices arrived at through joint meetings with Staff and the Utilities.

[17] IEEE 100 7th Edition: Contact Voltage (human safety) (PE)[8],[84] (2000).

IV. COMMENTS REGARDING MOBILE STRAY VOLTAGE TESTING STATE-WIDE

Solicitation Of Comments On The Efficacy Of Mobile Testing On A Statewide Basis

The Utilities have several major concerns regarding to mobile testing on a state-wide basis. The upstate electric system consists primarily of overhead transmission and distribution facilities. Field demonstrations in overhead distribution areas have shown that mobile testing cannot be performed accurately in such areas due to electromagnetic fields created by overhead distribution facilities. Electromagnetic fields create interference that causes inaccurate readings from the instrument.

In addition, there is no clear specification which states the distance from overhead facilities that is required for accurate testing by the mobile test unit. Without a full specification, the Utilities cannot be confident that the mobile testing unit can be used in non-networked underground areas, which are often near overhead primary facilities.

The mobile stray voltage testing unit lacks clear specifications regarding accurate testing capabilities near overhead facilities, can be utilized in only a very limited territory that is not characteristic of the electric system in the large majority of the state (which consists primarily of overhead transmission and distribution facilities), and presents a significant cost for testing. For these reasons, the Utilities are opposed to its implementation statewide at this time. The Commission states in the Notice that mobile stray voltage testing technology is "not included as a revision to the Safety Standards at this time."[18] The Commission should maintain this approach given that the record lacks

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[18] Notice p. 2.

any basis for the Commission to implement statewide mobile stray voltage testing in an order to be issued on the Staff Proposal or otherwise.

V. REPORTING OF RESEARCH AND ANALYSIS

The New York utilities have compiled a number of reports pertaining to the efficacy of the testing and inspection programs and the potential safety and other benefits of the various testing and inspection activities. The three reports described below were prepared by the New York utilities' working group in an effort to better understand the practical and safety implications of certain elements of testing and inspection activities. The reports evaluate elements of the current programs and make recommendations on how the testing and inspection activities and schedules might be modified to increase the effectiveness of the programs. For example, based on the reports and significant additional experience gained implementing the programs, the Utilities have concluded, for example, that certain equipment could be effectively tested on a schedule that parallels facility inspections (e.g., 20% per year with 100% completed in each five year cycle).

Underground Residential Development ("URD") pad mounted study, provide by the NY Utilities working group January 2008. (Appendix 4)

In an effort to support modifications to the stray voltage testing requirements for pad mount transformers, the Utilities hereby resubmit for review by the Commission the research and data findings as documented in the attached Stray Voltage on Pad Mounted Transformers Report (Appendix 4).

A summary of the report findings indicates that several successive years of annual testing have demonstrated that the presence of stray voltage on pad mounted transformers is an uncommonly rare event. With over 300,000 stray voltage tests conducted on pad mounted transformers as of the date of the report, only two instances of stray voltage were found on the structures.

When examining the potential root causes of stray voltage on a pad mounted transformer, the inherent design of the transformer must be taken into account. In a typical configuration, the external housing of the pad mounted transformer is bonded to the secondary neutral, which is also bonded a ground pad or bus, which has two ground rods bonded to it as well. If a secondary fault occurs inside of the transformer, any current that would potentially energize the housing of the transformer should not pose a safety hazard as long as the ground rods and bonding are installed properly. The only potential for failure leading to stray voltage on the transformer should be due to improperly installed grounding or excessive corrosion in the ground bus. These conditions should be apparent during a periodic inspection of the transformer. If one of these deficiencies occurs, any stray voltage that may occur should be apparent from a post-installation stray voltage test.

In light of the years of experience and collected field data in regarding stray voltage testing in New York State, it is clear that an annual requirement to test for stray voltage on pad mounted transformers is excessive. Analysis of the data, combined with the inherent design of the transformers and existing periodic inspections, demonstrates that any potential safety benefit does not justify the cost of annual testing of these structures.

Transmission Line Neutral-to-Earth Voltage Analysis Final Report, dated December 14, 2007 (Appendix 5)

In an effort to support modifications to the transmission line structure annual stray voltage testing, the Utilities would like to resubmit for review Commission a research paper that was requested by Staff and previously submitted in December 2007.

Based on the findings of this study, testing these facilities does not provide a reasonable return (e.g., measurable safety benefit) for the significant cost investment. The requirement for continued annual testing of transmission facilities should be eliminated. Key findings from the study are listed below:

- A normal characteristic of transmission lines is that they induce voltages on nearby conductors.

- The combined effects of induced voltage and a circulating current (which adds an additional 5% to the induced voltage in a 69kVAC line and less than 10% in a 115kVAC line) can create a voltage from the pole neutral (tower/static wire) to earth of almost 25 VAC. These induced voltages are normal and not considered lethal to humans according to the 50 VAC limit described in OSHA Standard 1910.333, which deals with Safety Related Work Practices. Field measurements indicate that when the voltage is applied across a 500 ohm shunt resistor, it will collapse to below 5 VAC.

- The normal methods of reducing these voltages by applying expensive changes such as reducing substation ground resistance, reducing pole ground resistance, line re-design and even transposing the lines showed very limited benefits.

- These voltages are expected on virtually all transmission towers with no apparent human injuries or fatalities on conventional multi-grounded transmission static wire applications.

Joint Upstate Utilities Stray Voltage Tests and Findings Report (Appendix 6)

Attached is a report by the upstate utilities of all voltages found for the period 2005 through 2007. In summary, it is apparent that the percentage of voltages found above the 4.5 V_{AC} and 8 V_{AC} thresholds are minimal. The percentage of units tested with voltages greater than or exceeding 4.5 V_{AC} is 0.019% of the total. Meanwhile, the percentage of units testing over 8 V_{AC} is 0.011% of the total. Nearly 75% of voltages greater than 8 V_{AC} were detected on streetlights, which represent only 6% of the units tested. In addition, more than 80% of voltages detected in the 1 – 4.5 V_{AC} range were detected on distribution and transmission facilities, consistent with NEV and induced voltages discussed previously in this document. Based on these findings, a predominant focus should be placed on streetlights and traffic signal structures. In contrast, overhead distribution and pad mount transformers (Underground Residential Development) should be tested with the 5-year inspection cycle.

VI. SUMMARY

For the reasons stated herein, the Utilities respectfully request that the Commission modify the Staff Proposal and adopt the additional proposed revisions and clarifications to the Standards proposed by the Utilities.

Respectfully Submitted:

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Appendices

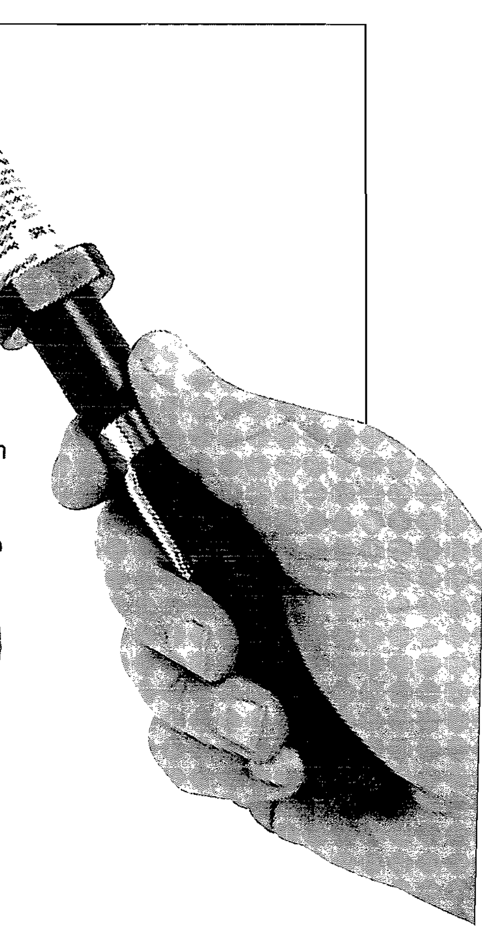
Appendix 1 - HD Detector Specification
Appendix 2 - Modified Appendix B: Summary of Stray Voltage Findings
Appendix 3 - Modified Appendix D: Summary of Deficiencies and Repair Activity
Appendix 4 - Stray Voltage on Pad Mount Transformer Report
Appendix 5 - Transmission System Report
Appendix 6 - Upstate Utilities Stray Voltage Tests and Findings Report

APPENDIX 1

Appendix 1

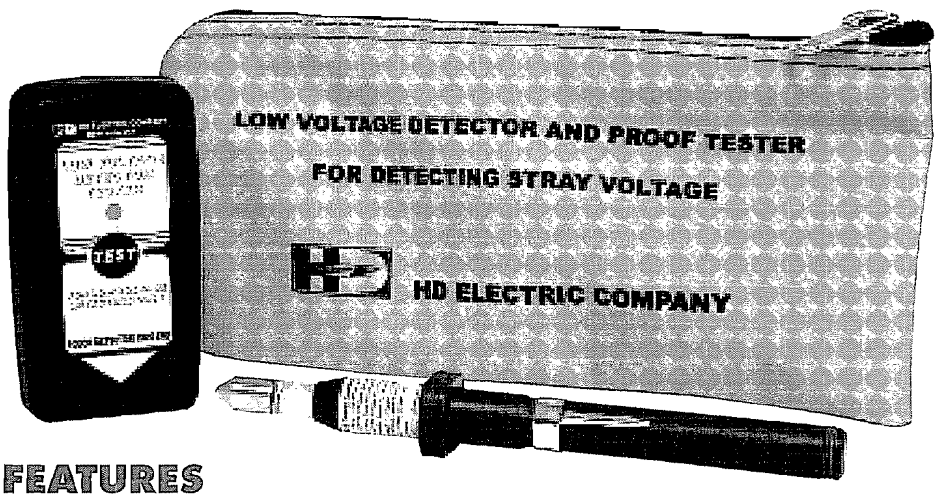
HD Detector Specification

STRAY VOLTAGE DETECTOR



HD Electric's Stray Voltage Detector, model LV-S-5, detects extremely low stray voltages which may be present within electrically conductive sources. The Detector operates by holding it with a bare or gloved hand, or by using the optional Extension Handle, creating a "virtual ground" and directly contacting the metal tip of the Detector to the potentially energized source.

Three optional accessories are available for the LV-S-5. The Detector Tester supplies a low voltage AC signal for testing the LV-S-5 before and after use. The Extension Handle extends the reach of the LV-S-5, allowing the Tester to test equipment on the ground or hard to reach locations. The Ground Shield is used in areas where high voltage lines or other energized conductors are present which prevent the LV-S-5 from giving normal voltage tests.



FEATURES

- Low threshold voltage sensing design picks up voltages from 5 VAC to 600 VAC with direct contact and above 600 VAC at a distance
- Ultra bright, long-lasting, red LED indicates when voltage is present
- Detector is always on, ready to use, and operates on two AAA alkaline batteries
- Rugged, utility-grade design is waterproof
- Optional Detector Tester supplies a low voltage AC signal for testing before and after use
- Rugged carrying bag holds one LV-S-5 Detector and one Tester; offered as optional accessory
- Optional Extension Handle extends the reach of the Tester for testing equipment on or near the ground or other hard to reach locations
- Optional Ground Shield used in areas where energized conductors are present and interfere with normal voltage tests

®

HD ELECTRIC COMPANY

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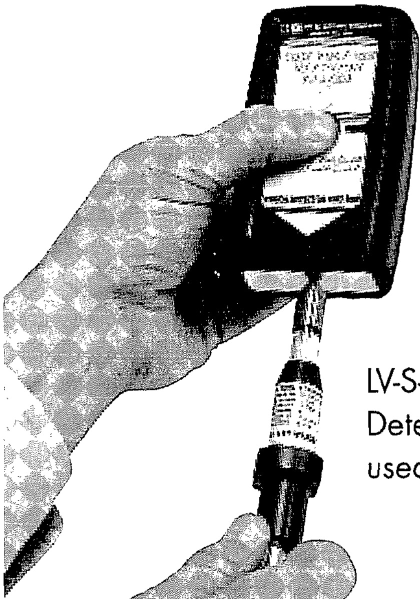
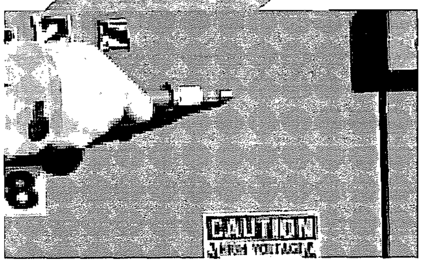
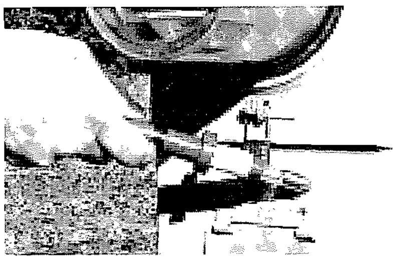
LV-S-5 VOLTAGE DETECTOR



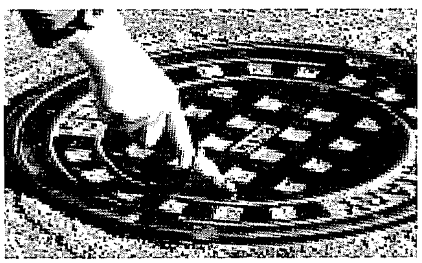
LV-S-5 Voltage Detector being used with Tester.



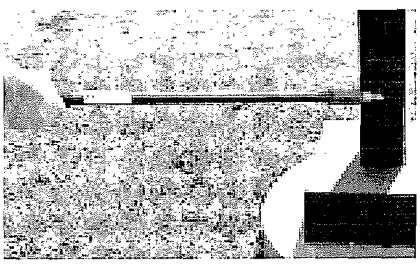
Testing pad mount transformer enclosure.



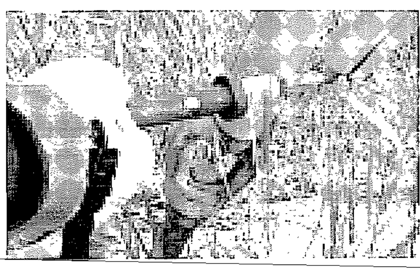
Testing a meter pedestal.



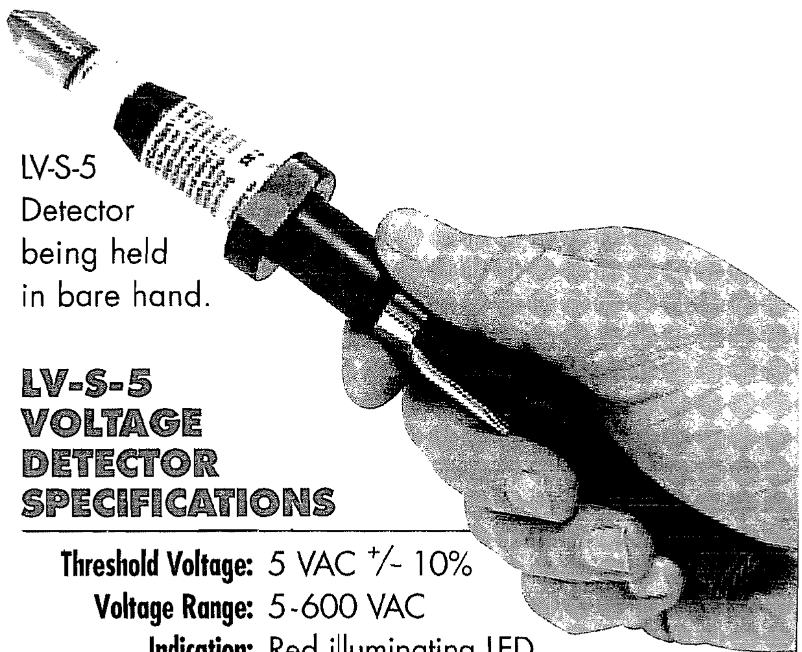
Testing manhole cover.



Testing street light cover with extension handle.



Testing anchor on a power pole.

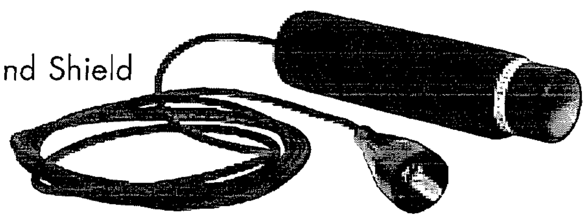


LV-S-5 Detector being held in bare hand.

