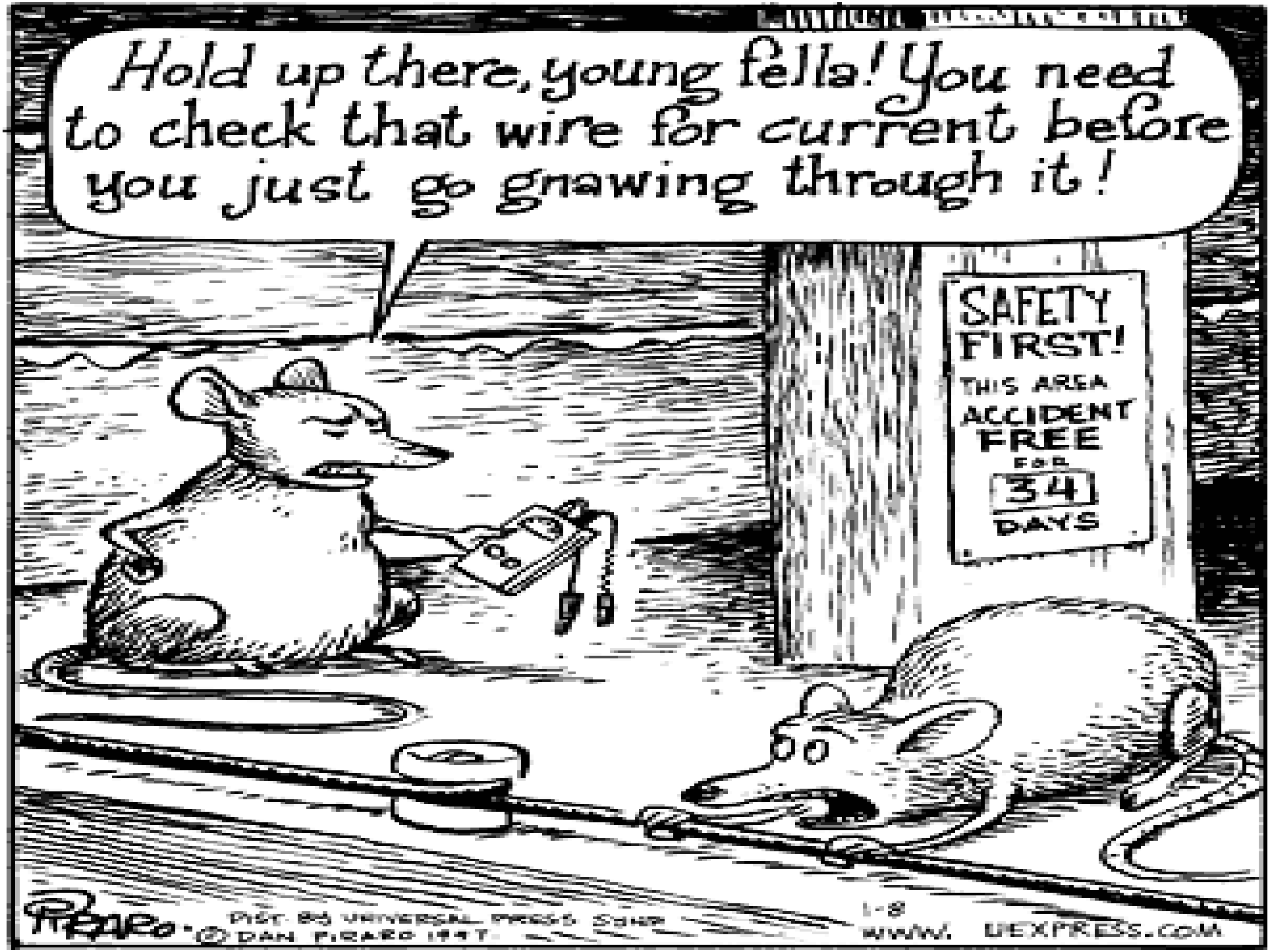
“Test Before Touch” Easier Said Than Done

