atis Protection Engineers Group

DALLAS, TX - MARCH 14 - 16, 2017

PEG CONFERENCE

Improving Network Infrastructure Reliability and Sustainability

"New Secondary Network Protection Element"

March 14, 2017

By Russ Gundrum, MBA PMP SSGB
Principal Consultant
Telecom Problem Solvers, LLC

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“Primary” Protection

Electrical protection devices *legally* required to be placed by Communication Service Providers at a building’s entrance and before any terminal equipment if their Outside Plant cable facilities are exposed to voltages in excess of **300 Vg**.

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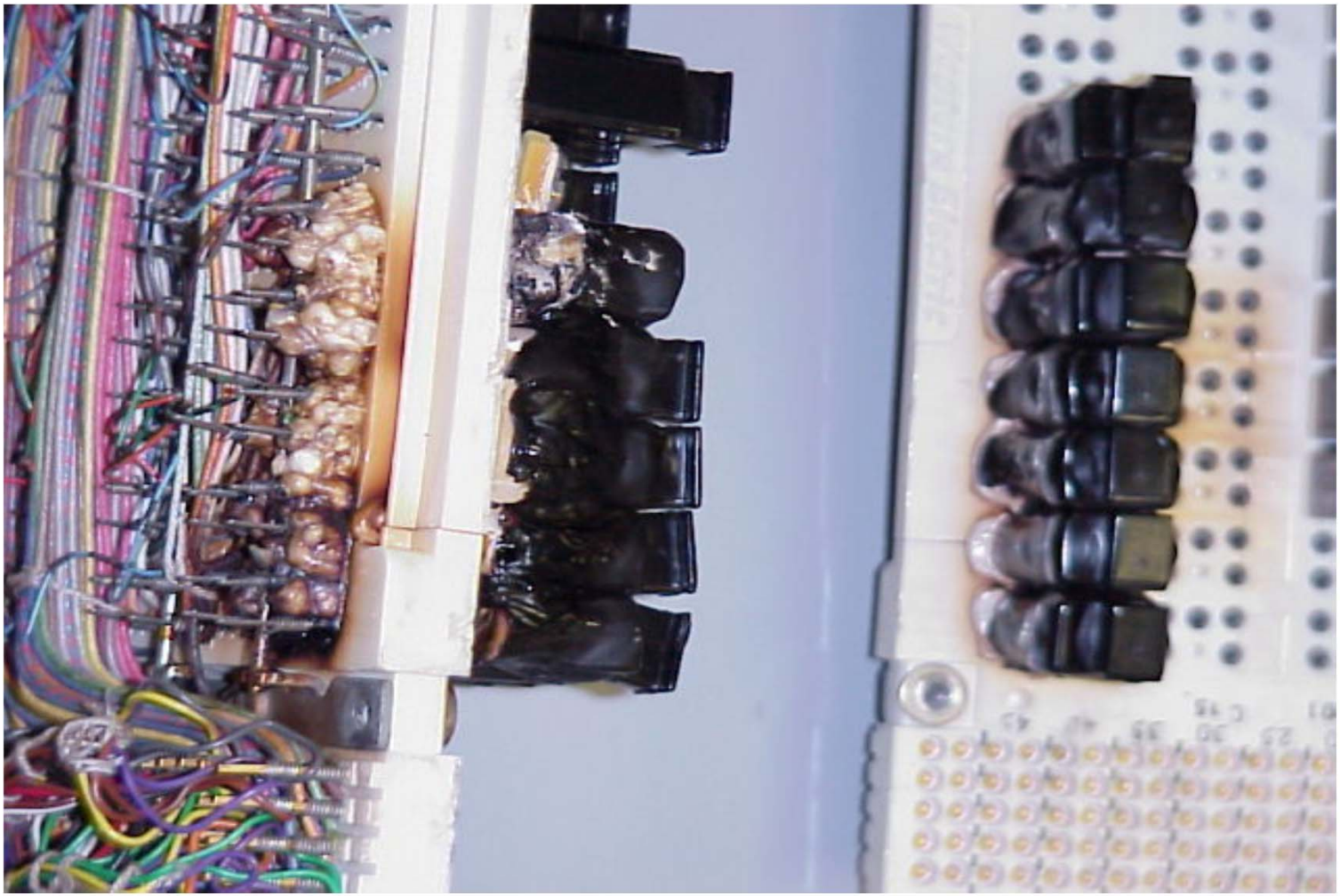
“Secondary” Protection

Electrical protection devices usually provided by the *end user* or that may be built into the terminal equipment by the manufacturer to suppress voltages that are **under the operational threshold of the primary protector** and/or to limit *currents*.

With better coordination of primary & secondary protection devices, maybe we could hopefully avoid situations like this:



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Rethink Possible

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IEEE COMMUNICATIONS SOCIETY

DONALD W. MCLELLAN

MERITORIOUS SERVICE AWARD

"This award for outstanding long-term service was first presented in 1976 as the IEEE Communication Society Meritorious Service Award. It was renamed the Donald W. McLellan Meritorious Service Award after his untimely death in 1978. During his career Don served as a model for personal service to the IEEE and to the profession. He was also widely known as an authority on induced noise and mitigation and was completely dedicated to the idea that **all interference and noise problems are amenable to technical solution**."

http://www.comsoc.org/about/memberprograms/comsoc-awards/mclellan

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776-1992 IEEE Guide for Inductive Coordination of Electric Supply and Communication Lines

Abstract

The inductive environment that exists in the vicinity of electric power and wire-line telecommunications systems and the interfering effects that may be produced are addressed. An interface that permits either party, without need to involve the other, to verify the induction at the interface by use of a probe wire is presented. This recommended practice does not apply to railway signal circuits.

at&t

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IEEE Guide for the Implementation of Inductive Coordination Mitigation Techniques and Application

Circuits and Devices

IEEE Communications Society

Sponsored by the
Transmission Systems Committee

Computer

Electromagnetics and Radiation

Energy and Power

Industrial Applications

Signals and Applications

Standards Coordinating Committees

IEEE Std 1137-1991

Published by the Institute of Electrical and Electronics Engineers, Inc., 345 East 47th Street, New York, NY 10017, USA.

IEEE

June 1, 1992

SH14803

1995 Letter to Editor *Cabling Installation & Maintenance* still on the web!

Grounding and bonding

November 1, 1995

Russ Gundrum
Kingwood, TX

Just wanted to add a few comments to Mark Waller`s article "Grounding and bonding ensure a safe installation" (see September 1995, page 21).

Instead of using modems, opto-isolators or data-port protectors, or replacing copper cable with fiber-optic cabling, I`d like to suggest a less-expensive and more-effective solution to the problem of induced voltages and currents on data lines. And shielded cable isn`t the answer either--as the telephone industry learned years ago.