LV-S-5 VOLTAGE DETECTOR SPECIFICATIONS

Threshold Voltage:	5 VAC +/- 10%
Voltage Range:	5-600 VAC
Indication:	Red illuminating LED sealed in plastic
Power Supply:	2 AAA alkaline batteries
Contact Requirements:	Direct metal-to-metal
Class Rating:	Category IV tested
Voltage Withstand:	600 VAC
Testing Certification:	Independent Lab tested for rated threshold voltage

Ground Shield



ORDERING INFORMATION

LV-S-5	Stray Voltage Detector
PT-LV-5	Tester for Stray Voltage Detector
EH-LV	Extension Handle, 30" long
GS-LV	Ground Shield with ground lead and alligator clip
B-25	Carrying Bag for LV-S-5 and PT-LV-5
LV-S-5/K01	Stray Voltage Detector Kit, includes LV-S-5, PT-LV-5, B-25

CAUTIONS/WARNINGS: For use by trained personnel only Do not use this Detector except as directed Applying this Detector to energized circuits or equipment above 600 VAC may lead to electric shock, severe injury or death Have a complete understanding and knowledge of working conditions, practices, regulations and operating instructions prior to use Refer all servicing to the factory

All sales are subject to the terms and conditions of the Limitation of Warranty and Liability set forth in the product Instruction Manual and at www HDElectricCompany com Users must read and agree to the Limitation terms, as stated, before using the product

HD Electric Company is committed to ongoing review and improvement of its product lines, and thus reserves the right to modify product design and specifications without notice

HD Electric Company products are available through HD sales representatives worldwide

APPENDIX 2

Appendix 2

Modified Appendix B: Summary of Stray Voltage Findings

Summary of Voltage Findings

	Findings from 4.5 to 24.9 VAC	Findings 25 VAC and above	Totals
Distribution Facilities	-	-	-
Pole	-	-	-
Ground	-	-	-
Guy	-	-	-
Riser	-	-	-
Other	-	-	-
Underground Facilities	-	-	-
Service Box	-	-	-
Manhole	-	-	-
Padmount Switchgear	-	-	-
Padmount Transformer	-	-	-
Vault – Cover/Door	-	-	-
Pedestal	-	-	-
Other	-	-	-
Utility/Non-Utility Street Lights / Traffic Signals	-	-	-
Metal Street Light Pole	-	-	-
Traffic Signal Pole	-	-	-
Control Box	-	-	-
Pedestrian Crossing Pole	-	-	-
Other	-	-	-
Substation Fences	-	-	-
Fence	-	-	-
Other	-	-	-
Transmission	-	-	-
Lattice Tower	-	-	-
Pole	-	-	-
Ground	-	-	-
Guy	-	-	-
Other	-	-	-
Non-Utility Owned Facilities	-	-	-
Sidewalk	-	-	-
Gate/Awning/Fence	-	-	-
Traffic Sign	-	-	-
Scaffolding	-	-	-
Bus Shelter	-	-	-
Fire Hydrant	-	-	-
Phone Booth	-	-	-
Traffic Control Box	-	-	-
Water Pipe	-	-	-
Riser	-	-	-
Other	-	-	-

APPENDIX 3

Appendix 3

Modified Appendix D: Summary of Deficiencies and Repair Activity

Visual Inspection Program

CASE 04-M-0159

APPENDIX D

Summary of Deficiencies and Repair Activity - Overhead Distribution

Deficiencies Identified	2009			2010			2011			2012			2013		
Priority Level	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Overhead Facilities/Poles															
Pole Condition	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Grounding System	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Anchors/Guy Wire	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Cross Arm/Bracing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Riser	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															

Visual Inspection Program

Summary of Deficiencies and Repair Activity - Overhead Distribution

Deficiencies Identified	2009			2010			2011			2012			2013		
Priority Level	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Conductors															
Primary Wire/Broken Ties	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Secondary Wire	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Neutral	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Insulators	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Pole Equipment															
Transformers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Cutouts	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Lightning Arrestors	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															

Visual Inspection Program

Summary of Deficiencies and Repair Activity - Overhead Distribution

Deficiencies Identified	2009			2010			2011			2012			2013		
Priority Level	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Miscellaneous															
Trimming Related	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Total															
Total	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired - Overdue	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Not Repaired - Not Due	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Not Repaired - Overdue	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Visual Inspection Program

CASE 04-M-0159

APPENDIX D

Summary of Deficiencies and Repair Activity - Transmission

Deficiencies Identified	2009			2010			2011			2012			2013		
Priority Level	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Transmission Facilities/Poles															
Pole/Steel Tower	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Anchors/Guy Wire	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Crossarm/Brace	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Grounding System	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Conductors															
Cable	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Static/Neutral	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															

Visual Inspection Program

Summary of Deficiencies and Repair Activity - Transmission

Deficiencies Identified	2009			2010			2011			2012			2013		
Priority Level	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Insulators	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Miscellaneous															
Right of Way Condition	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Total															
Total	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired - Overdue	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Not Repaired - Not Due	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Not Repaired - Overdue	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Visual Inspection Program

CASE 04-M-0159

APPENDIX D

Summary of Deficiencies and Repair Activity - Streetlights

Deficiencies Identified	2009			2010			2011			2012			2013		
Priority Level	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Base/Standard/Light	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Handhole/Service Box	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Service/Internal Wiring	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Access Cover	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Miscellaneous															
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Total															
Total	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired - Overdue	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Not Repaired - Not Due	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Not Repaired - Overdue	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Visual Inspection Program

CASE 04-M-0159

APPENDIX D

Summary of Deficiencies and Repair Activity - Underground Structures

Deficiencies Identified	2009			2010			2011			2012			2013		
Priority Level	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
UG Structure															
Damaged Cover	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Damaged Structure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Congested Structure	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Damaged Equipment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															

Visual Inspection Program

Summary of Deficiencies and Repair Activity - Underground Structures

Deficiencies Identified	2009			2010			2011			2012			2013		
Priority Level	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Conductors															
Primary Cable	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Secondary Cable	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Neutral Cable	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Racking Needed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Miscellaneous															
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Total															
Total	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired - Overdue	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Not Repaired - Not Due	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Not Repaired - Overdue	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Visual Inspection Program

CASE 04-M-0159

APPENDIX D

Summary of Deficiencies and Repair Activity - Pad Mount Transformers

Deficiencies Identified	2009			2010			2011			2012			2013		
Priority Level	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Padmounts															
Cable Condition	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Off Pad	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Oil Leak	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Lock/Latch/Penta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Structure Integrity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															
Miscellaneous															
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame															
Repaired - Overdue															
Not Repaired - Not Due															
Not Repaired - Overdue															

Visual Inspection Program

Summary of Deficiencies and Repair Activity - Pad Mount Transformers

Deficiencies Identified	2009			2010			2011			2012			2013		
Priority Level	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Total															
Total	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired in Time Frame	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repaired - Overdue	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Not Repaired - Not Due	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Not Repaired - Overdue	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Visual Inspection Program

Summary					
	Total	Repaired In Time Frame	Repaired - Overdue	Not Repaired - Not Due	Not Repaired - Overdue
2009	-	-	-	-	-
Level I	-				
Level II	-				
Level III	-				
2010	-	-	-	-	-
Level I	-				
Level II	-				
Level III	-				
2011	-	-	-	-	-
Level I	-				
Level II	-				
Level III	-				
2012	-	-	-	-	-
Level I	-				
Level II	-				
Level III	-				
2013	-	-	-	-	-
Level I	-				
Level II	-				
Level III	-				

APPENDIX 4

Appendix 4

Stray Voltage on Pad Mount Transformer Report

Stray Voltage on Pad Mounted Transformers Report

With years of experience and collected field data in regards to stray voltage testing in the state of New York, it is the unified opinion of the regulated New York electric utilities that annual requirement to test for stray voltage on URD pad mounted transformers is excessive in ensuring the safety of the public from stray voltage on these structures. Analysis of the data, combined with the inherent design of the transformers and existing periodic inspections, provides ample evidence that annual testing of these structures is not an effective use of utility and ratepayer expense.

Several successive years of annual testing have shown that the presence of stray voltage on pad mounted transformers is a rare event. Attachment 1 shows the number of stray voltage tests conducted on pad mounted transformers by the NY Upstate utilities from 2005 through the summer of 2007. With over 300,000 stray voltage tests conducted on pad mounted transformers over the period, only two instances of stray voltage were found on the structures. One of those instances was caused by a bad neutral connection on a distribution overhead pole, not with the pad mounted transformer itself. The other was caused by faulty customer wiring, and was not related to the pad mounted transformer.

When examining the potential root causes of stray voltage on a pad mounted transformer, the inherent design of the transformer must be taken into account. In a typical configuration, the external housing of the pad mounted transformer is bonded to the secondary neutral, which is also bonded a ground pad or bus, which has two ground rods bonded to it as well. If a secondary fault occurs inside of the transformer, any current that would potentially energize the housing of the transformer should not pose a safety hazard so long as the ground rods and bonding are installed properly. The only potential for failure leading to stray voltage on the transformer should only be due to improperly installed grounding or excessive corrosion in the ground bus. These issues should be apparent during a periodic inspection of the transformer. If one of these deficiencies occurs, any stray voltage that may occur should be apparent from a post-installation stray voltage test.

Life expectancy of the transformer must also be considered in regards to the potential of stray voltage on the unit, due to the possibility of stray voltage conditions occurring when there is a failure. According to ANSI/IEEE standard C57.91-1981, a pad mounted unit should have a normal life expectancy of 20 years, given normal loading circumstances (see Attachment 2 for details). Potential issues that may cause stray voltage on transformers, as stated in the previous section, should be detected with periodic inspections.

Attachment 3 categorizes the issues that were designated for repair from the New York electric utilities' periodic inspection program. From these inspections, the only issue that could potentially cause a stray voltage condition would be 'Damaged Grounds'. Of the 2,488 issues that were found through these inspections, only 17 damaged grounds conditions were found, and none were critical 'Level 1' conditions that needed immediate repair. Details regarding condition levels are contained in Attachment 4.

Based on reviewing the available data and design information in combination with the rarity of occurrences of stray voltage detected on pad mounted transformers, it is the opinion of the regulated New York electric utilities that annual testing of pad mounted transformers for stray voltage is an excessive effort, and the resources devoted to this effort may be better utilized for other public safety initiatives.

Attachment 1
Summary of Pad Mounted Transformer Testing, NY Regulated Utilities

New York State Regulated Utilities

Summary Report of Padmount Transformer Testing

2005 - 2007	Total Padmounts Tested	Stray Voltage Findings	Failure Rate
Test Year 2005	131,630	0	0%
Test Year 2006	115,453	1*	0.001%
Test Year 2007 (as of 8/31/07)	57,671	1**	0.002%
Total	304,754	2	0.001%

* This elevated voltage was the result of a bad neutral connection on a distribution pole, and was not caused by the padmounted transformer.

** The voltage found on the transformer was from a customer owned driveway lighting circuit that had a broken conduit and exposed conductors.

Attachment 2
ANSI/IEEE standard C57.91-1981

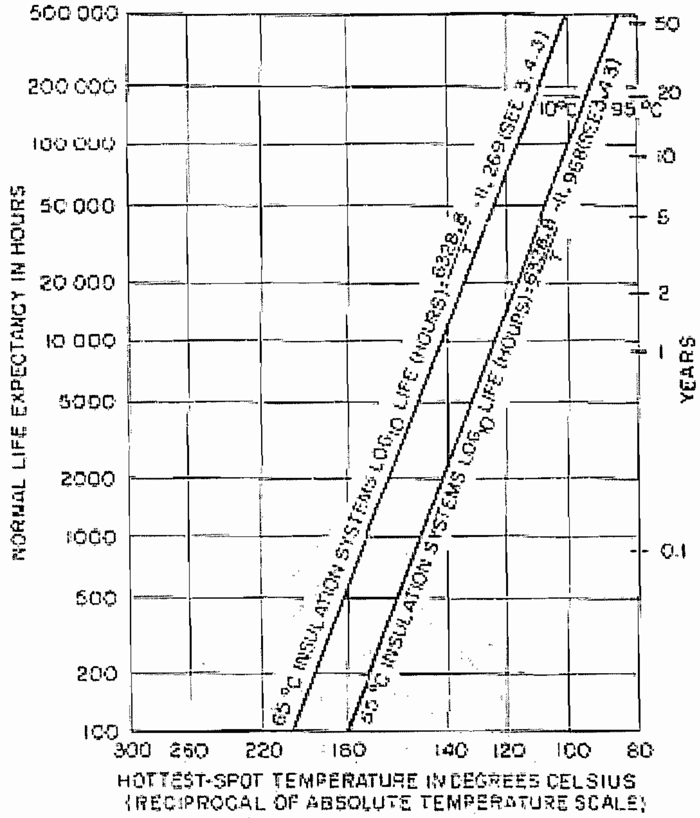


Fig 1
Life Expectancy Curve

perature and time follows an adaptation of the Arrhenius reaction rate theory which states that the logarithm of insulation life is a function of the reciprocal of absolute temperature:

$$\log_{10} \text{life(h)} = A + \frac{B}{T} \qquad \text{(Eq 1)}$$

where

T = absolute temperature in degrees kelvin, $= \theta_{hs} + 273$ (as shown in Eq 14) where θ_{hs} equals the temperature at the hottest-spot

A and B = constants for appropriate life expectancy curve

For the 65 °C insulation systems

A = −11.269 B = 6328.8

For the 55 °C insulation systems

A = −11.968 B = 6328.8

3.5 Transformer Life Expectancy

3.5.1 Transformer life expectancy at any operating temperature is not accurately known, but the information given regarding loss of insulation life at elevated temperatures is considered to be conservative and the best that can be produced from present knowledge of the subject. The effects of temperature on insulation life are being investigated continuously, and new data may affect future revisions of this guide. The word *conservative* as used above is used in the sense that the expected loss of insulation life for a single overload cycle will not be greater than the amount stated.

3.5.2 Because the cumulative effects of temperature and time in causing deterioration of transformer insulation are not thoroughly established, it is not possible to predict with any great degree of accuracy the length of life of a transformer even under constant or closely controlled conditions, much less under widely varying service conditions.

Deterioration of insulation is generally characterized by a reduction in mechanical strength and in dielectric strength, but these characteristics may not necessarily be directly related. In some cases, insulation in a charred condition will have sufficient insulating qualities to withstand normal operating electrical and mechanical stresses. A transformer having insulation in this condition may continue in service for many months or even years, if undisturbed. On the other hand, any unusual movement of the conductors, such as may be caused by expansion of the conductors due to heating resulting from a heavy overload or to large electromagnetic forces resulting from short circuit, may disturb the mechanically weak insulation such that turn-to-turn or layer-to-layer failure will result.

3.5.3 The recommendations of this guide are based upon the life expectancy curves of Fig 1 which relate to the insulation system, but do not account for such factors as deterioration of gaskets, rusting of tanks, etc. which are induced by exposure to the elements of the weather in normal operations.

3.5.4 Normal Life Expectancy.

(1) The basic loading of a transformer for normal life expectancy is continuous loading at rated output when operated under normal service conditions as indicated in 4.1.6(1) and 4.1.6(2) of ANSI/IEEE C57.12.00-1980 [1]. It is assumed that operation under these conditions is equivalent to operation in a constant 30 °C ambient. Normal life expectancy will result from operating continuously with hottest-spot conductor temperature of 110(95) °C or an equivalent cycle.

(2) The hottest-spot conductor temperature is the principal factor in determining life due to loading. This temperature cannot be directly measured on commercial designs because of the hazard in placing any temperature detector at the proper location because of voltage. The indicated allowances have therefore been obtained from tests made in the laboratory.

(3) The hottest-spot temperature at rated load is the sum of the average winding temperature and a hottest-spot allowance, usually 15(10)°C. For mineral oil-immersed transformers operating continuously under the foregoing conditions this temperature has been limited to a maximum of 110(95)°C.

(4) The normal life expectancy at a continuous hottest-spot temperature of 110(95) °C is 20 years as shown in Fig 1.

3.5.5 The many variables and, particularly, the many varying conditions of load and ambient to which a transformer can be subjected in service make it impossible to give definite rules for the loading of transformers. It is possible to give only suggested loadings under specified conditions, and look to the user to make the best use of this information for his particular problem.

3.6 Limitations

3.6.1 It must be recognized that when loading transformers above nameplate rating, other limitations may be encountered. Among these limitations are: oil expansion, pressure in sealed units, and the thermal capability of bushings, leads, tap changers or associated equipment such as cables reactors, circuit breakers, disconnecting switches, and current transformers. Any of these items may limit the loading and manufacturers should, therefore, be consulted before loading transformers above nameplate rating.

Operation at hottest-spot temperatures above 140 °C may cause gassing in the solid insulation and the oil. Gassing may produce a potential risk to the dielectric strength integrity of the transformer and this risk should be considered when the guide is applied.