Ken Crawford, DuPont

Kent Haggerty, Dupont

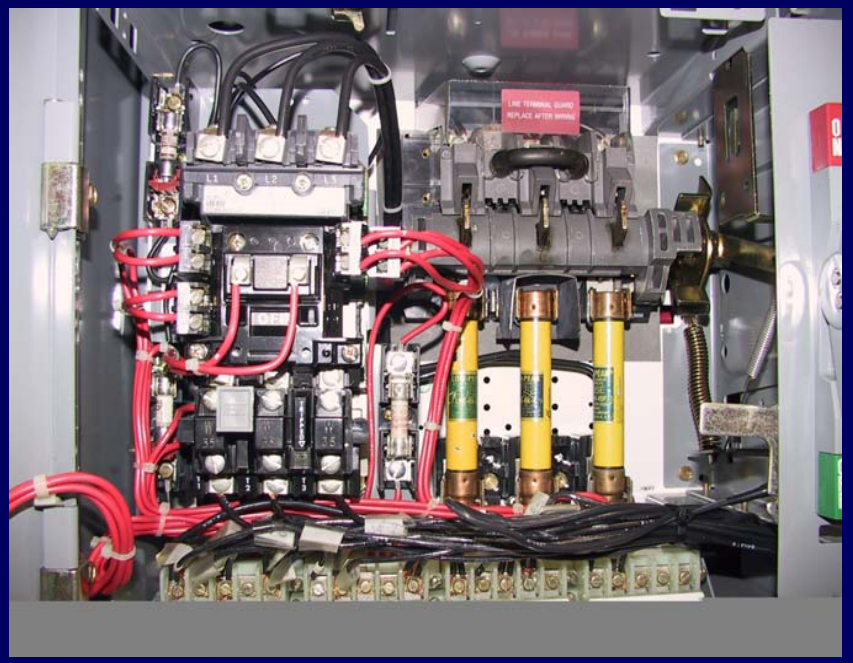
Overview

- Test Before Touch (TBT) Principles
- Key Learnings by One Company
- One Method for Performing a TBT
- Induced Voltages
- Medium Voltage Testing
- Summary & Conclusions


Hold up there, young fella! You need to check that wire for current before you just go gnawing through it!
SAFETY FIRST!
THIS AREA
ACCIDENT
FREE
FOR
34
DAYS
PIRATE
DIST. BY UNIVERSAL PRESS SYND.
© DAN PIRARO 1997
1-8
WWW.UEXPRESS.COM

How Would You Verify Power is Off?

- What would be the plan?
- What could go wrong?
- What instruments to use?
- What PPE is needed?
- How to minimize hazards?
- Where are the shock and arc hazards?
- Are you qualified to work on this equipment?



Key Learnings in One Company

- TBT Not Fully Understood
- Inadequate Training
  - No Planned Approach
  - Best Practices Not Documented
  - Did Not Warn of Common Mistakes
- Concepts Seemed Simple
- Proper TBT Involves Knowledge and Planning

"Test Before Touch" (TBT) Key Principles

- Consider All Circuits Energized Until Tested
- Test *EVERY* Conductor To Be Touched
- PPE Is Required Until Test is Completed
- Test Instrument Must Be Verified
- Knowledge of Equipment Is Essential
- Test Circuit Again If Job Continuity Is Broken
- Testing Must Be Done At Each Location Where Conductors Are Going To Be Touched