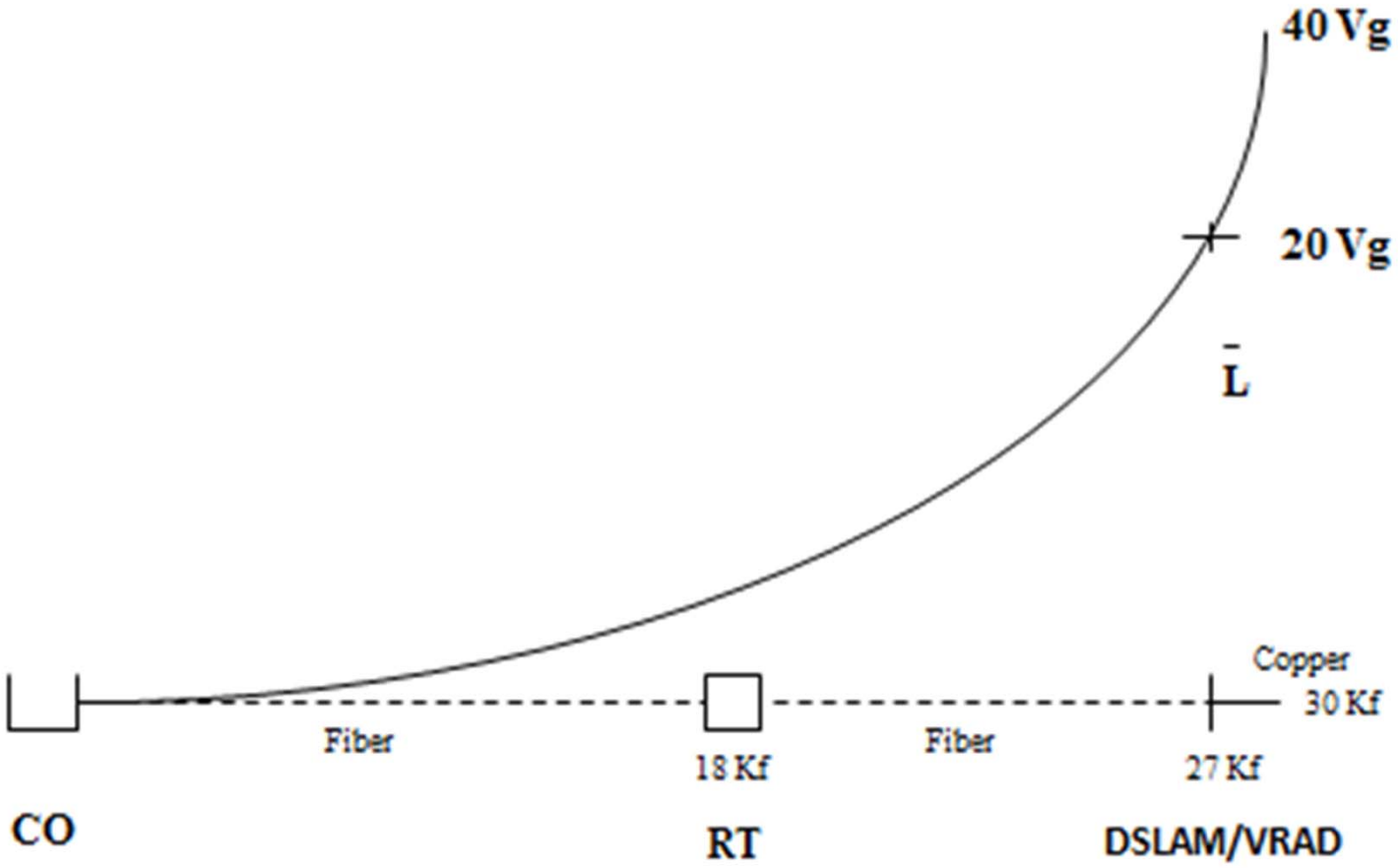
Neutralizing transformers were developed more than 60 years ago for use on open-wire telephone lines to reduce induced voltages and currents simultaneously. You don`t need to specify an operating threshold for this device because it doesn`t clamp the circuit and shunt it to ground. There is no time delay, because it operates instantaneously, and it is a multi-pair device, so you only need it at one end of the circuit.

In the 1960s, large units were built for critical telecommunications and data circuits serving substations and power plants that might be exposed to thousands of volts. In the 1970s, smaller and less-expensive units were designed to suppress hundreds of volts.

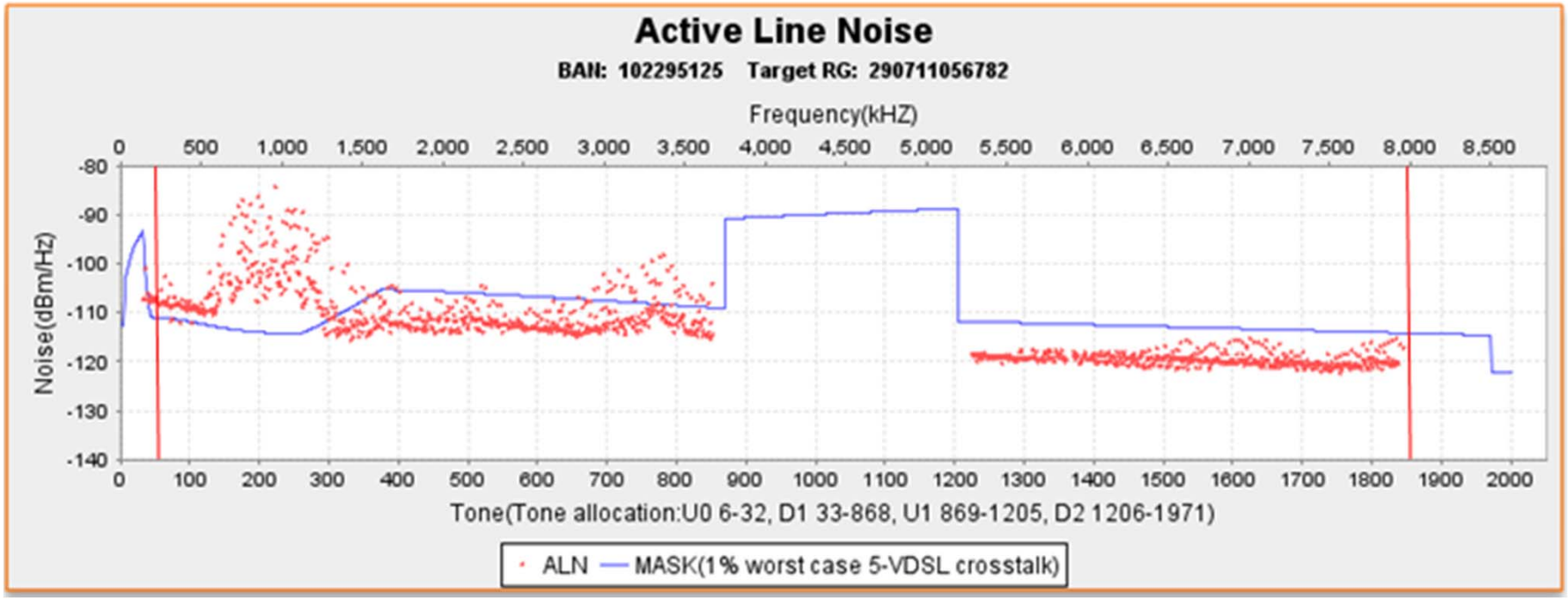
Now I`m waiting for one to be designed for the local area network market to solve an even lower voltage problem. **Any takers out there?**

http://www.cablinginstall.com/articles/print/volume-3/issue-11/crosstalk-feedback/to-the-editor/grounding-and-bonding.html