3.6.2 Transformers are sometimes installed in subsurface manholes and vaults of minimum size with natural ventilation through roof gratings. This type of installation results in a higher ambient temperature than the outdoor air. The amount of increase depends on the design of the manholes and vaults, net opening area of the roof gratings, and the adjacent subsurface structures. Therefore, the increase in effective ambient temperature for expected

Attachment 3
Pad Mount Transformer Post-Inspection Repairs, NY Regulated Utilities

1/1/2005 – 8/31/2007

Repair Cause	*Central Hudson*	*Consolidated Edison*	*Orange & Rockland*	*National Grid*	*NYSEG*	*RGE*
Total Units Inspected	**13,698**	**2,417**	**12,721**	**45,898**	**16,077**	**10,023**
Bushings Broken/Cracked	**9**	**7**	**-**	**2**	**-**	**-**
Level 1	-	-	-	-	-	-
Level 2	-	7	-	1	-	-
Level 3	9	-	-	1	-	-
Door Broken	**20**	**-**	**5**	**129**	**-**	**64**
Level 1	16	-	-	8	-	1
Level 2	4	-	-	83	-	9
Level 3	-	-	5	38	-	54
Elbows tracking/burned	**-**	**-**	**-**	**-**	**-**	**3**
Level 1	-	-	-	-	-	2
Level 2	-	-	-	-	-	-
Level 3	-	-	-	-	-	1
Ground Damaged	**-**	**3**	**-**	**17**	**-**	**-**
Level 1	-	-	-	-	-	-
Level 2	-	3	-	11	-	-
Level 3	-	-	-	6	-	-
Oil Weeping	**29**	**-**	**65**	**109**	**-**	**52**
Level 1	-	-	11	2	-	11
Level 2	-	-	14	99	-	31
Level 3	29	-	40	8	-	10
Pad broken/Damaged	**108**	**69**	**414**	**184**	**1,075**	**187**
Level 1	43	-	28	6	42	5
Level 2	65	69	106	59	33	81
Level 3	-	-	280	119	1,000	101
Primary Damaged	**3**	**-**	**-**	**-**	**-**	**1**
Level 1	-	-	-	-	-	-
Level 2	3	-	-	-	-	1
Level 3	-	-	-	-	-	-
Misc	**16**	**13**	**24**	**-**	**-**	**6**
Level 1	-	7	9	-	-	-
Level 2	-	-	7	-	-	1
Level 3	16	6	8	-	-	5

Attachment 4
Description of Priority Levels for Joint Utility Pad Mount Report

High Priority:
Central Hudson: Severity 6
Con Edison: Tier 1A
Orange & Rockland: Priority Five
National Grid: E Priority
NYSEG: Level 1
RG&E: Level 1

Medium Priority:
Central Hudson: Severity 5
Con Edison: Tier 1B
Orange & Rockland: Priority Four
National Grid: A Priority
NYSEG: Level 2
RG&E: Level 2

Low Priority:
Central Hudson: Severity 4
Con Edison: Tier 2
Orange & Rockland: Priority Three
National Grid: B Priority
NYSEG: Level 3
RG&E: Level 3

Not Included in Joint Report Numbers:
Central Hudson: Severity 0 – 3
Orange & Rockland: Priority Two and One

Attachment 5
Description of Priority Levels for Each Utility

Central Hudson Explanation of Severity Levels

Severity 0 – Record Discrepancy

Severity 1 – Insignificant (No action needed)

Severity 2 – Very minor condition (No action needed at this time)

Severity 3 – Monitor for future action

Severity 4 – Serious condition (may cause an interruption of service or problem in future)

Severity 5 – Critical Condition (likely to cause an interruption)

Severity 6 – New in 2007 - This is an immediate response condition (immediate threat to life, property or interruption of service)

Con Edison Priority Classification

Tier 1A – Issues that must be repaired immediately upon discovery

Tier 1B – Issues that must be repaired on location if possible, or will be designated for follow up

Tier 2 – Recommendations made for future improvement

Orange & Rockland Priority Classification and Repair Schedule

Priority Five – Requires immediate notification to O&R field representative. Requires O&R crews to correct within 24hrs.

Priority Four – Requires correction within seven (7) days for O&R crews to repair and / or notification due to non-owned O&R equipment.

Priority Three – Condition that should be corrected as soon as manpower and system requirements permit.

Priority Two – Situation that should be evaluated as routine maintenance is performed.

Priority One – Condition that can be monitored and recorded. The repair and / or replacement are not a priority.

National Grid Explanation of Priority Levels

E Priority – An identified facility/component that must be replaced/repaired immediately to address public safety or system reliability. The inspector shall notify the appropriate operations department for immediate response and corrective action any time an E priority is found during an inspection.

A Priority – An identified facility/component or tree condition that must be repaired/replaced as soon as practicable.

B Priority – An identified facility/component condition that shall be considered for repair/replacement as the feeder is scheduled for maintenance by Distribution Planning and Engineering. These identified conditions will be corrected as preventive maintenance and or facility life extension.

NYSEG Description of Condition Levels

Level I Condition – A condition of any electrical equipment, device or structure on an electric transmission or distribution system, overhead or underground, that poses a serious and immediate threat to either the safety of the general public or the reliability of the electric transmission or distribution system. Such conditions shall require an immediate response by the appropriate maintenance and repair personnel to correct the situation.

Level II Condition – A condition of any electrical equipment, device or structure that, if not corrected for an extended period of time (6 months or more), could develop into a Level I Condition. Such conditions require a response within a 60 day period based on the evaluation of the inspector.

Level III Condition – A condition of any electrical equipment, device or structure that has deficiencies, but those deficiencies do not pose any risk to public safety or the reliability of the electric transmission or distribution system. These conditions can be corrected through normal electric system maintenance practices within 12 - 24 months based on the evaluation of the inspector.

RG&E Description of Condition Levels

Level I Condition – A condition of any electrical equipment, device or structure on an electric transmission or distribution system, overhead or underground, that poses a serious and immediate threat to either the safety of the general public or the reliability of the electric transmission or distribution system. Such conditions shall require an immediate response by the appropriate maintenance and repair personnel to correct the situation.

Level II Condition – A condition of any electrical equipment, device or structure that, if not corrected for an extended period of time (6 months or more), could develop into a Level I Condition. Such conditions require a response within a 60 day period based on the evaluation of the inspector.

Level III Condition – A condition of any electrical equipment, device or structure that has deficiencies, but those deficiencies do not pose any risk to public safety or the reliability of the electric transmission or distribution system. These conditions can be corrected through normal electric system maintenance practices within 12 - 24 months based on the evaluation of the inspector.

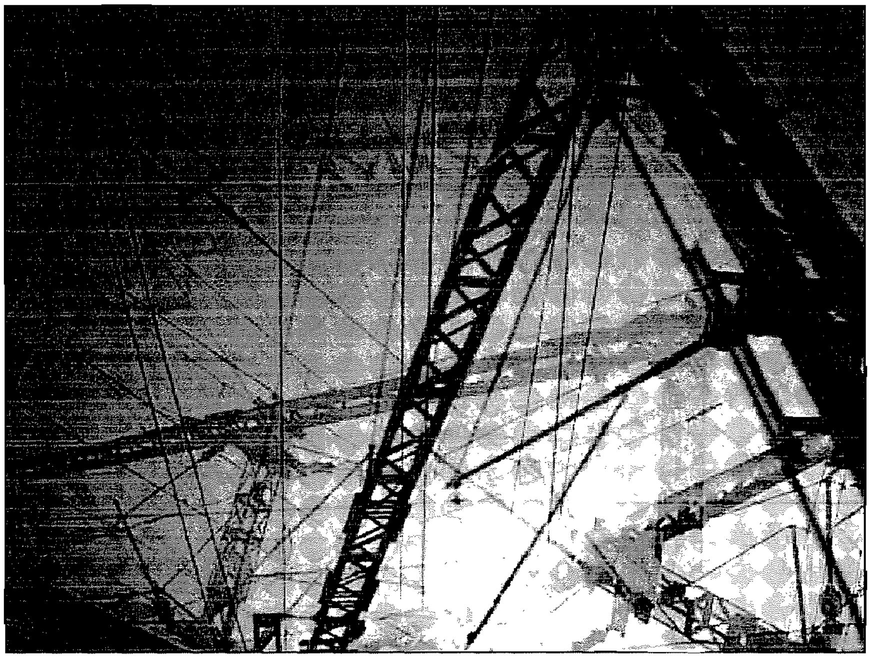
APPENDIX 5

Appendix 5

Transmission System Report

October 24, 2007

Transmission Line Neutral-to-Earth Voltage Analysis Final Report



Prepared for: **National Grid / Central Hudson Gas & Electric / Rochester Gas & Electric / New York State Electric & Gas**

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Table of Contents:

Executive Summary

On 12/15/04, the New York State Public Service Commission approved a comprehensive electric safety standard designed to ensure the public safety of electric systems. The safety standards include requirements that regulated electric utilities in New York State annually test all of their publicly accessible transmission and distribution facilities for stray voltage and inspect all their electric facilities at least once every 5 years.

One consequence of this standard is that regulated utilities are now obligated to test for voltages between any conductive transmission structure or device and the earth. The voltages found on these structures or devices are a result of induced voltages from the power line to the shield wire and circulating currents in the circuit resulting from normal voltage differences between substations.

A study was authorized by National Grid, Central Hudson Gas and Electric, Rochester Gas and Electric and New York State Electric and Gas to address the following issues:

1. What is the expected magnitude of these voltages?
2. What is the impact of standard mitigation practices?

Computer simulations were performed for both 69kV and 115kV transmission line models, as shown in Figure 1.

Detailed power system data was obtained from the participating utilities in an effort to provide digital calculations/computer simulations which would reflect actual field conditions. The worst case scenario simulated was for the 69kV line between Staatsburgh and East Park for an un-transposed line with circulating current caused by a 2kV voltage potential between the substations with a 20Ω pole grounding resistance. The results are shown in Figure 2 and indicate a voltage of almost 15V between the system static wire and the earth.

The 115kV line between the Rhinebeck Substation and the Milan Substation was also simulated. The example showed in Figure 3 shows results for both a transposed and un-transposed line having a circulating current resulting from the 2kV difference in substation voltage potential. This line has 125 poles at approximately 375 feet apart (about 9 miles long). The line has 5 different pole configurations and a substation impedance of 0.75Ω.

Two things are quite apparent in this figure. First, the neutral-to-earth voltage levels approach 25V. Secondly, the usually effective mitigation practice of transposing the line, while effective in some parts of the system, does not seem to effectively control the highest voltages between poles 70 and 80.

QUANTA TECHNOLOGY

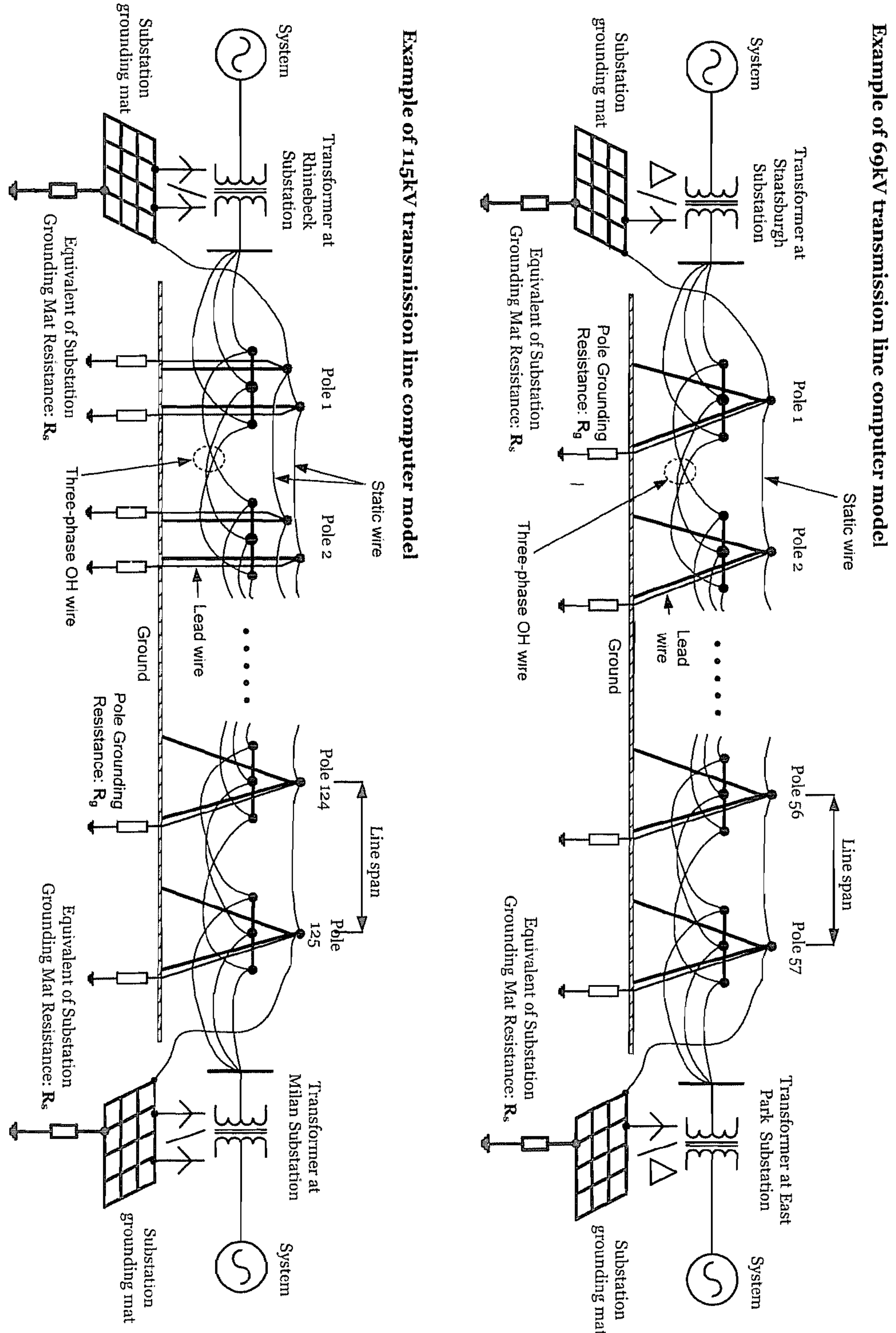


Figure 1: Example of models of 69kV and 115kV transmission lines.

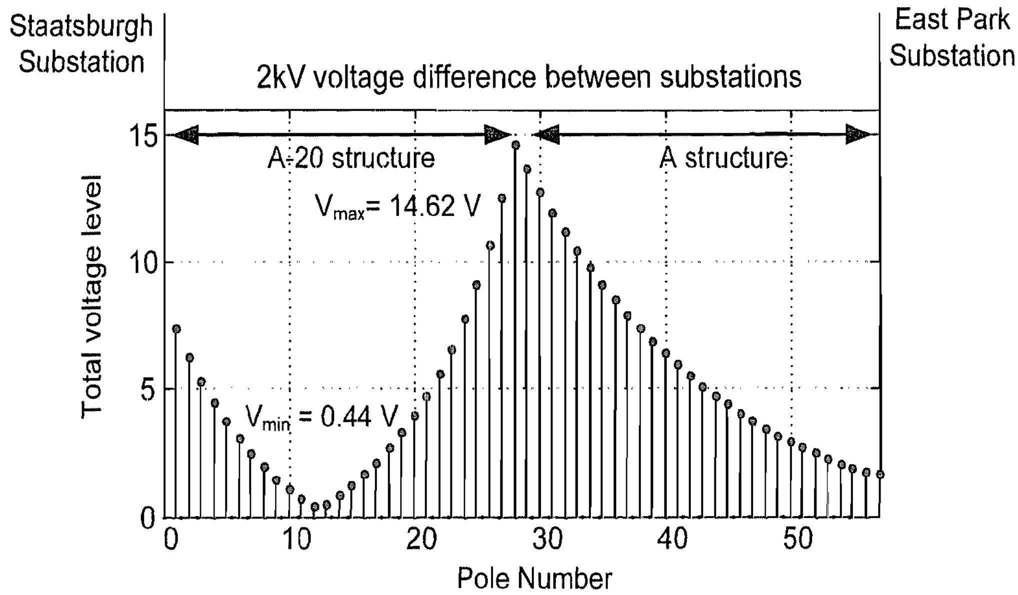


Figure 2: 69kV line between Staatsburgh and East Park substations.