Protect the Person

Shock Protection

"#" indicates US ANSI voltage class
"00" rated 500 volts;
"2" rated 17,000 volts

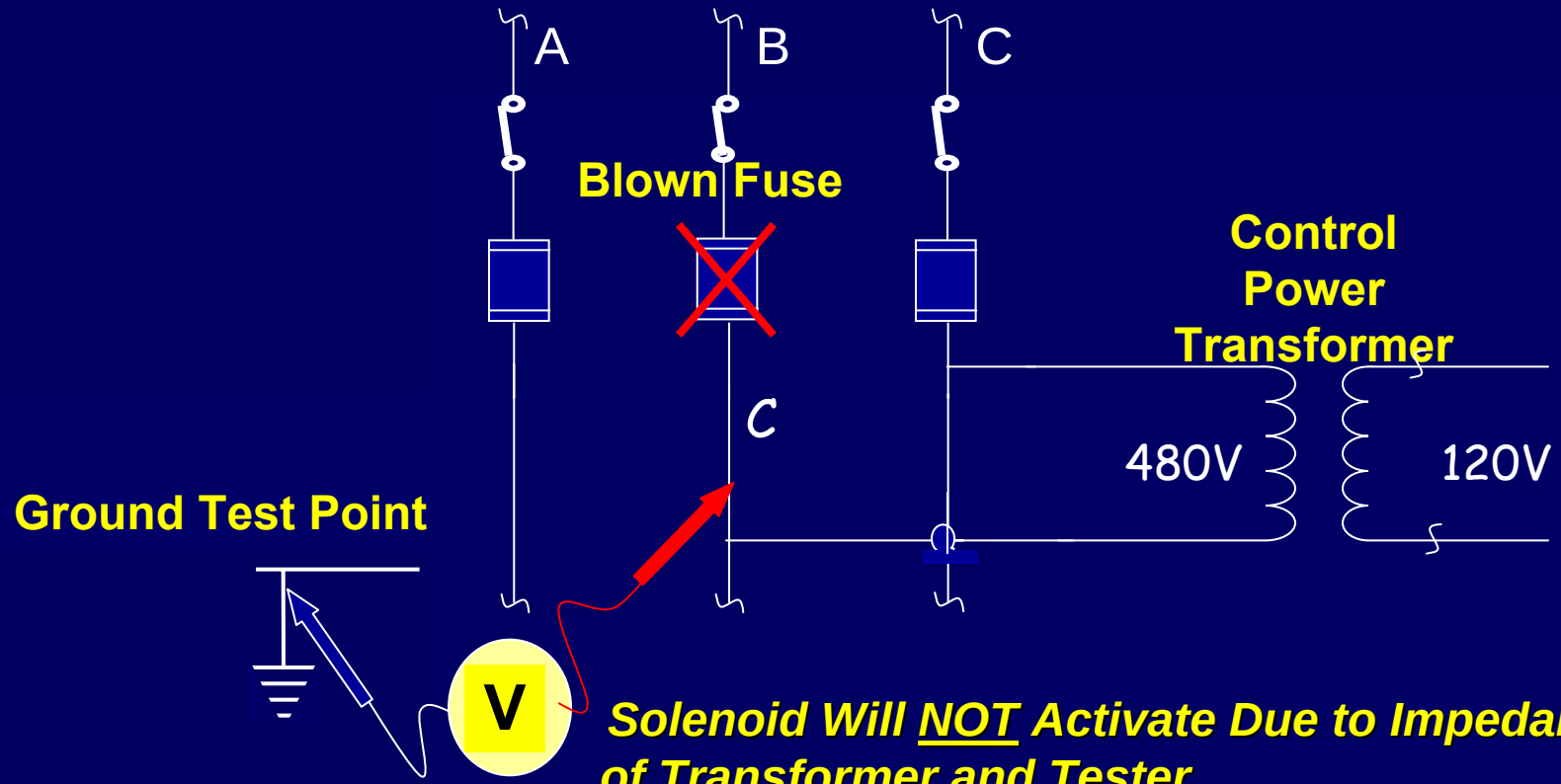
Arc Flash Protection

Selecting The Proper Tester

- Zero Indication Must Mean No Voltage Present
- Testers With Limitations
  - Multi-meters Can Be on Wrong Setting
  - Some Solenoid Testers May Not Always Indicate
  - Proximity Testers May Give False Indication
- Voltage Only Tester Should Be Used for TBT
- No Single Voltage Tester Will Cover All Applications

Solenoid Tester Limitations

Solenoid testers may not indicate backfeed from control power transformer



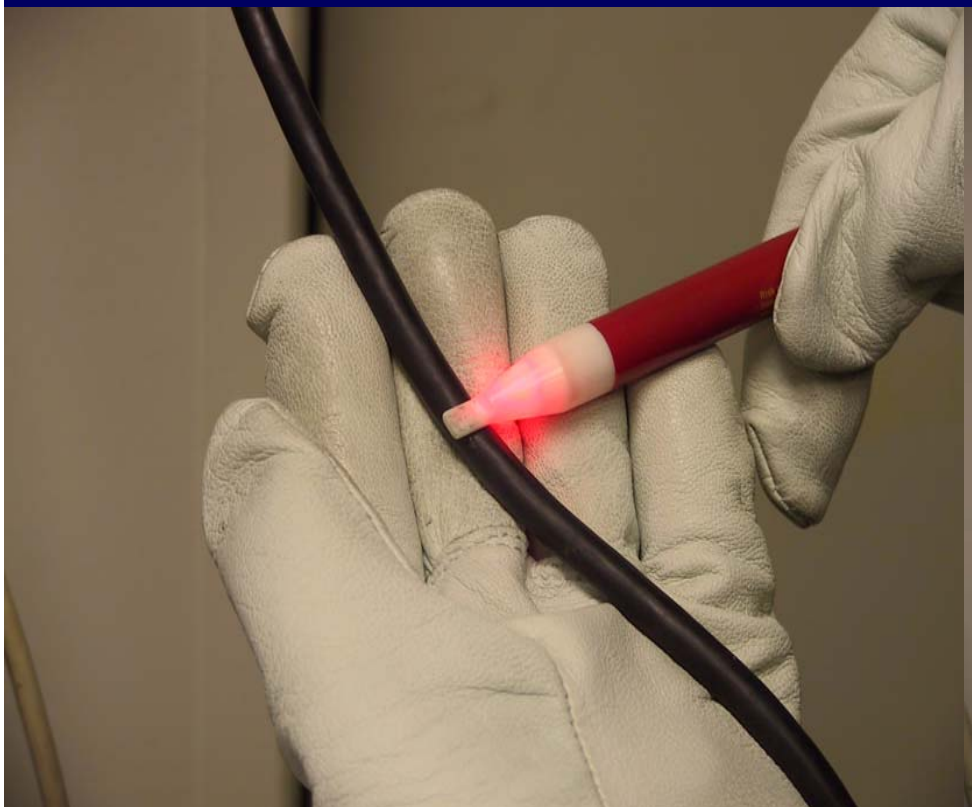
Solenoid Will <u>NOT</u> Activate Due to Impedance of Transformer and Tester