Typical Induced Voltage Profile With or W/O an RT



Induced 60 Hz/Noise Effects on VDSL



AC Power can affect a very broad range of frequencies at once. AC can amplify other minor or severe impairments causing the modest of impairments to become severely detrimental.
(**Blue** indicates a satisfactory level; **red** indicates measured noise levels)

Effects on video service:

Pixilation Freezing High FEC count REINIT's (Dropping Sync)

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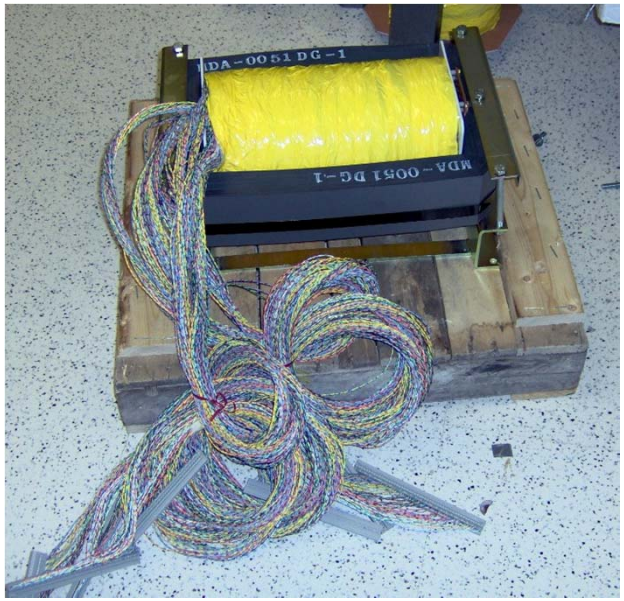

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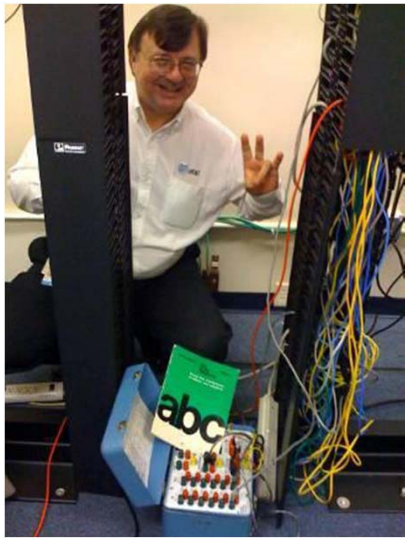
AT&T Technology Lab at UH's College of Technology http://uh.edu/tech/att/

INT in HumZapper used on U-verse Circuit

Successful Demo of INT on AT&T Lab's U-verse Circuit October 2008



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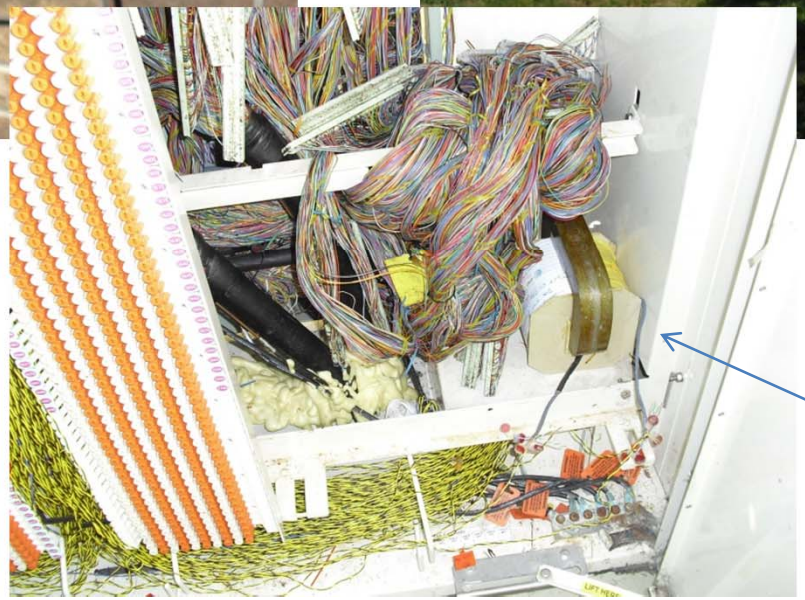
DSL INT Prototype Added to a Pair Bonded U-verse Customer in Houston on 10/01/10



DSL INT Prototype in SAI

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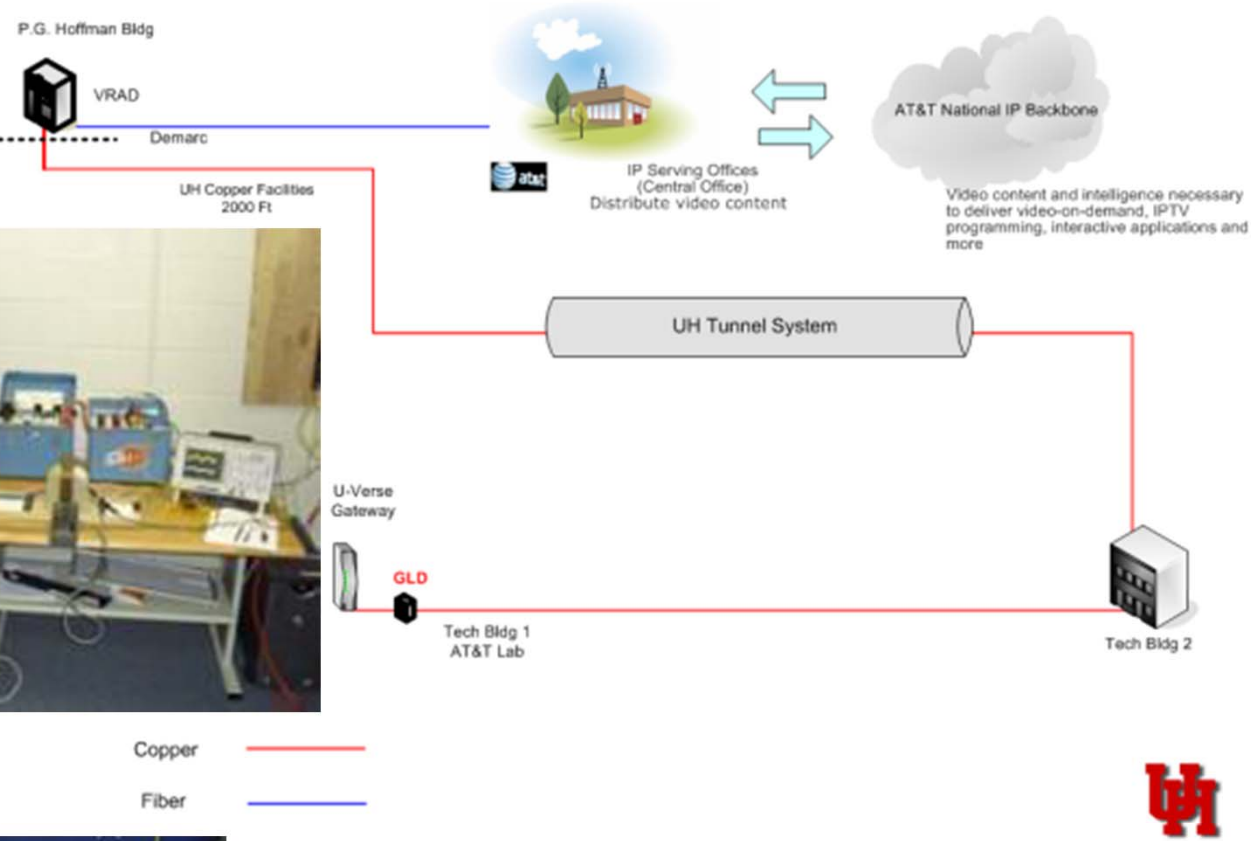
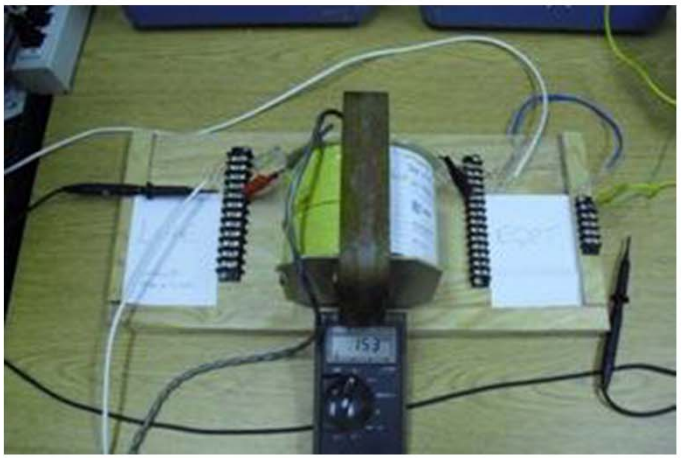
AT&T U-Verse GLD Evaluation Test Circuit

