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• Specializing in
  – Protective Grounding
  – Arc Flash Analysis & Protection
  – On-Site Hazard Analysis
  – Technical & Safety Training
Associated Training Corp.

Presents

GROUNDING
MYTHS
&
MYSTERIES

Especially for the
EEI Safety & Health
Committee Conference
April 26, 2004
PROTECTIVE GROUNDING

• Been used forever
• Everyone understands or misunderstands it
• Every worker has their own way
• Each has a specific statement requiring grounds and grounding
• Everyone requires grounding of de-energized lines before work begins
• Which of the following do you use?
GROUNDING INSTRUCTIONS

• Ground between worker and source
• Ground on both sides of work area
• Ground between workers and all sources
• Ground at place of work
• And OSHA (1910.269)
  – "Equipotential zone." Temporary protective grounds shall be placed at such locations and arranged in such a manner as to prevent each employee from being exposed to hazardous differences in electrical potential.
GROUNDING MYTHS

• Ground between worker and source

Do your workers ground this way?
GROUNDING MYTHS

• Ground both sides of work area

Maybe your workers ground this way?
GROUNDING MYTHS

• Ground between workers and all sources? 

Can it be done?
GROUNDING MYTHS

• Is it possible to ground between workers & induced voltages?

I don’t think so!
Why is it impossible?

- If either line is energized both lines are energized – Grounded or not!

Grounding does not eliminate voltages or currents
Grounding Induced Voltages

- Magnetic field around conductor causes voltage rise in adjacent lines
  - Like a transformer

Adding grounds completes circuit and current flows
GROUNDING MYTHS

• Ground at place of work

• Any of these fit that requirement!
GROUNDING INSTRUCTIONS

• And OSHA (1910.269)
  – "Equipotential zone." Temporary protective grounds shall be placed at such locations and arranged in such a manner as to prevent each employee from being exposed to hazardous differences in electrical potential.
  – DOES THIS MEAN EVERYONE?
  – BOTH LINE MECHANICS AND GROUND PERSONNEL?

The following is from an IEEE Transaction paper written by WAPA engineers and published in July 1997.

At least four tests were staged using a 230kV line with two overhead static conductors.

Three-phase bracketed grounding, combination grounding, single-phase worksite grounding and three-phase worksite grounding were evaluated and reported.

Footing currents and voltage drops that would appear across line workers were measured and reported. Step potential readings were recorded at 1, 3 and 10 meters.
GROUNDING METHOD TEST #1

Bracket Grounding

- $I_{\text{Fault}} = 1713\text{a}$
- $V_{\text{worker}} = 35\text{v}$
- $V_{\text{Step}} = 500\text{v}$

Grounds on both sides of work area or grounds between workers and all sources.
GROUNDING METHOD TEST #2

Combination Grounding

- $I_{Fault} = 1788a$
- $V_{worker} = 0.33v$
- $V_{Step} = 571v$

Grounds on both sides of work area or grounds between workers and all sources and equal potential zone
GROUNDING METHOD TEST # 3

1 Phase Worksite Grounding

- $I_{\text{Fault}} = 1754\text{a}$
- $V_{\text{worker}} = 3.6\text{v}$
- $V_{\text{Step}} = 650\text{v}$
GROUNDING METHOD TEST #4

3 φ Worksite Grounding

- $I_{\text{Fault}} = 1682\text{a}$
- $V_{\text{worker}} = 3.3\text{v}$
- $V_{\text{Step}} = 614\text{v}$

Equal Potential Zone

Equi-Potential Grounding
Where Can Workers Safely Stand?

Ground Personnel are probably safe from Step Potential at these fault current levels if they stay 10 – 15 feet from tower legs. 

But don’t touch pole grounds or tower legs!

Less than 2000A
Where Can We Safely Park?