Solenoid Testers With Voltage Indicating Lights Are Preferred

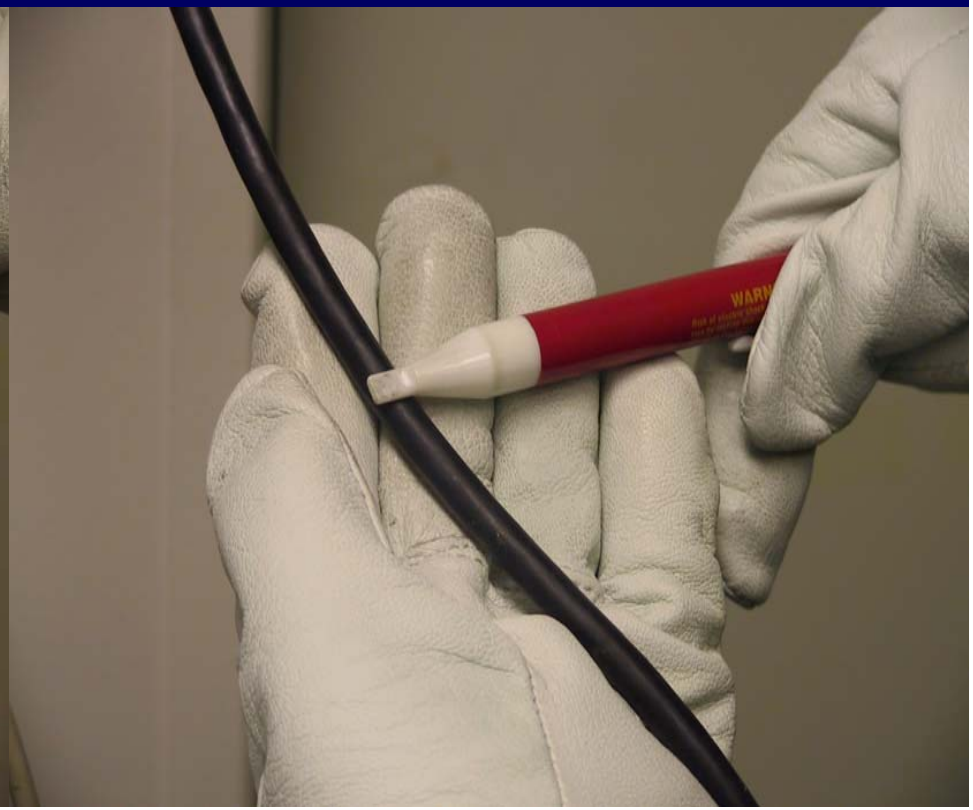
Limitations of Proximity Testers

Multi-Conductor or Shielded Cables Require Special Attention

Proximity Tester Reads Energized Conductor



Ground Conductor Shields Energized Conductor



Proximity Tester Limitations for Low Voltage Testing

- Detects AC Voltage Only
- Will Not Indicate Voltage Inside
  - Grounded Enclosures
  - Shielded Cables
  - Internally Wet Cables
- May Not Indicate Voltage if
  - Cable is Partially Buried
  - Insulated Test Point is Against Grounded Metal
  - Operator Isolated From Ground