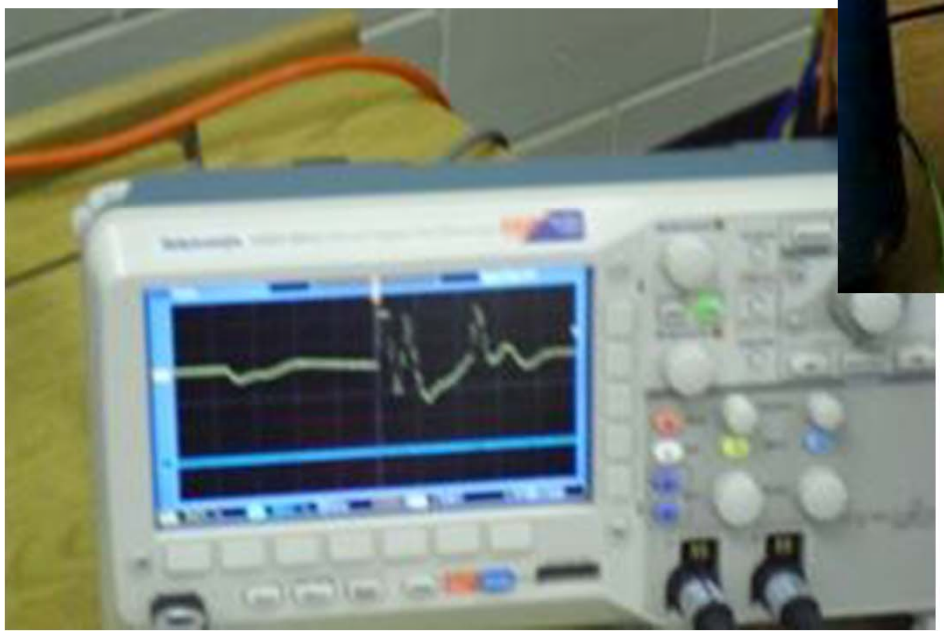




DSL INT Prototype

Telecom Problem Solvers, LLC

Before & after 60 Hz transient with 6 pair INT in HumZapper



Before & after lightning transients through DSl INT Prototype on AT&T Lab U-verse Circuit November 8, 2011

Telecom Problem Solvers, LLC

“I agree the area of noise reduction is important and often underestimated. This is certainly a good step in the right direction, particularly for the lightning surges that won't be solved by digital processing.”

Dr. John Cioffi

February 18, 2012

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References

- ISE EXPO Presentation by Russ Gundrum in San Antonio, TX, on September 22, 2016 **"Update on the Impact of Interference on Wired Broadband xDSL/IPTV Systems"**. Available on my LinkedIn page, by request or online: http://iseexpo.com/wp-content/uploads/2016/10/Telecom-Problem-Solvers_ISE-Expo-2016.pdf
- **"*What's Old is New Again… Why Gundrum's Law Still Applies to VDSL2/G.fast and IPTV Services*"**, by Russ Gundrum, September 2016, ISE Magazine (Available on my LinkedIn page or by request)
- IEEE Globecom 2011 Broadband Forum 1 Obtaining the Full Potential of xDSL Presentation by Russ Gundrum on **"DSL Quality Suite - Ensuring More Than Speed"**. Available on my LinkedIn page, by request or online: https://www.researchgate.net/publication/283488361_IEEE_Globecom_2011_Broadband_Forum_1_Obtaining_the_Full_Potential_of_xDSL_DSL_Quality_Suite_-_Ensuring_More_Than_Speed
- Russ Gundrum's Third DSL INT patent awarded on November 15, 2011 **U.S. Patent # 8,059,725** https://www.google.com/patents/US8059725
- "***The Secret Lives of INT's…Bringing the INT into the 21st Century to Solve AC Interference Issues Affecting IPTV Services***", Russ Gundrum, March 2011 OSP Magazine http://www.ospmag.com/issue/article/The-Secret-Lives-of-INTs
- Russ Gundrum's University of Houston Masters in Project Management TEPM 6304 Six Sigma Project Fall 2010 on **"*U-verse Service Improvement*"** (Available on my LinkedIn page or by request)
- OSP Expo Presentation by Russ Gundrum in San Antonio, TX October 13, 2010 on **"*AT&T's Patented DSL INT for IPTV Applications*"** (Available on my LinkedIn page or by request)
- Russ Gundrum's Second DSL INT patent awarded on October 8, 2008 **U.S. Patent # 7,433,412** https://www.google.com/patents/US7433412
- Russ Gundrum's First DSL INT patent awarded on September 4, 2007 **U.S. Patent # 7,266,154** https://www.google.com/patents/US7266154
- OSP Expo all-day seminar by Russ Gundrum on the **"*The Lost Art (and Science!) of AC Interference Mitigation – Solve Induction Problems Affecting your FTTN/IPTV Services, While Extending Your Reach*"** in San Jose, CA on August 28, 2007 (Available on my LinkedIn page or by request)
- Volume 14 abc of the Telephone on ***Power Line Interference: Problems and Solutions*** by Russ Gundrum published in 1982, but no longer available in print. Available on my LinkedIn page, by request or on Google Books: https://books.google.com/books?id=inHIPwAACAAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

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Questions??????