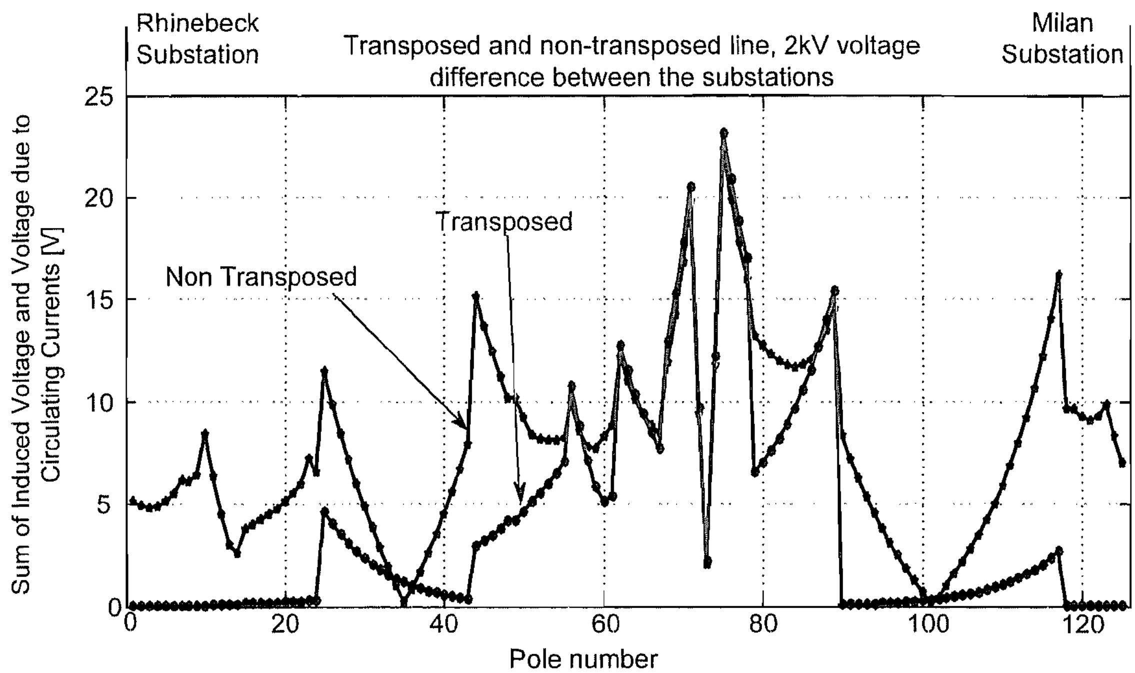


Figure 3: 115kV line between Rhinebeck and Milan substations.

Various other mitigating techniques were simulated (lower substation ground resistance, pole spacing, loading level, pole configuration, etc…) as shown in Appendix D of this report. Figure 4 shows the impact of changing the value of the pole grounding impedance. As shown below, improving the transmission pole grounds has very little impact on these voltage levels. These results confirm similar studies performed for the distribution system.

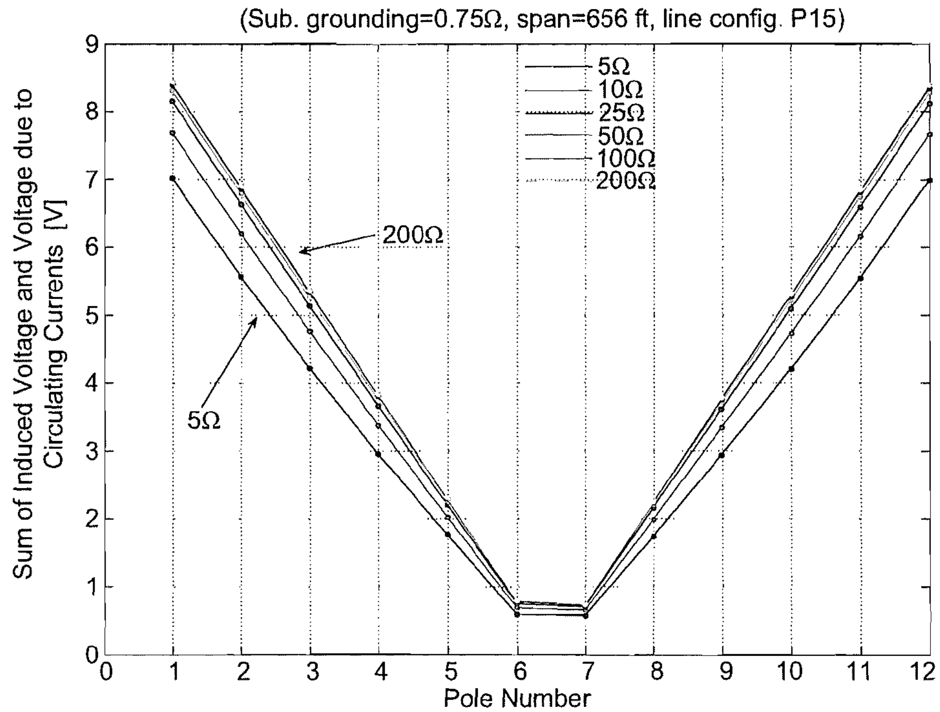


Figure 4: Impact of pole grounding on induced voltage levels.

In summary, unbalanced currents on transmission lines, caused by un-transposed lines and/or un-balanced loads, induce a voltage on parallel lines along the same right-of-way. Circulating currents resulting from potential differences do the same. These lines could be the static wire, communication facilities, neutrals or other transmission and distribution wires. Induced voltages are considered to be 60Hz and steady state so they manifest similar characteristics to "stray voltages". They are a normal characteristic of a utility system and sometimes cannot be mitigated without considerable cost. These voltages occur on 3 wire systems with a static wire—hence the argument that the 4 wire multi-grounded system is the culprit is simply not valid. Static wires are an integral part of the transmission system for protection against lightning flashover. These induced voltages are normal and not considered lethal to humans, since they are generally less than 25V (see study results). It would seem inappropriate to test for these voltage levels on transmission facilities, since the voltages are low level and these facilities (transmission towers, etc…) are not normally contacted by the public. The voltage level of 25V or less may, under certain conditions (wet, no shoes, etc…), present an uncomfortable situation, but is not considered lethal (per OSHA Standard 1910.333) and is generally avoidable, even for animals. Finally, the mitigation of these induced voltage levels is not trivial (as shown in the study) and requires considerable investments. This investment is questionable in light of the fact that we are unaware of any documented cases of induced voltages that have impacted human life. The factors that contribute to the level of induced voltages (none of which are easily altered) are:

- Currents in the transmission line conductors
- Transposition characteristics
- Proximity to other lines
- Length of the parallel section
- Soil resistivity

1. Introduction

This document presents the comprehensive results of induced voltage and voltage due to circulating currents in the circuit studies for the National Grid / Central Hudson Gas & Electric / Rochester Gas & Electric / New York State Electric & Gas transmission system. All computer simulations were performed based on the technical data provided and agreed to by each utility (real-time case situations).

2. Detail Results

2.1. Computer Models

For the purpose of this project, the project team defined and built a complete set of structural and electrical models *(Appendix B)* using the EMTP-RV program *(Appendix C)*, necessary to perform accurate computer simulations and studies. The models were tested for simulation accuracy reflecting real-time work conditions.

The computer models were created based on the circuit maps provided by Central Hudson and a standardized set of real-time system data agreed to by all the utilities participating in this project.

2.2. Transmission line: 69kV

Transmission line between ***Staatsgurgh and East Part Substations***, single circuit, 69kV nominal voltage (Figure 2.1.).

Simulated transmission subsystem

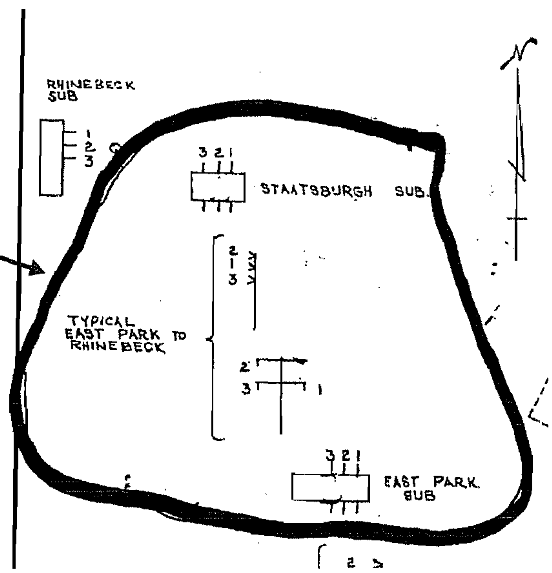


Figure 2.1. 69kV transmission line.

Real-time data provided by the utilities and the computer model assumption data used during computer simulations is provided in Table 2.1.

Table 2.1. Transmission grid data for 69kV line

Transmission Grid Data for 69kV Line	
Provided Information	
Number of poles/structures	57
Span length	375 feet
Structure types	28 poles: A-20 type, 29 poles: A type
Wire-wire, wire-ground spacing	Based on the standards provided by Central Hudson (Appendix C)
Line transposition	No/Yes
OH line type	
Phases	336.4 MCM ACSR 18/1 (Merlin)
Static	101.8 MCM ACSR 12/7 (Petral)
Lead	Solid CU #4
OH line impedance	Based on data from the specification document as indicated above
Static wire configuration	Continuous run between substations
	Grounded at each pole/structure
	Grounded to substation mat on both ends
Line loading	I=180A / phase
System balance	Case 1: 100% balanced
	Case 2: 2kV voltage difference between substations
Transformer Data	
Voltage	V=115kV/69kV for both substations
Configuration	Delta/Grounded Wye for both substations
Pole grounding resistance	R_g = 7Ω, 20Ω, Vary *(values: Table 2.2.)*
Equivalent of substation mat grounding resistance	R_s = 0.75Ω
Computer Model Assumptions	
Transformer Data	
Power	P = 50MW
Impedance	$\underline{Z}$ = (0.00375+j0.075) p.u.

The typical pole grounding resistance as provided by the utilities is shown in Table 2.2.

Table 2.2. Typical pole grounding resistance.

Typical Pole Grounding Resistance			
Pole number	***Resistance [Ω]***	***Pole number***	***Resistance [Ω]***
1	7.3	29	29.4
2	5.3	30	29.4
3	4.5	31	7.3
4	18.9	32	5.3
5	6.4	33	4.5
6	3.5	34	18.9
7	8.5	35	6.4
8	1.6	36	3.5
9	1.8	37	8.5
10	33.5	38	1.6
11	43.5	39	1.8
12	54.5	40	33.5
13	41	41	43.5
14	33.2	42	54.5
15	28.5	43	41
16	1.8	44	33.2
17	0.7	45	28.5
18	4	46	1.8
19	6.3	47	0.7
20	8.9	48	4
21	11.5	49	6.3
22	21.4	50	8.9
23	10.4	51	11.5
24	20.2	52	21.4
25	14.2	53	10.4
26	16.3	54	20.2
27	21.3	55	14.2
28	43.2	56	16.3
		57	21.3

2.2.1. Simulation Results

Measured values:

- Case 1: 100% system balance -- Induced voltage at each pole,
- Case 2: 2kV voltage difference between substations – Induced voltage and voltage due to circulating currents in the circuit at each pole.

Each simulation case includes voltage measurements for transposed and non-transposed transmission lines as well as changing values of pole grounding resistance (Table 2.2.).

a) Transposed transmission line, pole grounding resistance: 7Ω, 20Ω, vary (Table 2.2.), Case 1 and Case 2.

Voltage levels in this situation are negligible. Its value does not exceed 1.5×10^{-8} V.

b) Non-transposed transmission line, pole grounding resistance: 7Ω, Case 1 and Case 2.

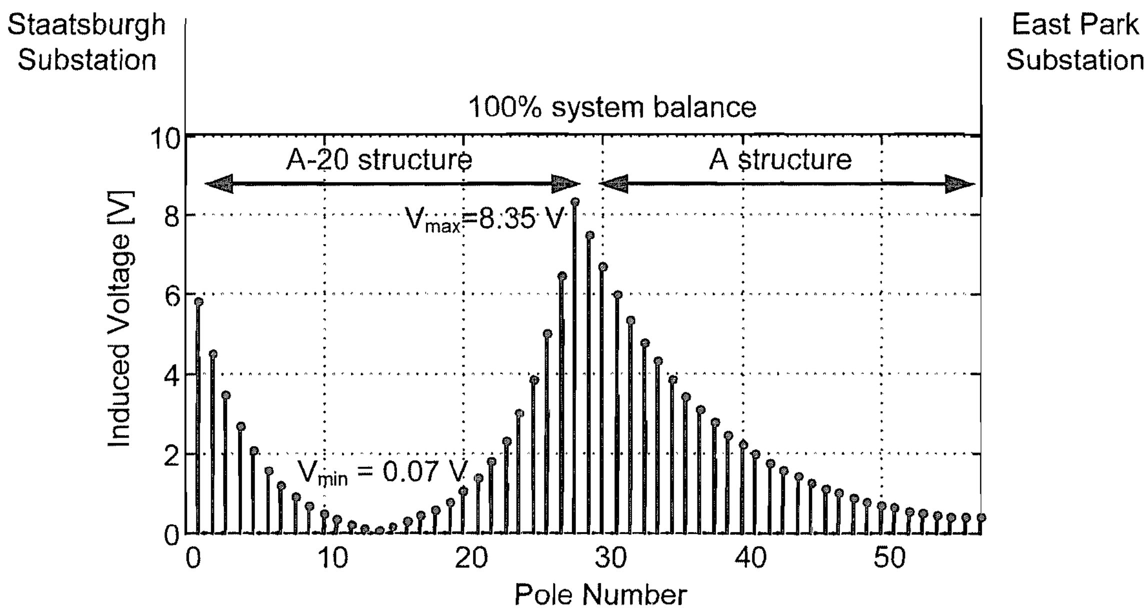


Figure 2.2. Case 1: Induced voltage.

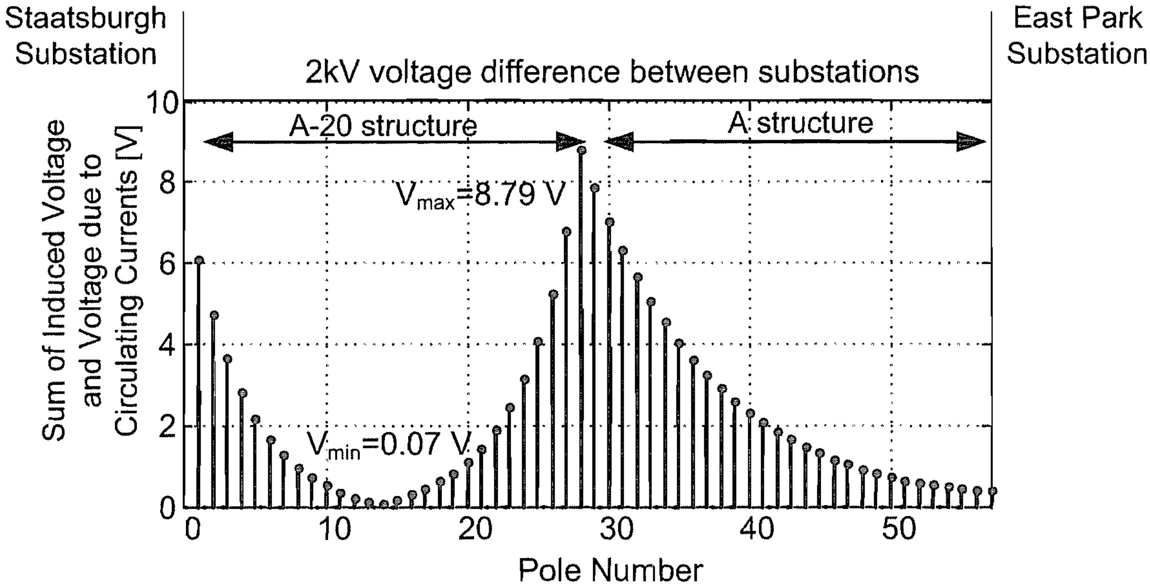


Figure 2.3. Case 2: Sum of induced voltage and voltage due to circulating currents.

Conclusions:

Maximum Voltage: V_{max}	8.79 V
Voltage increase due to circulating currents	~5%

c) Non-transposed transmission line, pole grounding resistance: 20Ω, Case 1 and Case 2.