Trucks can cause GROUND POTENTIAL TRANSFER

V = 1250 - 1000 = 250v
• At today’s fault current levels no method protects everyone

• Our world has changed and so must we!
Equi-Potential Grounding

- All grounding methods have limitations
- Even Equi-Potential grounding causes Step & Touch Potentials

And this worker just violated the EPZ boundary
Equi-Potential Grounding

• Even Equi-Potential grounding causes Step & Touch Potentials
• All grounding methods have limitations

Every worker must recognize
their protection has limitations
Equi-Potential Grounding

• Equal potential zone both poles
• Workers aloft would be in EPZ
• Ground personnel should wear rubber gloves

We just need’em to think!
Equi-Potential Boundary

- Equal Potential is the best we have and it’s not perfect
- Workers must recognize boundaries and zones of protection
EPZ Boundaries

- Equi-potential boundary hazard
  - Operator is safe
  - Worker in Sub is safe
  - Worker touching truck unsafe
GROUNDING MYSTERY

Eqi-potential grounding is not a mystery

But, it does require understanding
A REAL GROUNDING MYSTERY

The Case of the Psychic Dog

Equi-Potential Grounding
GROUNDING MYSTERY

• Clues
  – An elderly lady called Verizon Phone Company to say that her telephone failed to ring when her friends called
  – On the few occasions when it did ring her dog always barked before the phone rang.
  – The telephone repairman proceeded to the scene, mostly just to see this psychic dog or senile elderly lady.
GROUNDING MYSTERY

• More Clues
  – He climbed a nearby telephone pole, hooked in his test set, and dialed the subscriber's house.
  – The phone didn't ring but the dog barked loudly and then the telephone would ring.

Have you figured it out?
GROUNDING MYSTERY

Climbing down from the pole, the telephone repairman found:

- 1. The dog was tied to the telephone system's ground post via an metal chain and collar.
- 2. The dog was receiving 90 volts of signaling current when the phone number was called.
- 3. After several such jolts, the dog would start barking and urinate on the ground.
- 4. The wet ground would complete the circuit and the phone would ring.

• Solution Create an Equi-Potential zone
GROUNDING MYSTERY SOLVED

• Equal Potential Zones don’t make the voltage go away!
• It just controls it better.
Grounding Method
No EPZ

- Note current paths
- Worker provides current path
Equal Potential Grounding Explained

- Notice worker is still a current path
- But paralleled by a very low impedance path
Equal Potential Perimeters Remain Hazardous

- Workers hands & feet at different potential
  - Worker - high resistance path
  - Pole – high resistance path
- Worker may receive electrical shock!
Myths & Mysteries

• Equi-Potential Grounding
  – Is not a mystery
  – Requires understanding
  – Has limitations
  – Provides best protection to date
  – Is not the only solution
  – Does not eliminate all exposure
To Be Protected

- Workers must understand the limitations of protective grounding
To Be Protected

- Workers must learn this was never true!

- Did you ever believe this?

\[ V_{Source} = 7.2kV \]

\[ V_{Worker} = 0kV \]

\[ V_{Feedback} = 7.2kV \]
To Be Protected Workers Must Know

- If this one is in service

- They must understand this line is always energized!
Grounding parallel lines provides a path for current to flow.

It does not eliminate induced voltages or currents.

Both aerial and ground workers must understand this situation as well as the limitations and hazards of protective grounding!
Not a Mystery

• Equi-Potential Grounding
  – Is not a mystery
  – Will work, but has limitations
  – Is not a cure all
  – Requires
    • Understanding
    • Training
    • Planning
    • Proper Equipment
What About Underground and Manholes

• How do we create an equal potential zone in:
  – Manholes?
  – Vaults
  – Trenches

• And what type of grounds are available?
What About Underground and Manholes

- Imagine working in a manhole with grounds that become energized.

- We need to work on grounding specifications and equipment for grounding in manholes and pad mounted equipment.

Somebody said grounds could blow off! Now what about arc hazard?
The Challenge

• Equi-Potential Grounding probably started around 1958
• Even after 40+ years it’s still new in some places
• Protective grounding is widely misunderstood
• URD & Manhole grounding equipment and methods need attention
• Arc hazards need addressing
The Future

• We think Protective Grounding is misunderstood
• We think grounding is widely misunderstood because:
  – A lot of people don’t understand grounding’s purpose or it’s limitations
  – And because “If it’s not grounded it’s not dead”.
Thanks for having me here today

• And if anyone at Associated Training Corp. can be of assistance or help please let us know!

Contact us at info@atc-trng.com
or visit our web site at www.atc-trng.com
Test Your Knowledge

Answers to both this exercise and the written test can be found on our web site

www.atc-trng.com

Thanks & have Great Day!

Equi-Potential Grounding