For more information:

Russ Gundrum
Principal Consultant
Telecom Problem Solvers, LLC
www.telecomproblemsolvers.com
2261 Northpark Drive, Suite 428
Kingwood, TX 77339
281-315-9120
russgundrum@telecomproblemsolvers.com
https://www.linkedin.com/in/russgundrum

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Appendix

BELL SYSTEM PRACTICES
AT&TCo Standard

SECTION 873-505-107
Issue 1, May 1975

INDUCTIVE COORDINATION
LOW VOLTAGE
NEUTRALIZING TRANSFORMERS

CONTENTS PAGE

1. GENERAL 1
2. PRINCIPLE OF OPERATION 2
3. LOCATION CONSIDERATIONS 5
4. DESIGN OF THE PRIMARY CIRCUIT . . 10
5. SAMPLE PROBLEM 10

1. GENERAL

1.01 This practice describes the use of neutralizing transformers for reducing excessive steady-state power line induced voltages on subscriber loop telephone cables. This particular type of neutralizing transformer is ***not*** designed for power station telephone protection since it does not have sufficient dielectric to withstand the large ground-potential rise or induced voltage environment that exists during a power line fault. Neutralizing transformers are normally considered for inductive interference mitigative purposes when the noise-to-ground on a cable pair exceeds 90 to 95 dBrnc (50 volts rms). Low-frequency longitudinal voltage and metallic noise reductions of 10 to 20 dB can be achieved at the station and terminal ends of exposed cable pairs as a result of the transformer installations. Transformer performance can be maintained in the presence of longitudinal direct currents up to a total of 20 mA.

1.02 The application of neutralizing transformers for the mitigation of steady-state inductive interference should be considered only when other methods of achieving mitigation prove impractical. The transformer may temporarily solve a magnetic induction problem, but it generally should not be used extensively over a continued period of time. This could result in a gradual, undetected intensification of the inductive environment, creating intolerable inductive conditions at some time in the future. Attempts should be made to correct telephone system susceptibility along with coordinated efforts with the power utilities to reduce power system influence. The use of neutralizing transformers could also restrict the future flexibility of telephone facilities while appearing to have the immediate effect of removing restrictions.

1.03 The following limitations in the use of neutralizing transformers must be considered when engineering their application for telephone plant:

(1) Administrative procedures must be adopted to insure continuity of the primary and secondary circuits, because trouble (such as a "short" or an "open" circuit) on one pair can affect all other pairs.

(2) Full-count lightning protection is required, which introduces additional maintenance considerations.

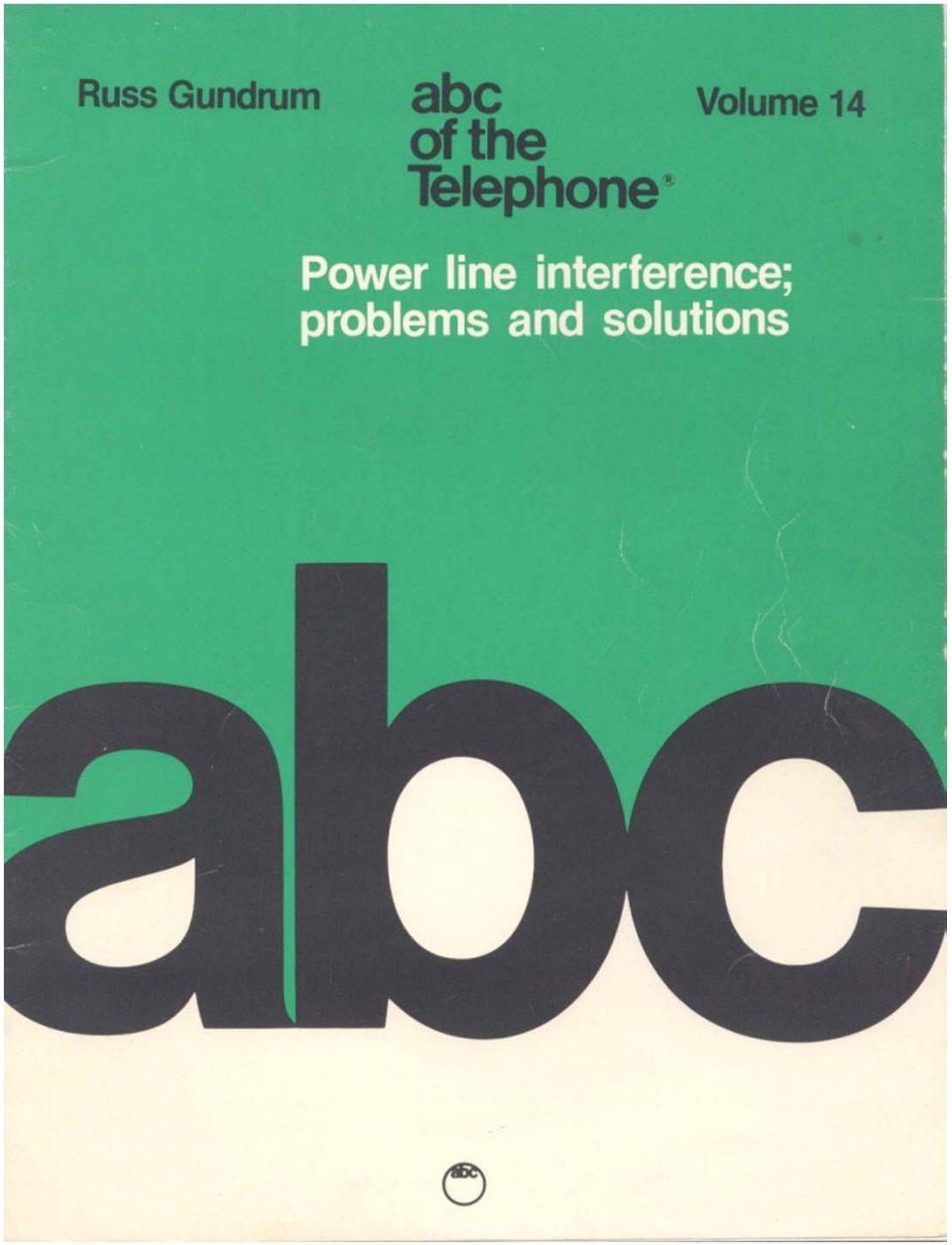
(3) Neutralizing transformers cannot be used on telephone circuits carrying more than 20 mA of longitudinal direct current.

(4) Some monitoring procedures are recommended, since ringing voltages may add to induced voltages without an indication on the telephone plant. This may result in an unsafe condition with higher voltages than normally expected appearing across the transformer terminals or between the terminals and ground.

(5) The insertion of range extenders or the relocation of load coils on the telephone circuits may be required to compensate for the additional length of cable inserted by the transformer windings.

The insertion of a neutralizing transformer in the telephone circuit alters the metallic impedance in the form of additional dc resistance and shunt capacitance. The only effect on the longitudinal

Inductive Coordination
Low Voltage
Neutralizing Transformers
873-505-107
May 1975



Foreword to Russ Gundrum's Volume 14 of the **abc of the Telephone** training manual on
Power Line Interference: Problems and Solutions, 1982
by C. M. Suche

"The telecommunications industry is experiencing power induction problems today that were anticipated by responsible and knowledgeable engineers many years ago. Many fine inductive coordination practices were written prior to and during the time power companies started converting their primary distribution systems from delta to grounded-wye operation. Unfortunately though, the rapid growth of both telephone and power systems, along with the application of questionable economic measures in the development of certain telecommunications equipment and materials, left many of the earlier requirements in the wake of what many of us regretfully remember as progress. However, a day of reckoning may be at hand. Many of the telecommunication services now appearing on the horizon have placed new significance on the transmission quality of telephone cable pairs and other types of voice channels.