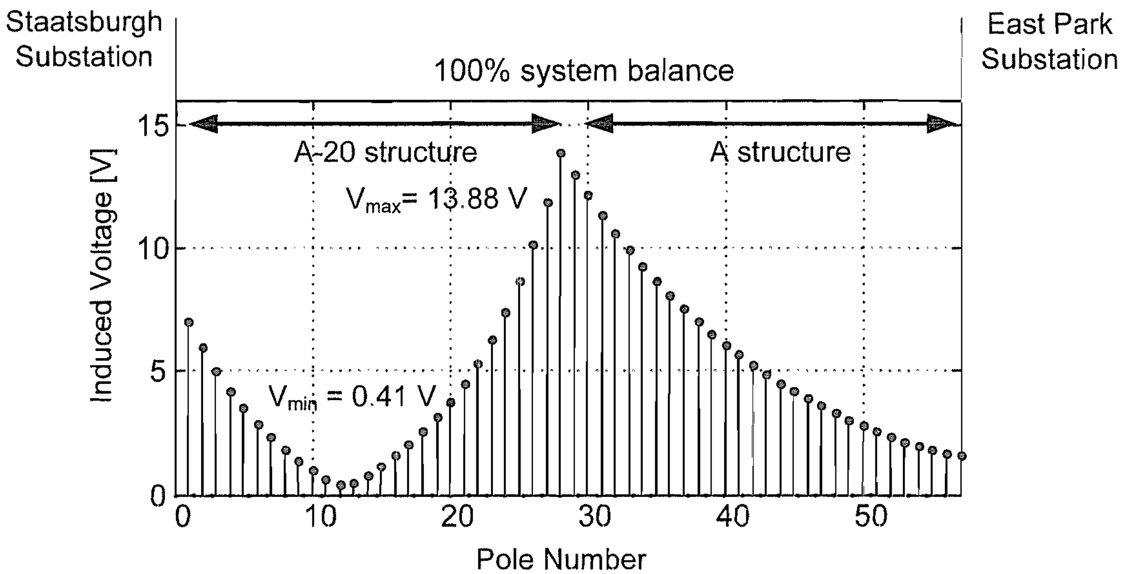


Figure 2.4. Case 1: Induced voltage.

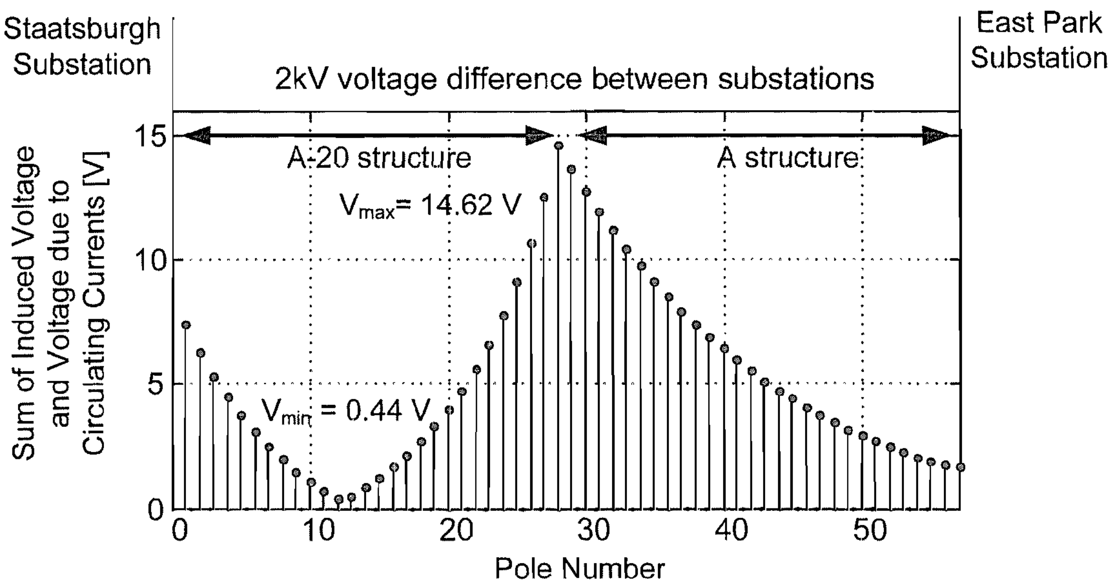


Figure 2.5. Case 2: Sum of induced voltage and voltage due to circulating currents.

Conclusions:

Maximum Voltage: V_{max}	14.62 V
Voltage increase due to circulating currents	~5%

d) Non-transposed transmission line, pole grounding resistance vary (Table 2.2.), Case 1 and Case 2.

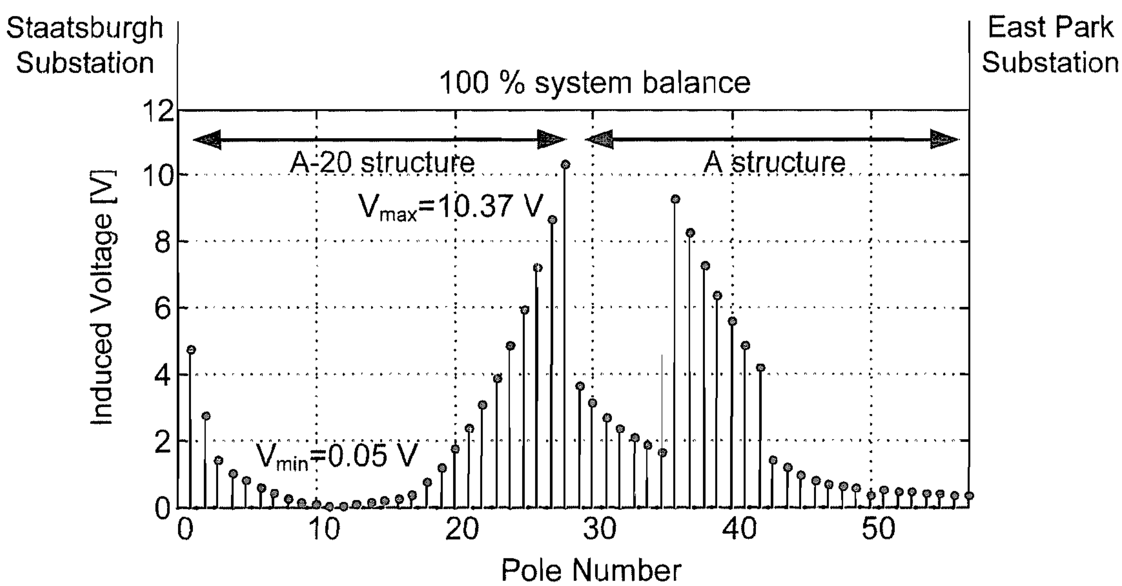


Figure 2.6. Case 1: Induced voltage.

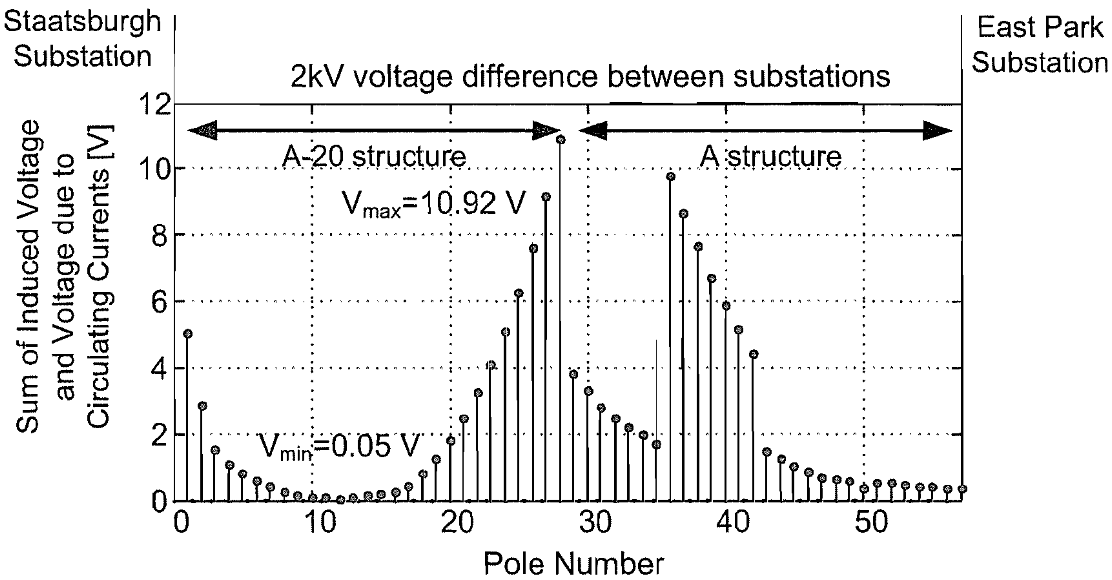


Figure 2.7. Case 2: Sum of induced voltage and voltage due to circulating currents.

Conclusions:

Maximum Voltage: V_{max}	10.92 V
Voltage increase due to circulating currents	~5%

2.3. Transmission line: 115kV

Transmission line between ***Rhinebeck and Milan Substations***, single circuit, 115kV nominal voltage (Figure 2.8.).

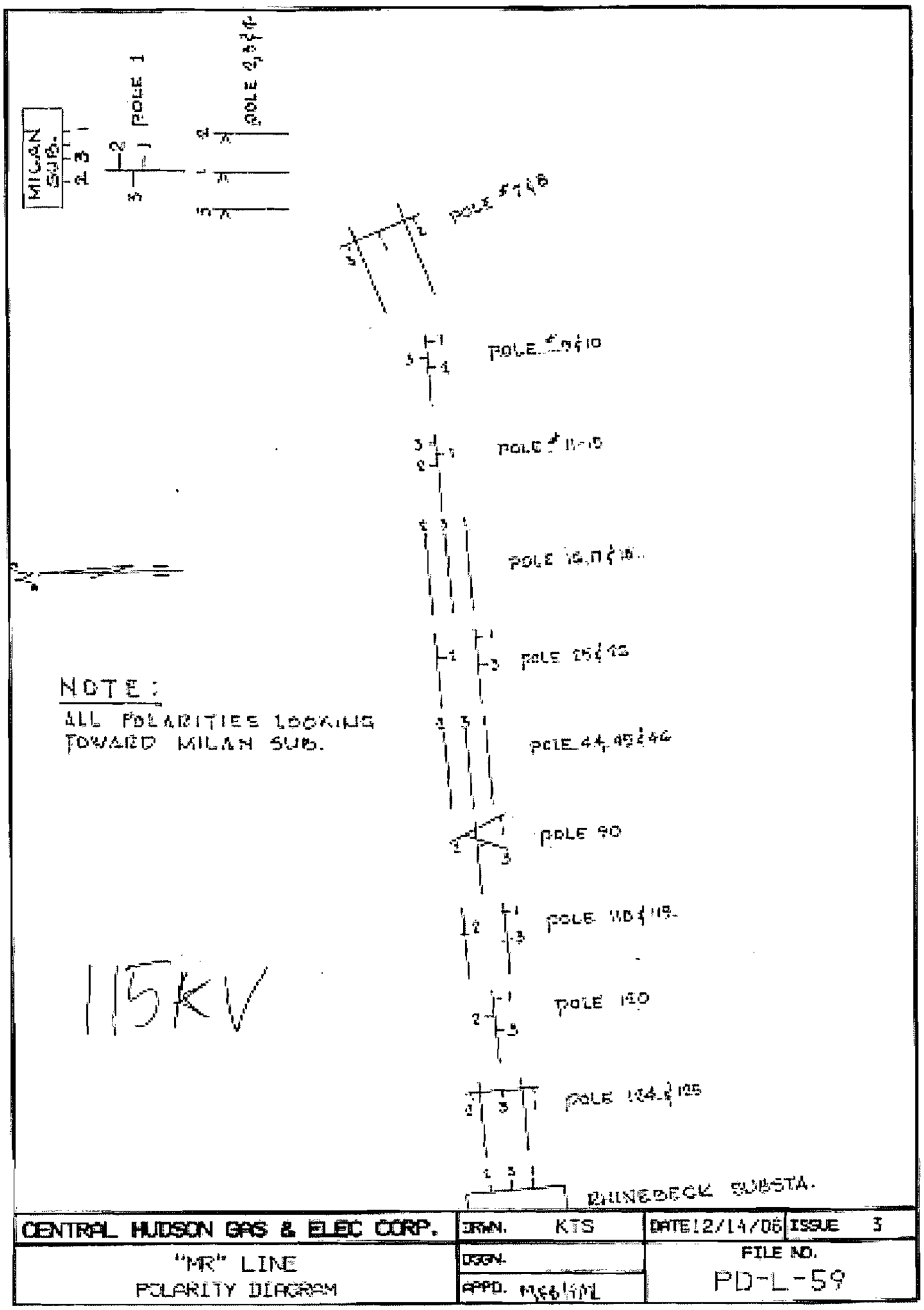


Figure 2.8. 115kV transmission line.

Real-time data provided by the utilities and the computer model assumption data used during computer simulations is provided in Table 2.3.

Table: 2.3. Transmission grid data for 115kV line.

Transmission Grid Data for 115kV Line	
Provided Information	
Number of poles/structures	125
Span length	375 feet
Structure types	5 different pole configurations: P-15, H-20, H, P-25, WT
Wire-wire, wire-ground spacing	Based on the standards provided by Central Hudson (Appendix C)
Line transposition	No/Yes
OH line type	
Phases	795 MCM ACSR 45/7 (Tern)
Static	101.8 MCM ACSR 12/7 (Petral)
Lead	Solid CU #4
OH line impedance	Based on data from specification document as indicated above
Static wire configuration	Continuous run between substations
	Grounded at each pole/structure
	Grounded to substation mat on both ends
Line loading	I=360A / phase
System balance	Case 1: 100% balanced
	Case 2: 2kV voltage difference between substations
Transformer Data	
Voltage	V=115kV/69kV for both substations
Configuration	Delta/Grounded Wye for both substations
Pole grounding resistance	R_g = 7Ω, 20Ω, Vary *(values: Table 2.4.)*
Equivalent of substation mat grounding resistance	R_s = 0.75Ω
Computer Model Assumptions	
Transformer Data	
Power	P = 80MW
Impedance	$\underline{Z}$ = (0.00375+j0.09) p.u.

Typical pole grounding resistance as provided by the utilities is shown in Table 2.4.

Table 2.4. Typical pole grounding resistance.

Typical Pole Grounding Resistance									
Pole number	***Resistance [Ω]***	***Pole number***	***Resistance [Ω]***	***Pole number***	***Resistance [Ω]***	***Pole number***	***Resistance [Ω]***	***Pole number***	***Resistance [Ω]***
1	7.3	31	7.3	61	7.3	91	7.3	121	7.3
2	5.3	32	5.3	62	5.3	92	5.3	122	5.3
3	4.5	33	4.5	63	4.5	93	4.5	123	4.5
4	18.9	34	18.9	64	18.9	94	18.9	124	18.9
5	6.4	35	6.4	65	6.4	95	6.4	125	6.4
6	3.5	36	3.5	66	3.5	96	3.5		
7	8.5	37	8.5	67	8.5	97	8.5		
8	1.6	38	1.6	68	1.6	98	1.6		
9	1.8	39	1.8	69	1.8	99	1.8		
10	33.5	40	33.5	70	33.5	100	33.5		
11	43.5	41	43.5	71	43.5	101	43.5		
12	54.5	42	54.5	72	54.5	102	54.5		
13	41	43	41	73	41	103	41		
14	33.2	44	33.2	74	33.2	104	33.2		
15	28.5	45	28.5	75	28.5	105	28.5		
16	1.8	46	1.8	76	1.8	106	1.8		
17	0.7	47	0.7	77	0.7	107	0.7		
18	4	48	4	78	4	108	4		
19	6.3	49	6.3	79	6.3	109	6.3		
20	8.9	50	8.9	80	8.9	110	8.9		
21	11.5	51	11.5	81	11.5	111	11.5		
22	21.4	52	21.4	82	21.4	112	21.4		
23	10.4	53	10.4	83	10.4	113	10.4		
24	20.2	54	20.2	84	20.2	114	20.2		
25	14.2	55	14.2	85	14.2	115	14.2		
26	16.3	56	16.3	86	16.3	116	16.3		
27	21.3	57	21.3	87	21.3	117	21.3		
28	43.2	58	43.2	88	43.2	118	43.2		
29	29.4	59	29.4	89	29.4	119	29.4		
30	29.4	60	29.4	90	29.4	120	29.4		

2.3.1. Simulation Results

Measured values:

- Case 1: 100% system balance -- Induced voltage at each pole,
- Case 2: 2kV voltage difference between substations – Induced voltage and voltage due to circulating currents in the circuit at each pole.

Each simulation case includes voltage measurements for transposed and non-transposed transmission lines as well as changing values of pole grounding resistance (Table 2.4.).

a) Transposed and non-transposed transmission line, pole grounding resistance: 7Ω, Case 1.