Although Russ Gundrum may be considered a member of today's telephone generation, it is made evident by his writing, that he possesses the rare ability to combine an outstanding technical knowledge of the general field of inductive coordination, with the practical application necessary to provide able assistance to all levels of power and telephone people in the field. His general attitude toward the problem is a throwback to a particular breed of engineers around the country who waged an up-hill battle against the growing effects of power induction throughout the years.

The author has picked the general subject problem of power induction up off the floor and displayed it in its proper importance on top of the table. A book of this type has been a long time coming. It should be made available to all levels of power and telephone people who are responsible for or interested in the quality of both present and future telecommunication services available to customers being served by each industry."

Introduction to Russ Gundrum's Volume 14 of the **abc of the Telephone** manual on
Power Line Interference: Problems and Solutions, 1982
By R. Stoneman

"Induction has caused more unproductive effort to be spent on telephone plant than any other force disturbing wire systems. In the past, ineffective measures, along with no real solutions, created a nightmare of noise complaints and equipment malfunctions and cast a pall of doubt on the ability of the most sincere and hard working people in the telephone industry.

Along with this came the frustration of engineers and managers unable to provide a consistently reliable, working telephone system.

It was out of this kind of environment that information and hardware necessary for the problem's solution became available. However, until now, no concise, one piece handbook was available to provide the kind of information that is desperately needed. It did not come without a substantial amount of anxiety and sacrifice by many people. Nothing worthwhile ever does."

Chapter 12 on *Summary and Investigative Considerations*, Volume 14 of the **abc of the Telephone** on Power Line Interference: Problems and Solutions, 1982
by Russ Gundrum

"If there is a common thread through all of the information presented in this manual, it is the fact that **the telecommunication industry should be informed of the serious consequences of inductive interference that impacts on the quality of service considerations such as noise, equipment malfunctions and damages, and public and personnel safety.** Once an awareness has been reached that induction problems can and will exist, and the trends are showing that they are going to get worse in the future, then **it is time to adopt the mitigative techniques required to live with power line interference and control it in the most economical manner possible.** The basic goal has been and should always be **providing the best possible service at the lowest possible price.**

In some circles, **noise has been considered taboo by many in the telephone industry and no one wants to admit they have it, even though everybody does**. Noise problems are what everyone can easily relate to, since they all can hear it, as opposed **to the less than obvious effects of raw induction which can't be heard, but which can be creating other seemingly unrelated havoc on the entire system**. Even though noise can be a reflection on the quality of workmanship and can reflect the abilities and commitments of management to control it, it should be emphasized that **the best efforts in trying to utilize the plant facilities as they were originally engineered, can still fall far short and the problems still remain**. Also, **all the sophisticated testing and analysis in the world will not make the problems disappear!**

Continued below in
notes & next slide

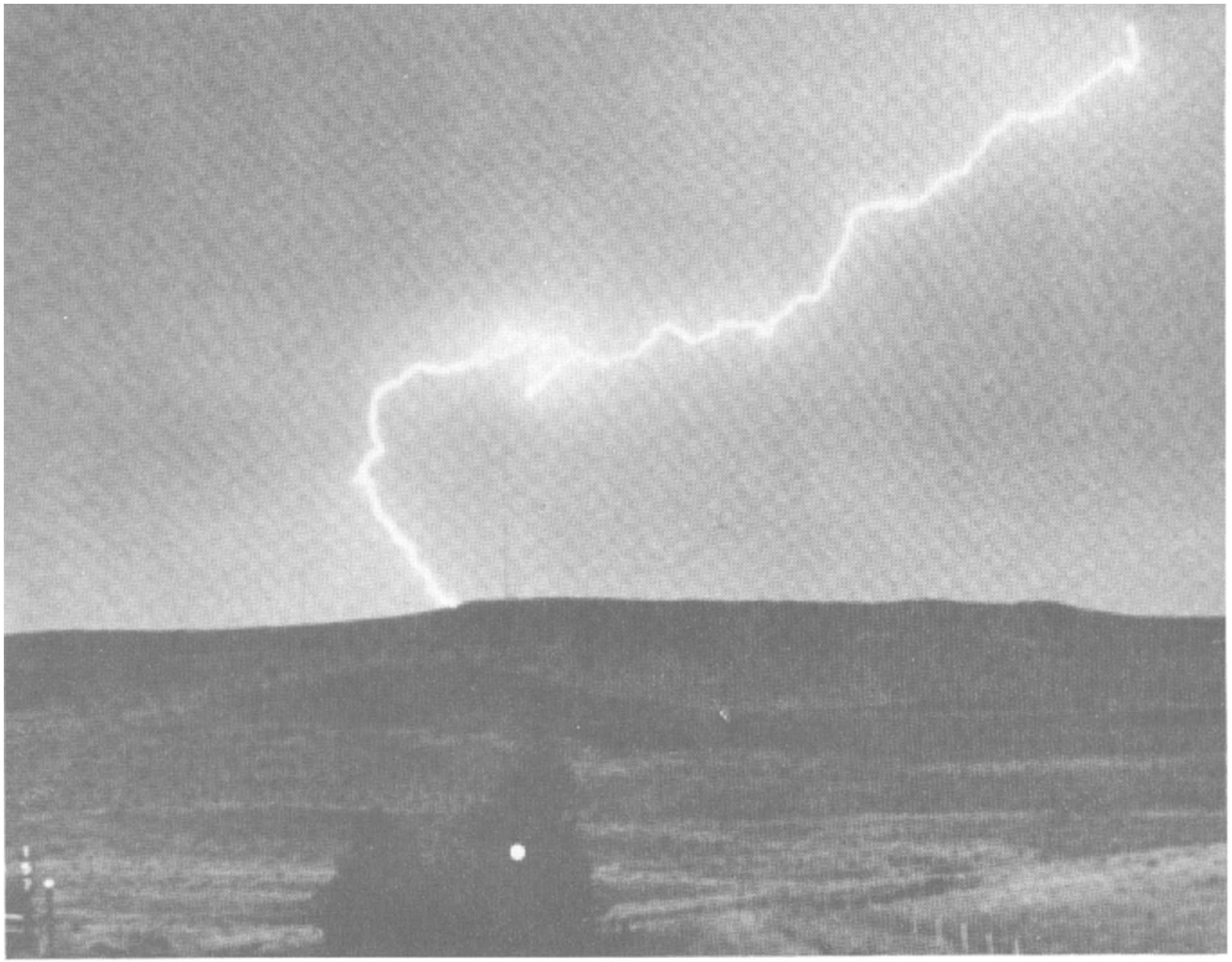
Continuation of Chapter 12 on *Summary and Investigative Considerations*, Volume 14
of the **abc of the Telephone** on Power Line Interference: Problems and Solutions, 1982
by Russ Gundrum

The telephone engineer need not feel bad about having to employ a mitigative device on his facilities, because **the technology and acceptance of the need for mitigation has been around for a long time**. Although some people may feel that something will surely come along to solve these problems, end even though the mitigation equipment works great, they think it is still a black-box technique and only a band-aide approach that masks the true solution. Of course there are no funny tricks or black magic being performed here. **The physics of the problems and solutions have been the same all of these many years.**

As a result **of today's electronic revolution and competition in the entire telecommunication field, a new engineering approach is needed to define the environment that a metallic telecommunication cable must operate within**. This approach **should be similar to electrical protection philosophy, but it should include the effects of inductive interference**. It is **often hard to distinguish where noise mitigation ends and protection engineering begins, since the two overlap**. From a total operating system's viewpoint, it **is usually more cost effective to mitigate the longer loops, since they will have the greater exposure to power lines and represent the bulk of all the noise and electrical protection problem areas**. This approach would also provide the best insurance policy against future, unforeseen power problems and many other hard to control factors, such as the weather.

Continued below
In notes

Horizontal Lightning (cloud-to-cloud) As A Source of Longitudinal Induction



Horizontal lightning or cloud-cloud lightning is a source of longitudinal induction.

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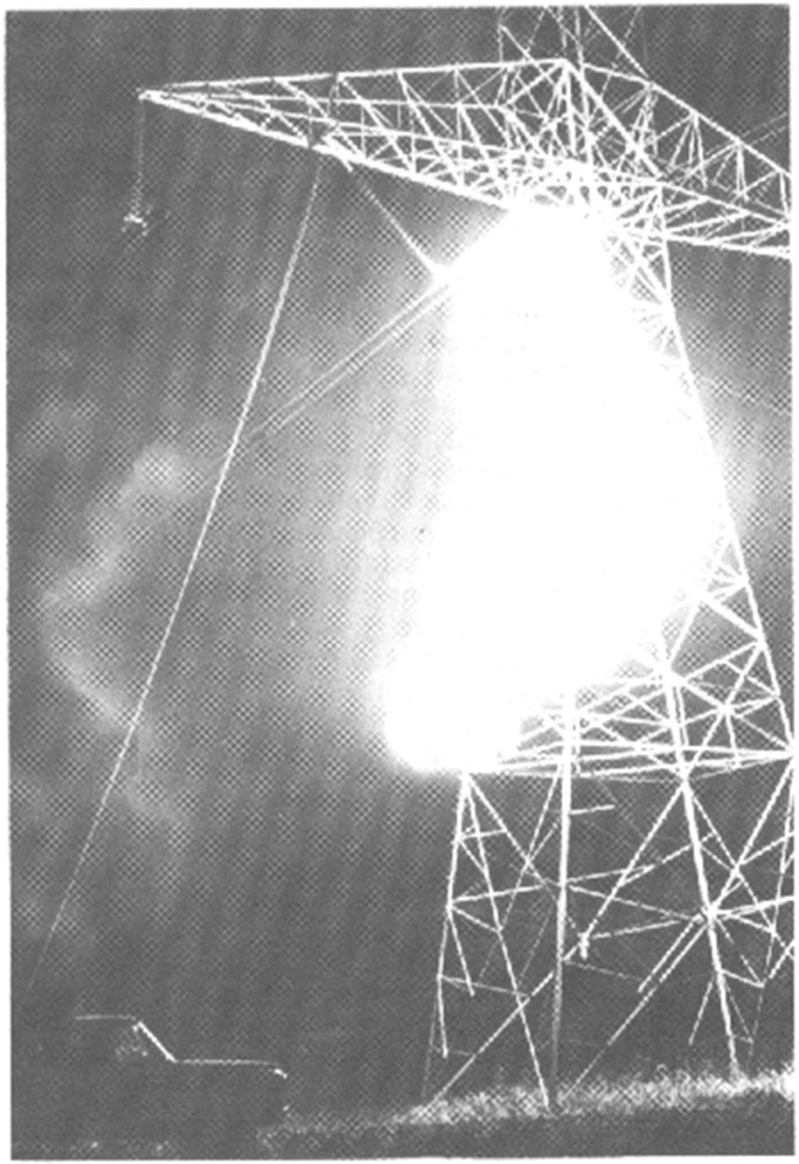
345 KV Fault-to-Ground



Worst-case induction occurs under temporary line-to-ground faults. This provides visual evidence of ground return current, but the resulting magnetic field still cannot be seen and appreciated.

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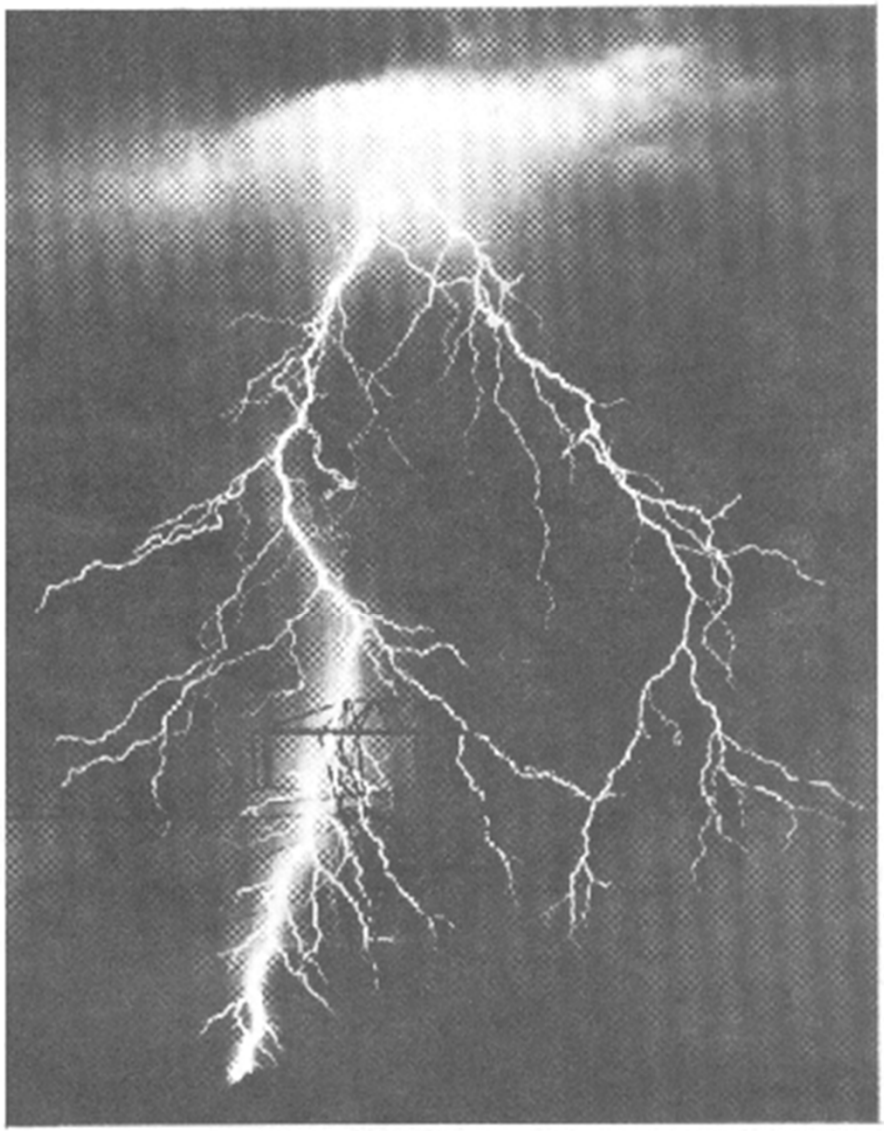
Lightning Hitting Power



While rarely witnessed or photographed, lightning striking power lines accounts for many protection problems. It's always interesting to correlate information from the power company to see what problems they have had after a storm passes by, and how it impacted on the telephone plant during the same time frame.