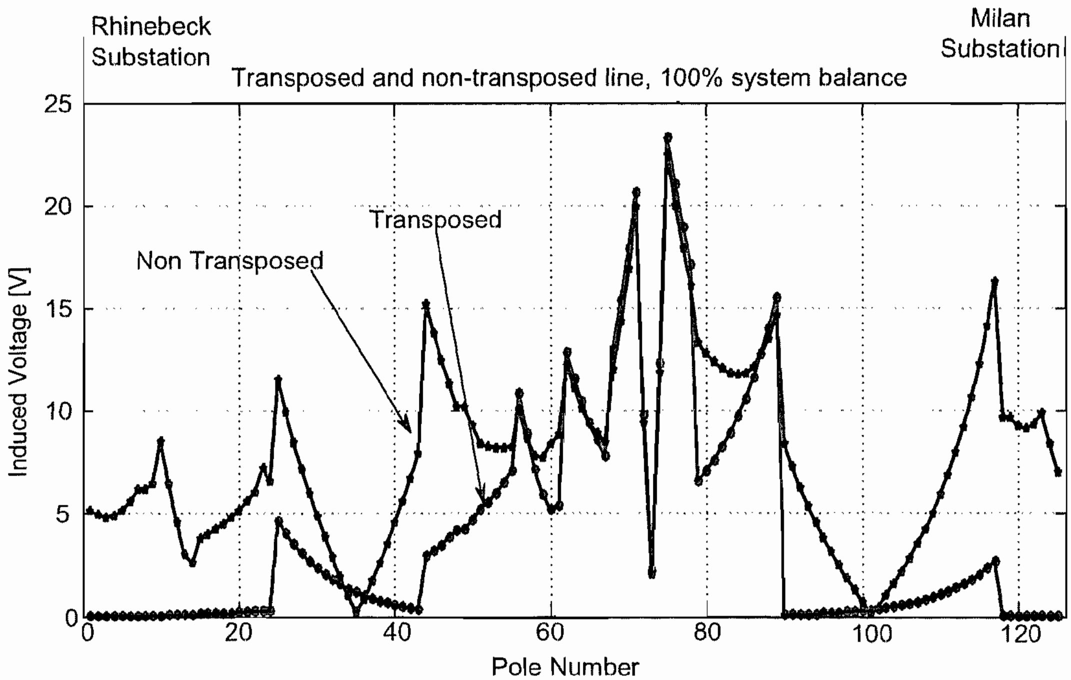


Figure 2.9. Case 1: Induced voltage.

b) Transposed and non-transposed transmission line, pole grounding resistance: 7Ω, Case 2.

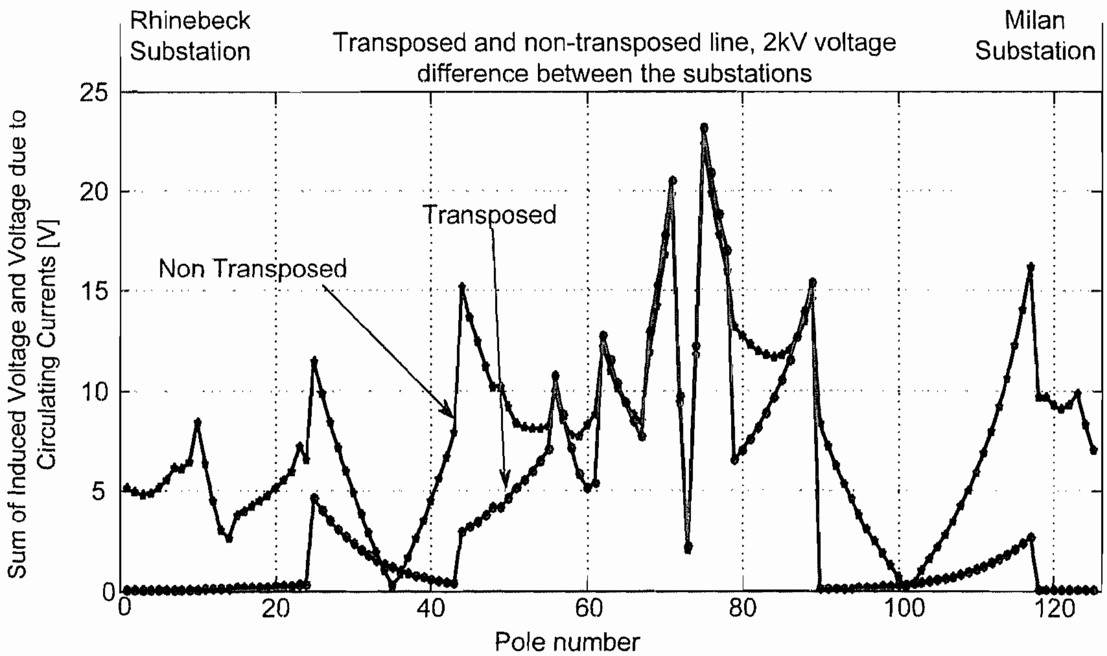


Figure 2.10. Case 2: Sum of induced voltage and voltage due to circulating currents.

c) Transposed and non-transposed transmission line, pole grounding resistance: 20Ω, Case 1.

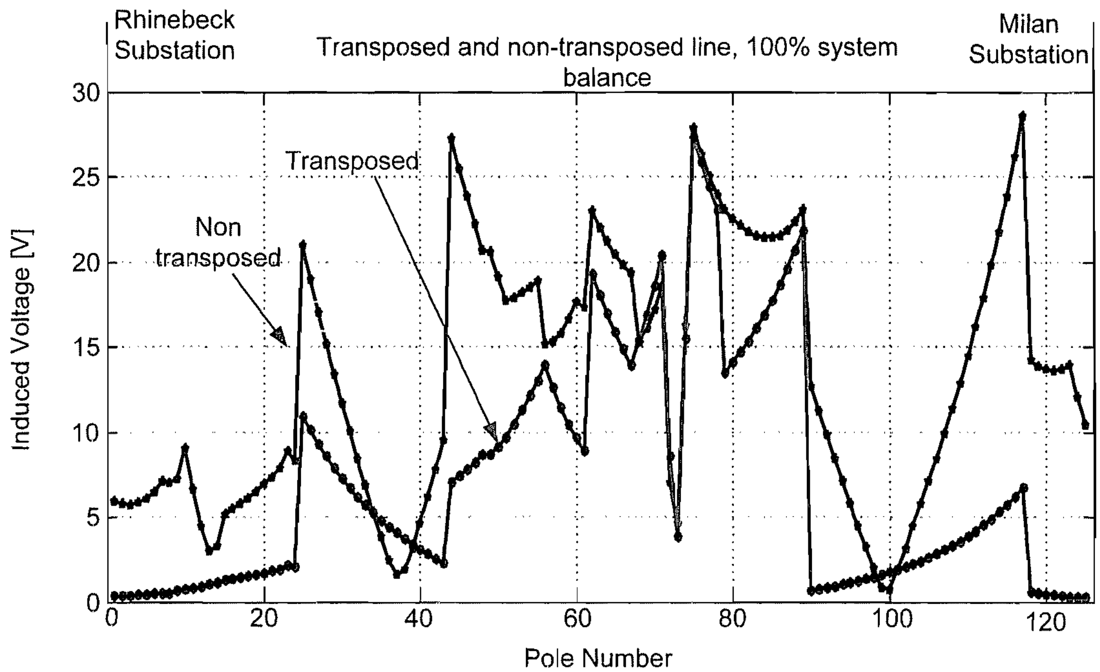


Figure 2.11. Case 1: Induced voltage.

d) Transposed and non-transposed transmission line, pole grounding resistance: 20Ω, Case 2.

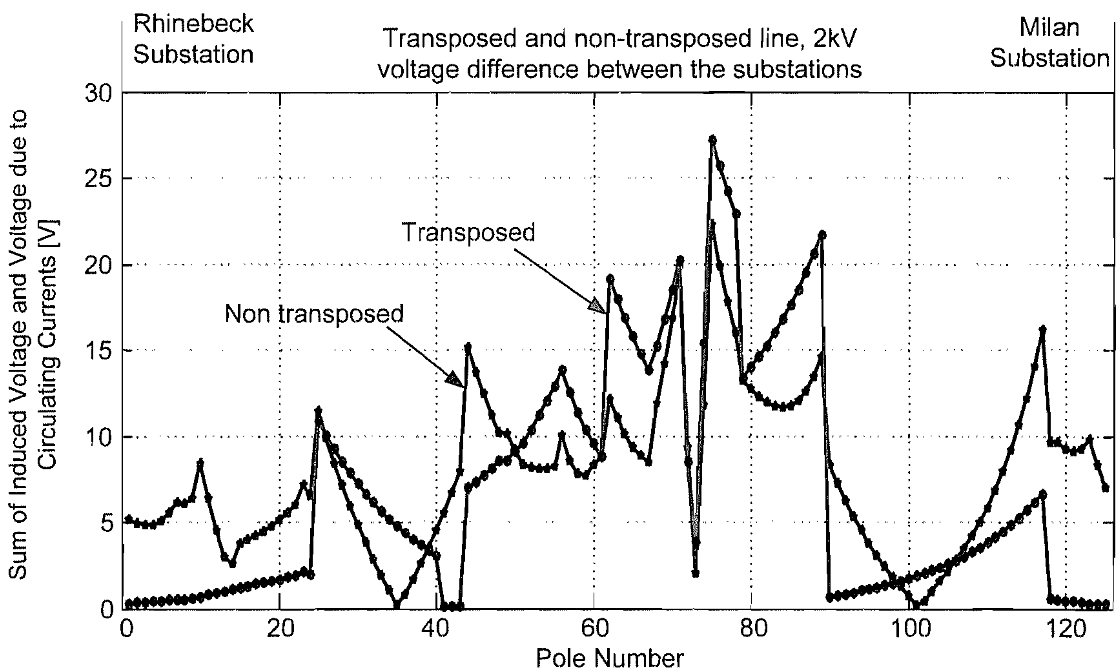


Figure 2.12. Case 2: Sum of induced voltage and voltage due to circulating currents.

e) Transposed and non-transposed transmission line, pole grounding resistance vary (Table 2.4.), Case 1.

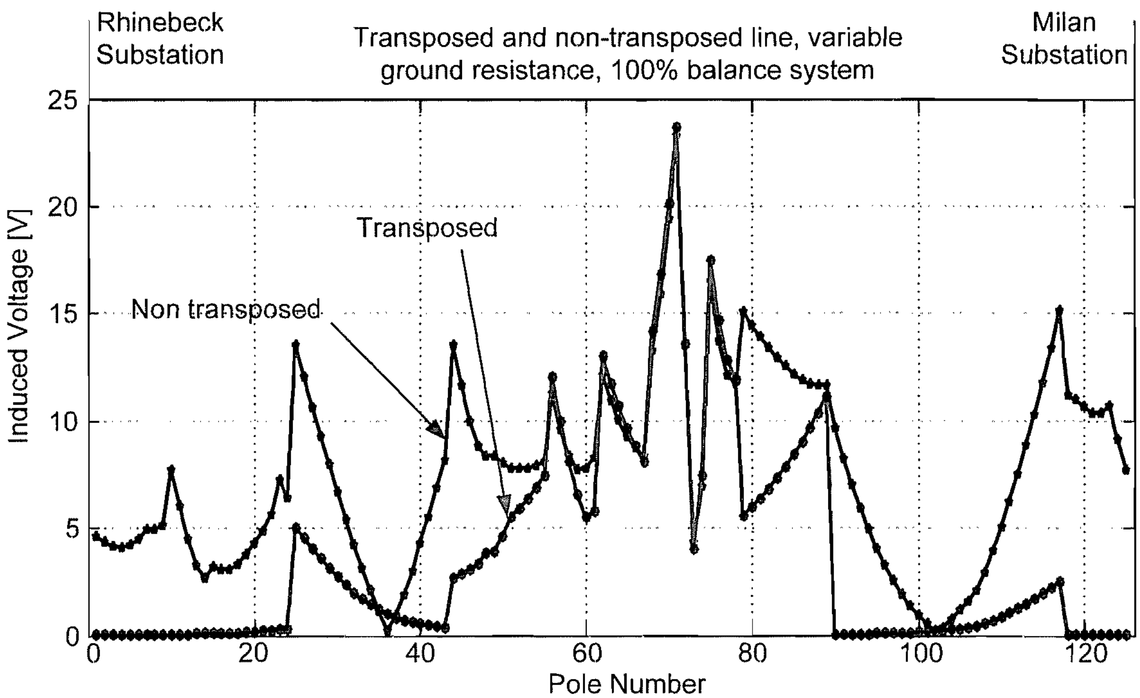


Figure 2.13. Case 1: Induced voltage.

Conclusions for the 115kV line:

For all simulated cases for the 115kV transmission line, the impact of the voltage due to circulating currents in the circuit on the induced voltage level is low and does not exceed 1% of the total voltage measured at each pole.

Line transposition does not effectively mitigate induced voltage along the whole length of the circuit. It can be noticed that between poles 50 and 90, induced voltage levels for the transposed line is similar, or in some locations, exceeds the value of induced voltage levels for the non-transposed line.

3. Report Conclusions

A normal characteristic of transmission lines is that they induce voltages on nearby conductors. The results of this study show that the combined effects of induced voltage and a circulating current (which adds an additional 5% to the induced voltage in a 69kV line and less than 1% in a 115kV line) can create a voltage from the pole neutral (tower/static wire) to earth of almost 25V. This voltage, while relatively high, is lower than the 50V limit described in OSHA Standard 1910.333, which deals with Safety Related Work Practices. The study also showed that the normal methods of reducing these voltages by applying expensive changes such as reducing substation ground resistance, reducing pole ground resistance, line re-design and even transposing the lines showed very limited benefit. These voltages would be expected to be on virtually all transmission towers throughout the world and have been on them since their inception with no apparent human injuries or fatalities. Based on the findings of this study, the cost of testing these facilities does not offset the significant costs currently associated with testing and attempts at mitigation for induced voltages.

QUANTA TECHNOLOGY

Appendix A: Historical Terminology Regarding Neutral-to-Earth Voltages

I. Introduction

Over the past 40 years, the IEEE has not formally defined terminology related to neutral-to-earth voltages. Also, many of the terms related to neutral/earth voltages, seem to overlap in their interpretation. The term "stray voltage" has to some, become a term that seems to reflect any voltage involving the neutral and/or the earth. This is not correct and is causing considerable industry confusion and debate. The following are terms commonly interchanged with the term "stray voltage":

a. <u>Stray Voltage</u> – A term generally defined by utility engineers referring to the normal steady state voltage imposed on the distribution primary neutral mostly resulting from return currents (due to unbalanced loads). Stray voltage is the normal condition resulting from current flowing in the neutral conductor and earth, as intended in the design of a 4 wire multi-grounded system. In the context of the last 40 years, this voltage is associated with problems in dairy farms, where stray voltages less than 1 volt are desired. These voltages generally do not exceed 10 volts and are not considered lethal to humans. Many papers, conferences and meetings have been held to discuss this issue primarily because the long term effect on cows has been associated with loss of milk production and increased susceptibility to disease, sometimes resulting in death. As defined here, "stray voltage" is the result of normal system operation and can be very difficult to mitigate.

b. <u>TOV</u> – Temporary Overvoltages (TOV) is a term that has been incorrectly referred to as stray voltages. TOV's are 60 Hz overvoltages that occur on the unfaulted phases of transmission and distribution systems during a fault. These voltages are primarily associated with the rating of arresters for lightning protection. Their duration is very short (usually less than 8 cycles on a sub-transmission or transmission system) and is a function of the overcurrent protection speed being used on the system (fuses generally operate in less than 1 cycle).

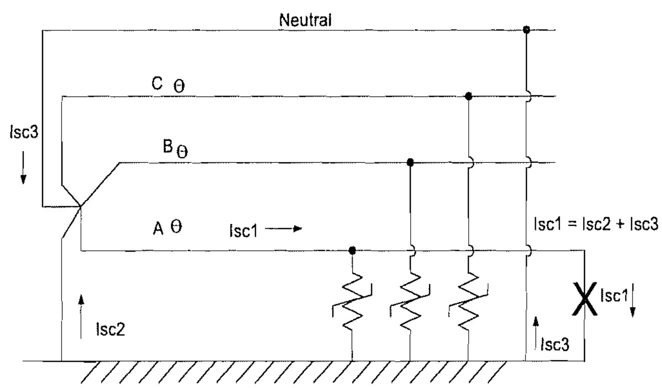


Figure 1 – TOV resulting from line to ground fault.

c. Contact Voltage – Normally the term contact voltage is used to describe the condition where the "hot" lead (120 volts or more) contacts a metallic structure such as a metallic streetlight pole. This voltage is dangerous and can result in death. Contact voltage is not "stray voltage" although it is sometimes misapplied in this context. Contact voltage has always been considered dangerous and should be mitigated immediately. This is true whether the condition exists on the utility system or on the customer side of the network (where proximity to humans is much more likely). Contact voltage should not be confused with stray voltage since contact voltage is dangerous and relatively easy to mitigate whereas "stray voltage" is not lethal and can be very difficult to mitigate.