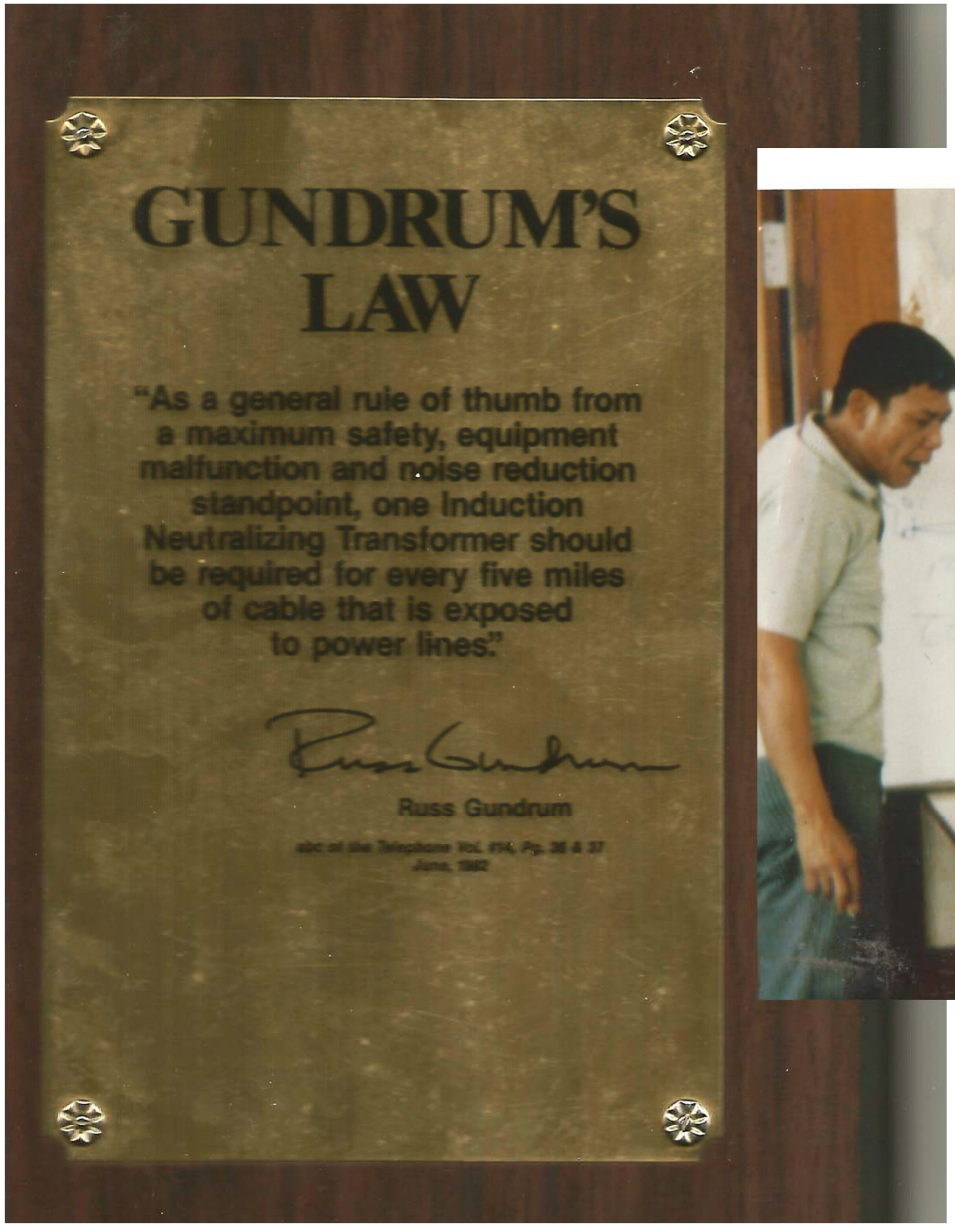


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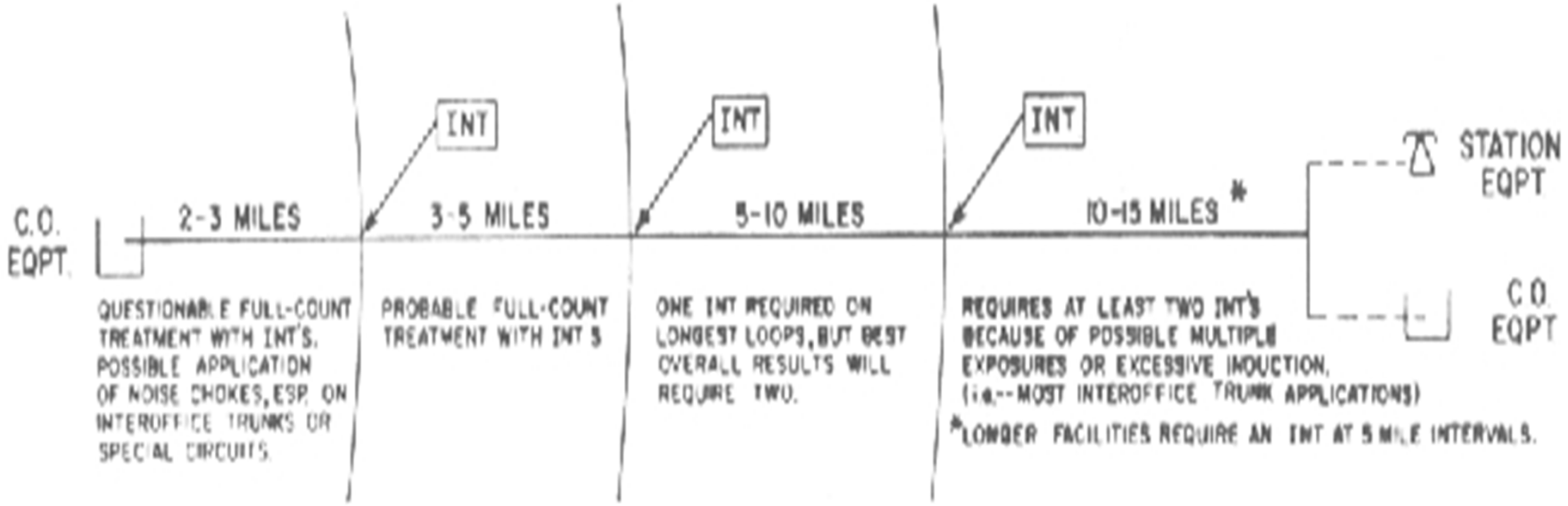
FIGURE 3

"Gundrum's Law"—Required treatment of wireline facilities exposed to power lines



Note: Suggested INT locations apply the principle of having the bulk of the subscriber distribution neutralized, since there is no voltage reduction obtained from the CC to the INT.