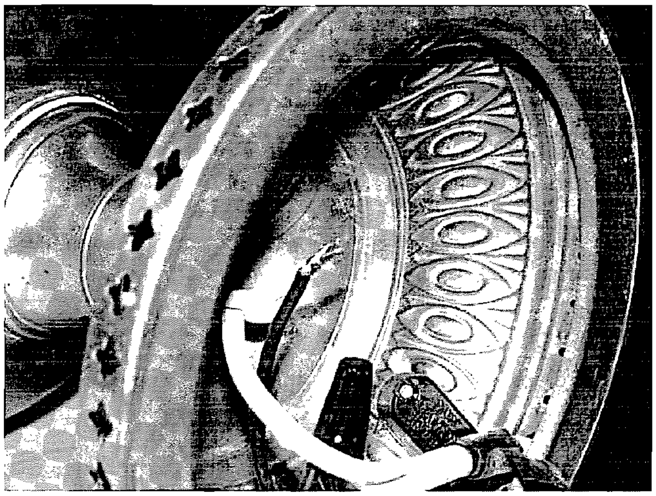


Figure 2 – Live wire resulting in possible contact voltage

d. Step and Touch Voltages – "Step and Touch" voltages are generally associated with the high voltages that can occur between an individual's two feet or a hand and foot during fault conditions. They are normally a concern in substations where fault currents can be very high (>10,000 amperes) and where the close proximity of personnel creates safety concerns. In short, "step and touch" voltages have always been associated with safety because they can be very dangerous. IEEE Std. 80, IEEE Design Guide for Safety in AC Substation Grounding provides general information about substation grounding and the specific design equations necessary to design a safe substation grounding system. Virtually all papers written on the subject of "Step and Touch" voltage concerns are related to substations. The use of this term in regards to "stray voltage" is very misleading since it mixes a non lethal voltage concern (stray voltage) with a very lethal concern due to voltages during faults in substations. The industry certainly does not want neutral-to-earth voltages associated with substation fault conditions. Such a misinterpretation could result in a lack of concern by personnel at substations.

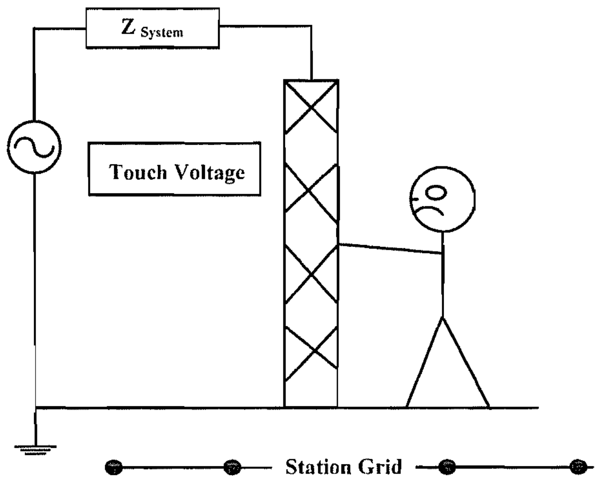


Figure 3 – Step-and-Touch voltage in a substation

e. <u>Static Discharge</u> – Static Electricity has also been incorrectly identified as a type of voltage considered as stray voltage. Static electricity is usually produced by friction i.e. when two materials are rubbed together. Static electricity in the atmosphere produces lightning.

f. <u>High Impedance Faults</u> – High voltages associated with impedance faults occur when a phase conductor falls on the ground. The contact impedance between the earth and the conductor is very high (>100 ohms) and consequently, very low values of fault current (generally less than 40 amperes) result, making overcurrent protection virtually impossible.

Table 1 – Typical Fault Impedance Values

Surface	Fault Impedance
Dry Asphalt	>1000 ohms
Concrete (non-reinforced)	>1000 ohms
Dry Sand	>1000 ohms
Wet Sand	500
Wet Asphalt	>1000
Dry Sod	381
Dry Grass	305
Wet Sod	191
Wet Grass	152
Concrete (reinforced)	102

High impedance faults are very dangerous because they create very high voltage gradients **(which are similar to, but not considered step and touch voltages)** usually resulting in death at distribution primary voltage levels. "Step and Touch Voltages", in the traditional terminology, refer to areas where current levels are high and grounding resistance is low, such as a substation. High impedance faults present the opposite condition where the fault currents are very low but resistance is very high, resulting in high ground voltage gradients. This differentiation should not be ignored since these are both dangerous conditions that can result in death. High impedance faults are extremely dangerous even at lower voltage levels of 120 or 240 volts. They are not "stray voltages".

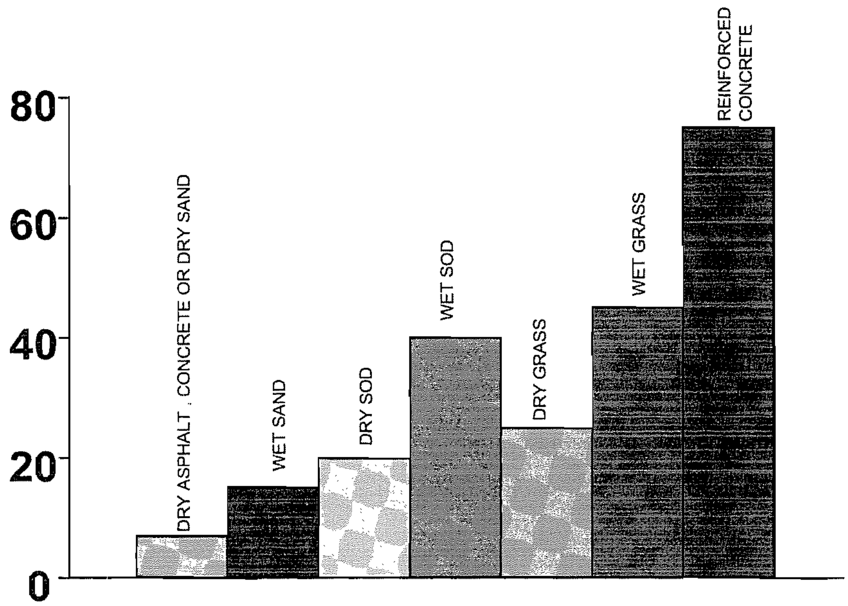


Figure 4 - Plot of current magnitude (in amps) for faults on different types of surfaces

g. <u>Stray Current</u> – The industry has been hearing the term "Stray Current" in recent years associated primarily with cow issues, but also with dangers to humans. Some might erroneously classify "circulating currents" in the neutral/earth return path as "stray currents". It would appear that some people using this term are saying that any current entering the earth is really a stray current, implying that it wasn't supposed to go there. The earth has always been considered a path for electrical currents by utility, radio and industrial engineers (using the same logic, radio waves going through the air would be called "stray radio waves"). Some currents are supposed to go to the earth, which is the reason why grounds are installed.

Some suggest that "stray currents" be monitored and not "stray voltage", since current causes death—not voltage. While it is a fact that it is current through the human body that can cause death, the only way to get current through the human body is to have a voltage difference. It should be noted that relatively high currents can exist in the earth in places like substations during fault conditions, but humans in the substations are safe. This is because the ground mat of the substation creates a semi-equipotential plane that insures that the voltages across human body contact points are low enough to not result in injury (i.e. lots of current but not a lot of voltage). It is important to remember that a high impedance fault can create a significant voltage and low current and can be lethal.

Finally, the path of unbalance current flow on a distribution system is very complex and virtually impossible to analyze accurately. One thing that greatly complicates an accurate model is that the loads are distributed making the flow of current between the neutral and earth very complex. Figure 5 shows the percentage of current in the neutral for various sizes of wire. The fault, in this case, is located 10 miles from the substation and most of the current at the fault location (could be load as well) is in the neutral. Near the middle of the feeder there is very little exchange of current, which means that in this area the neutral-to-earth voltage problem should be less. However, a shift in current can be seen near the substation which indicates higher neutral-to-earth voltage in the vicinity of the substation. This characteristic is somewhat similar to the computer computations performed in this study regarding induced voltages.

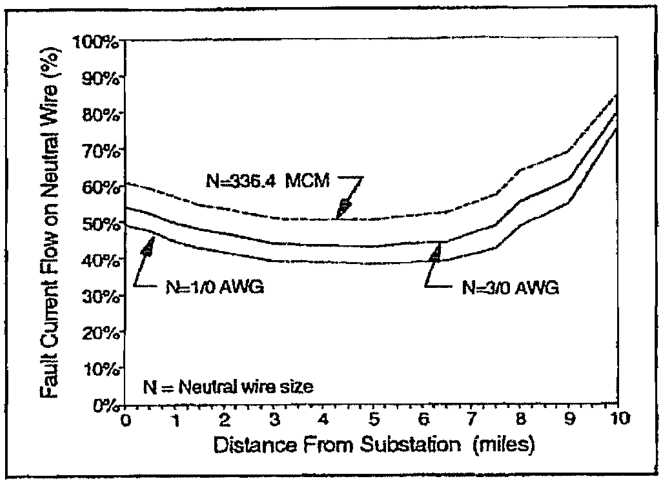


Figure 5 – Division of current for various neutral conductor sizes

h. <u>Induced Voltage</u> - Unbalanced currents on transmission lines, caused by untransposed lines and/or unbalanced loads, induce a voltage on parallel lines along the same right-of-way. These lines could be static wire, communication facilities, neutrals or other transmission and distribution wires. Induced voltages are considered to be 60 Hz and steady state so they manifest similar characteristics to "neutral-to-earth voltage". They are a normal characteristic of a utility system and sometimes cannot be mitigated without considerable cost. These voltages occur on 3 wire systems with a static wire—hence the argument that 4 wire multi-grounded systems are the only source is simply not valid. Static wires are an integral part of the transmission system for protection against lightning flashover. These induced voltages are normal and not considered lethal to humans, since they are generally less than 25 volts (see study results). It would seem inappropriate to test for these voltage levels on transmission facilities, since the voltages are low level and these facilities (transmission towers, etc…) are not normally contacted by the public. The voltage level of 25 volts or less may, under certain conditions (wet, no shoes, etc.), present an uncomfortable situation, but is not considered lethal (per OSHA) and is generally avoidable, even for animals. Finally, the mitigation of these induced voltage levels is not trivial and requires considerable investments. This investment is questionable in light of the fact that we are unaware of any documented evidence that induced voltages have impacted human life. The factors that contribute to the level of induced voltages (none of which are easily altered) are:

- Currents in the transmission line conductors
- Transposition characteristics
- Proximity to other lines
- Length of the parallel section
- Soil resistivity

II. Stray Voltage Mitigation Issues

When current flows through the neutral or static wire of a primary distribution system, it creates voltage. This voltage, generally a volt or two, is transferred by the distribution transformer to the customer. Figure 6 shows a distribution transformer where the primary and secondary neutrals are not connected. If this transformer connection was a typical construction technique, most "neutral-to-earth" voltages would not impact the customer. However, the National Electric Safety Code requires that the 2 neutrals be connected. This means that the small voltage (e.g. 5 volts) on the primary neutral is now imposed on the secondary. Now, neutral-to-earth voltage due to the primary neutral current on the utility system can impact customers (it should be noted that customers can and do cause many of the neutral-to-earth voltage problems).

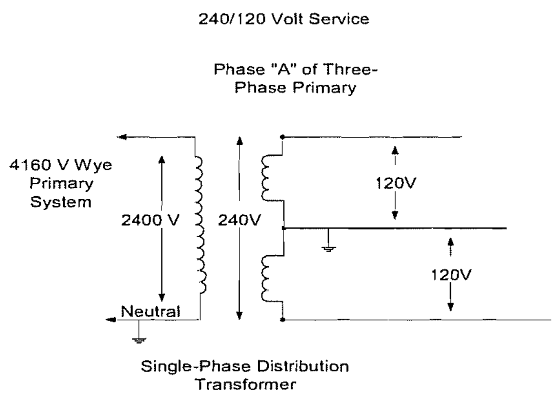


Figure 6 – Distribution transformer without neutral interconnection

Neutral-to-earth voltage issues are difficult. This is due to the fact that the cause(s) of the problem are complex and mitigation techniques may not be effective. An example of the difficulty is show in Figure 7. It would normally be assumed that better grounding reduces the level of neutral-to-earth voltage. This being the case, if the substation grounding is improved, one would conclude that neutral-to-earth voltages are reduced. Such is not necessarily the case as is shown in Figure 7. Voltages at the substation are reduced, but those out on the feeder actually increase due to the increase in neutral current. A similar phenomenon occurs when ground rods are driven at a customer location, i.e. the voltage at the ground rod location may go slightly down but neutral-to-earth voltages in other areas could go up.

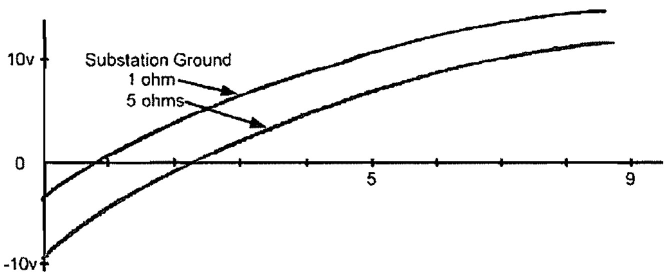


Figure 7 – Effect of distribution substation grounding on stray voltage

Utilities use a number of methods (see Figure 8) to reduce neutral-to-earth voltage, including better grounding, larger neutrals, balancing, etc... While many of these methods may help, they may not be sufficient to satisfy the requirements of some state commissions. Probably the most effective tool is a neutral isolator which isolates the customer neutral during normal conditions.

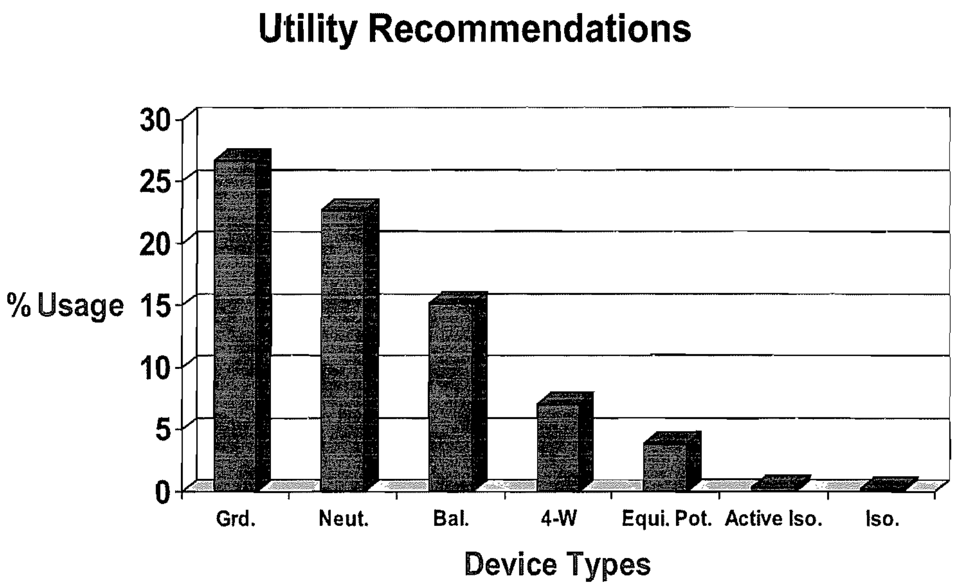
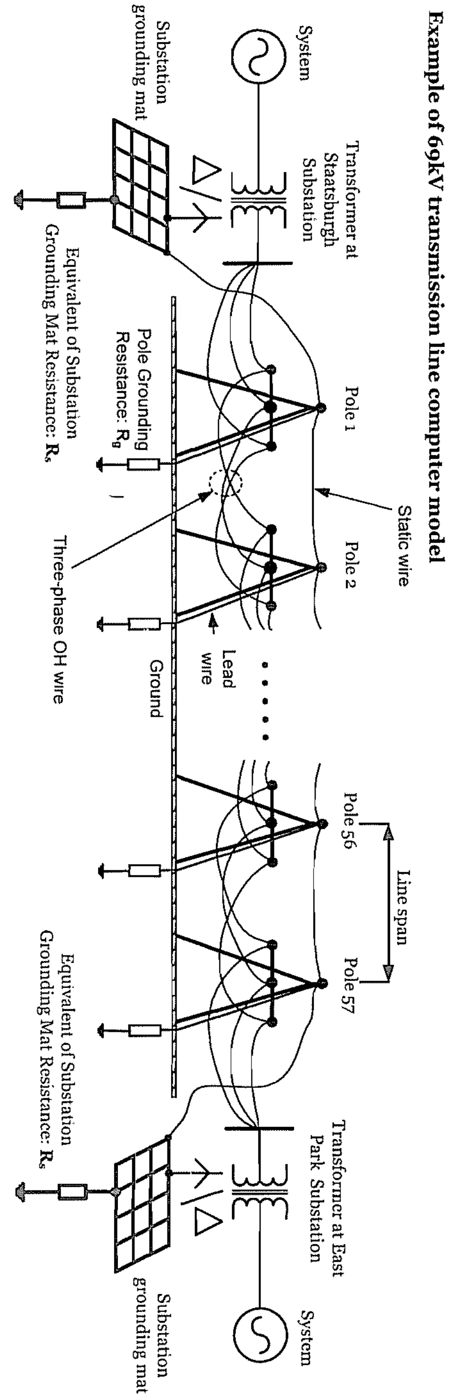


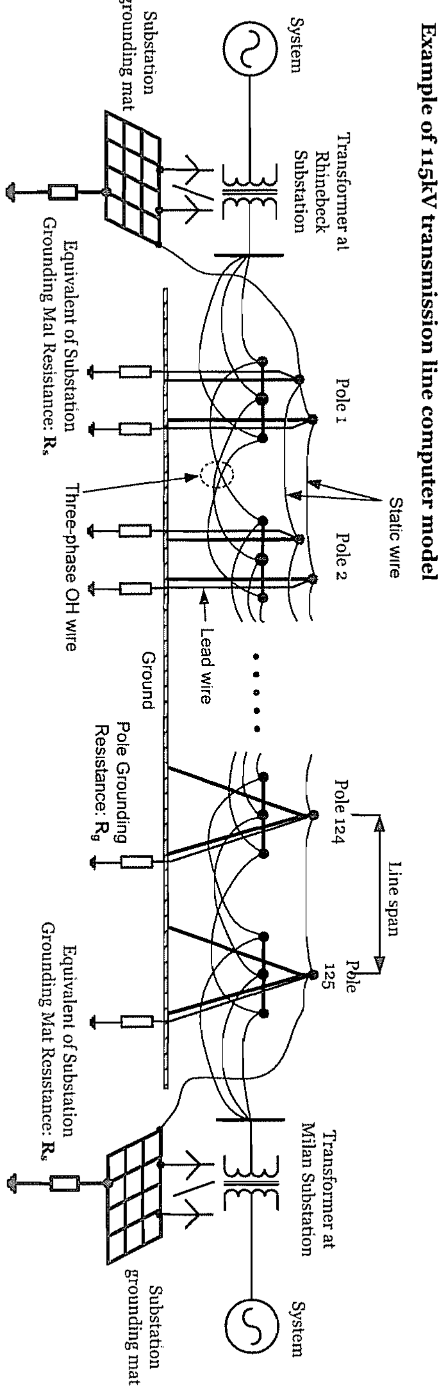
Figure 8 – Stray Voltage mitigating methods used by utilities

QUANTA TECHNOLOGY

Appendix B: Example of Computer Models

Example of computer models for transmission lines between substations used during computer simulations. The exact pole configuration and real-time data applied for each case during simulations is presented in Chapter 3.





Appendix C: Computer Simulation Program: EMTP-RV

Electro-Magnetic Transients Program (EMTP) is a well known program for transient and steady state problems of multi-phase power systems.

EMTP-RV is the enhanced computational engine with a new graphical user interface (GUI). The package is a sophisticated computer program for the simulation of electromagnetic, electromechanical and control system transients in multiphase electric power systems. It features a wide variety of modeling capabilities encompassing electromagnetic and electromechanical oscillations ranging in duration from microseconds to seconds. Examples of its use include stray voltage analysis, switching and lightning surge analysis, insulation coordination, shaft torsional oscillations, ferroresonance and power electronics applications in power systems.

EMTP-RV incorporates many power system equipment models including linear elements, transmission lines, transformers, synchronous generators, motors, sinusoidal sources, other types of sources than sinusoidal, breakers, diodes, thyristors, surge arresters, other non-linear elements and pi circuits. Other program features allow simulation of control systems (generator exciters, SVC thyristor switching, etc...).

EMTP-RV accepts several simulation options which are performed for arbitrary network configurations. All options are applicable to all devices within documented rules of device behavior. These are:

- Frequency scans.
- Steady-state solutions: linear harmonic steady-state solution, non-linear harmonic steady-state solution and three-phase power flow.
- Time domain solutions: fixed time-step trapezoidal with/without backward Euler method, automatic initialization from steady-state, startup from manual initial conditions and special option for power electronics instantaneous switching conditions within a time-step.
- Statistical/systematic analysis.

Appendix D: Voltage Mitigation Techniques

The purpose of these studies was to determine the impact of various system parameters on the total voltage levels (sum of induced voltage and voltage due to circulating currents) present in the static wire in the circuit.

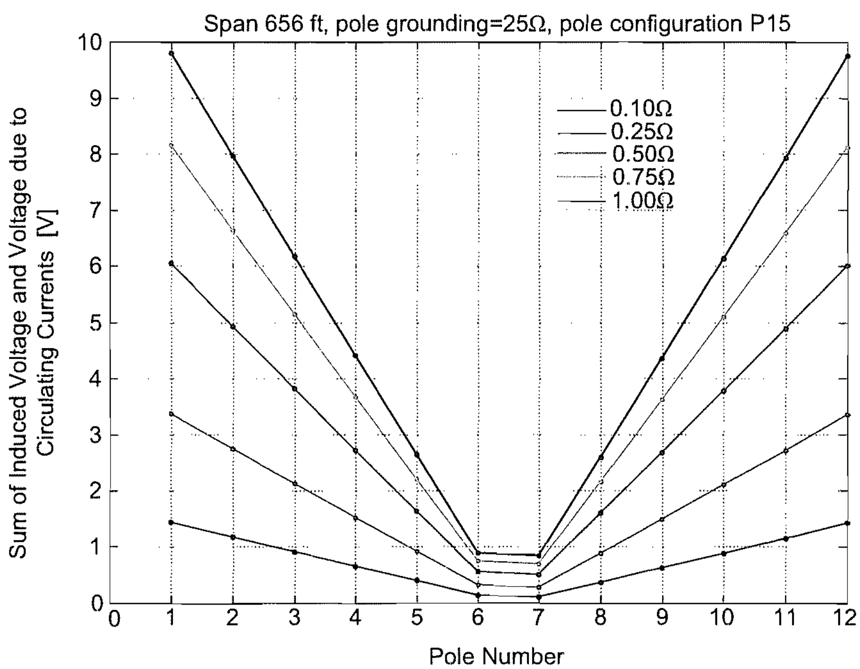
System specification:

- Substation 1 voltage: 10kV
- Substation 2 voltage: 11.7kV
- Substation 1 and 2 grounding resistance 0.75Ω
- Static wire: 101.8 MCM ACSR 12/7 (Petral)
- Phase wire: 795 MCM ACSR 45/7 (Tern)
- Lead wire from the static wire to the ground rod: solid #4 CU
- Pole grounding resistance: 25Ω
- Ground resistivity: 100Ωm
- Line span: 656ft
- Pole type: P-15

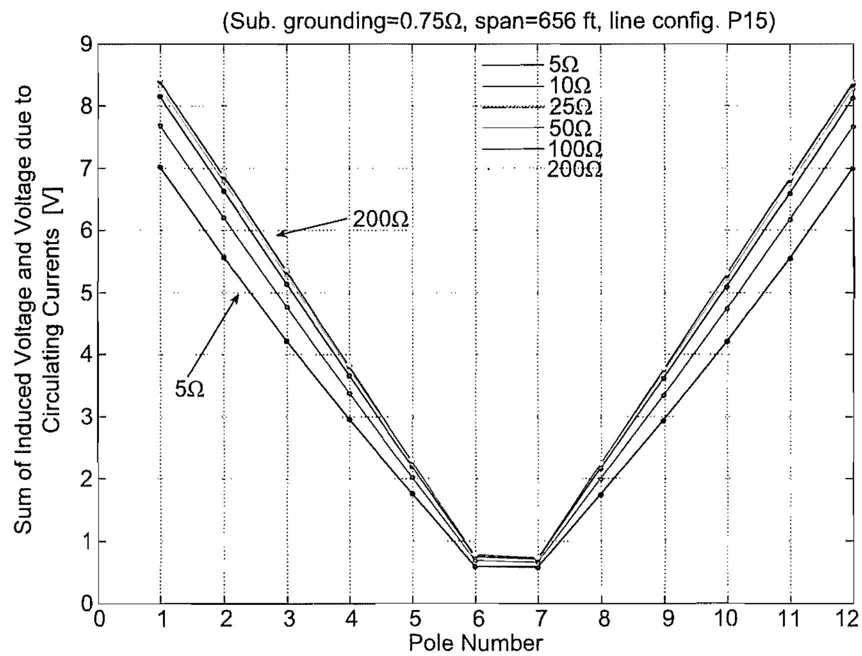
Variables used during computer simulations:

- Equivalent of substation grounding mat resistance R_s,
- Pole grounding resistance R_g,
- Line loading,
- Line span length,
- Pole configuration.

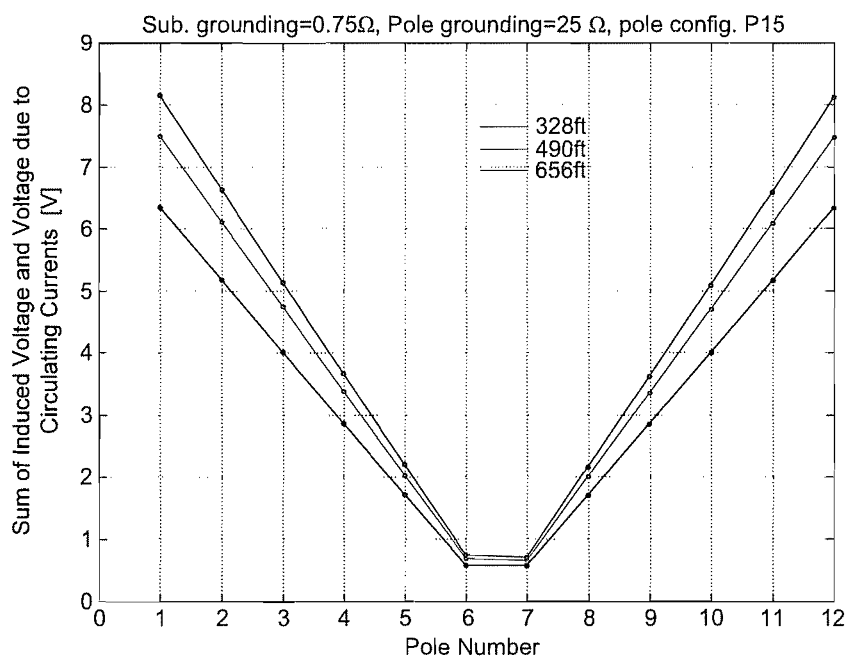
a) Substation grounding resistance R_s changes



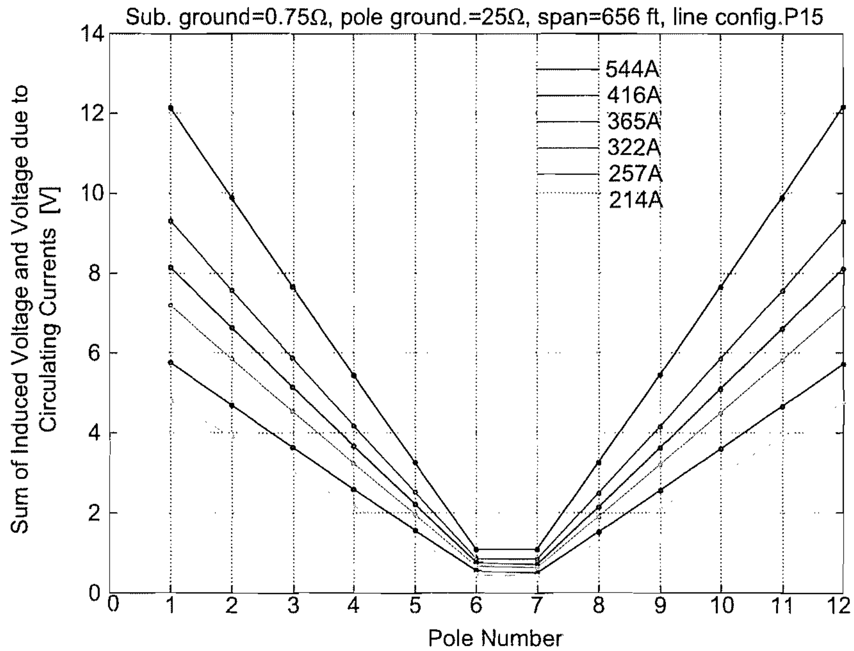
b) Pole grounding resistance R_g changes



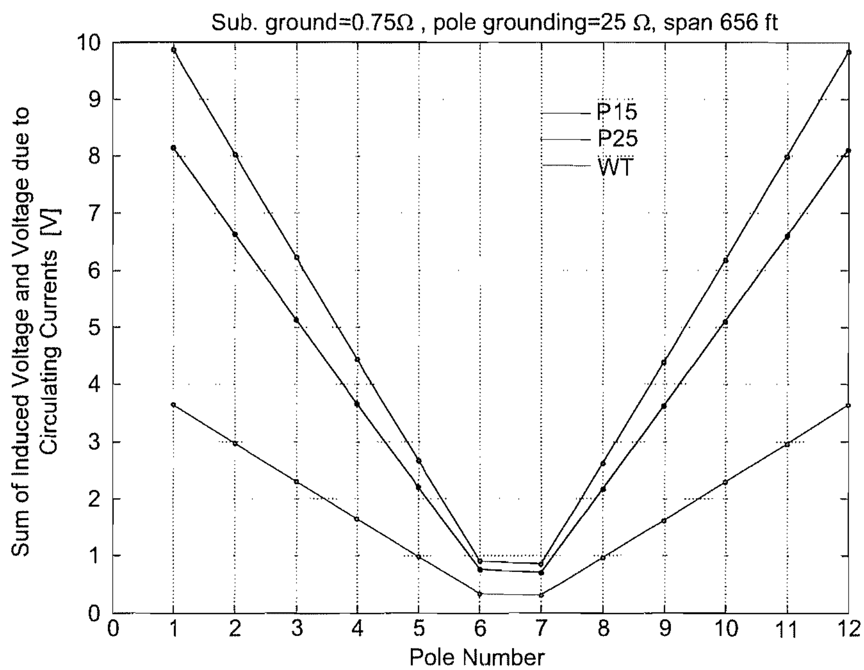
c) Line span length changes



d) Line loading changes



e) Pole configuration changes



Appendix 4

Joint Upstate Utilities Stray Voltage Tests and Findings Report

APPENDIX 6

Appendix 6

Upstate Utilities Stray Voltage Tests and Findings Report

Upstate Utilities 2005-2007 Final Testing Summary	Units Completed	Units with Voltage Found (>= 1.0v)	Percent of Units Tested with Voltage (>= 1.0v)	Units with Voltage Found (>= 4.5v)	Percent of Units Tested with Voltage (>= 4.5v)	Units with Voltage Found (>= 8v)	Percent of Units Tested with Voltage (>= 8v)
Distribution Facilities	5,069,071	2165	0.043%	244	0.005%	130	0.003%
% of Total	78%	43%		20%		17.5%	
Underground Facilities	625,672	43	0.007%	10	0.002%	7	0.001%
% of Total	10%	1%		1%		0.9%	
Street Lights / Traffic Signals	418,179	1351	0.323%	781	0.187%	544	0.130%
% of Total	6%	27%		64%		73.3%	
Transmission	408,651	1,505	0.368%	186	0.046%	61	0.015%
% of Total	6%	30%		15%		8.2%	
TOTAL	6,521,573	5,064	0.078%	1,221	0.019%	742	0.011%

Data Collected through November 30, 2007

Upstate Utilities Summary of Voltages Found	# of units between 1.0v and 4.4v	# of units between 4.5v and 7.9v	# of units between 8.0v - 24.9v	# of units between 25.0v - 99.9v	# of units greater than 100.0v	Total
Distribution Facilities	1,921	114	56	62	12	2,165
Pole	101	10	5	11	1	128
Ground	584	64	27	17	6	698
Guy	782	30	4	5	-	821
Riser	56	3	3	7	-	69
Fences	17	1	-	-	-	18
Other	381	6	17	22	5	431
Underground Facilities	33	3	4	3	-	43
Handhole / Pull box	2	-	3	1	-	6
Manhole	4	1	-	-	-	5
Padmount Switchgear	4	-	-	-	-	4
Padmount Transformer	3	1	-	2	-	6
Vault – Cover/Door	-	-	-	-	-	-
Pedestal	-	1	-	-	-	1
Other	20	-	1	-	-	21
Street Lights / Traffic Signals	570	237	362	170	12	1,351
Metal Street Light Pole	553	227	347	164	12	1,303
Traffic Signal Pole	7	1	6	5	-	19
Control Box	2	-	1	-	-	3
Pedestrian Crossing Pole	-	-	-	-	-	-
Other - NOT LISTED	8	9	8	1	-	26
Transmission (Total)	1,319	125	49	12	-	1,505
Lattice Tower	4	-	-	-	-	4
Pole	33	1	-	-	-	34
Ground	881	106	47	8	-	1,042
Guy	91	16	1	4	-	112
Other	310	2	1	-	-	313