Testing Method on Low Voltage Circuits

1. Test Ground to Phase for all Phases
   - Keeps Meter at Zero Volts for Most of the Test
   - Voltage Usually Lower (e.g. 277 Vs. 480)
2. Test Neutral to Phase (if available)
   - Provides Backup Test to Ground to Phase
3. Test Phase to Phase (if available)
   - Check Each Phase to All Other Phases (A-B,A-C,B-C)
   - May be Only Valid Test on Ungrounded Systems

Steps in Performing Absence of Voltage Tests

Step 1 - Probing Position

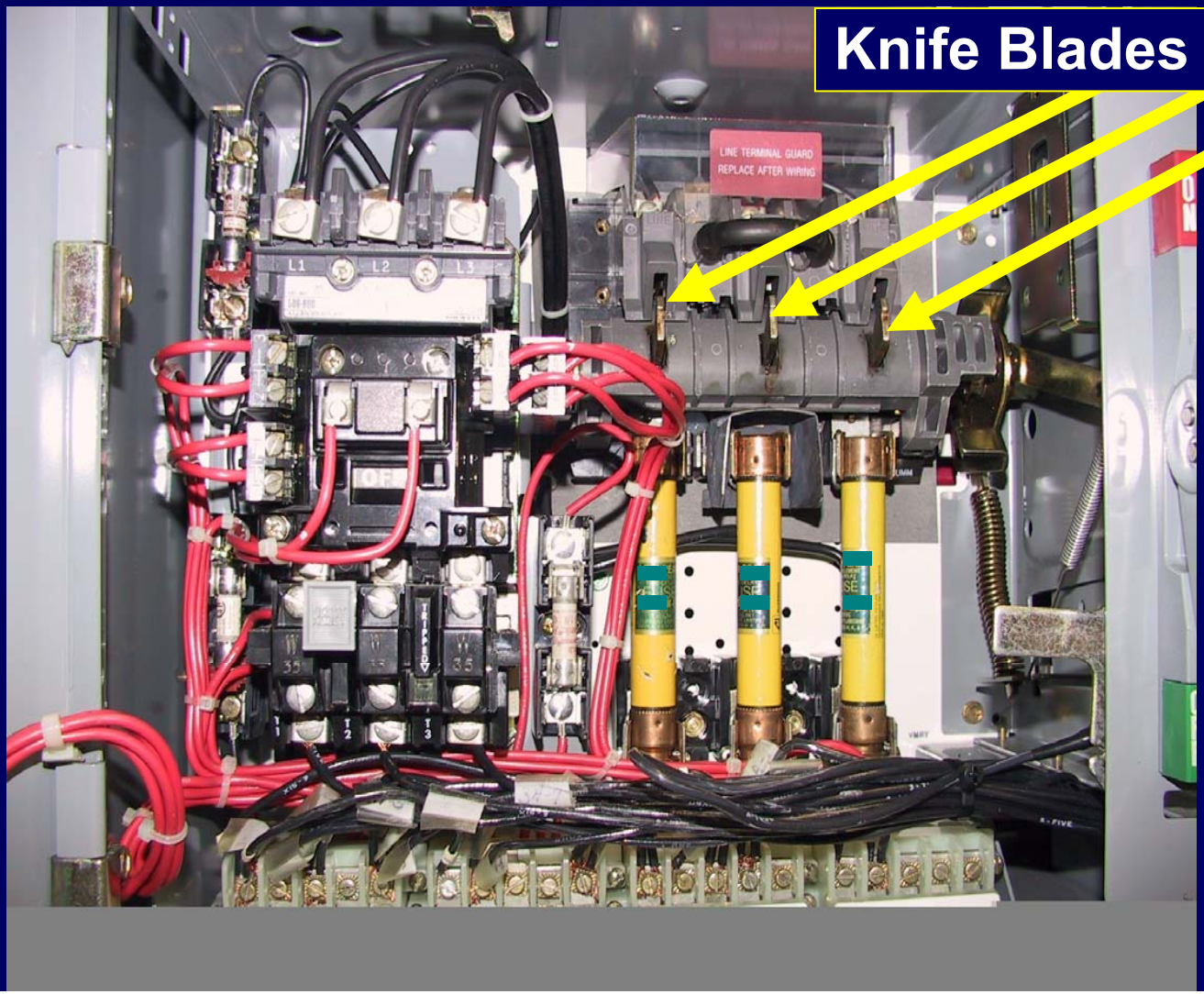
- Place the Red Lead in the Meter
  - Reduces Risk of Contact
- Black Lead Placed on Ground First and Removed Last

Step 2 - Check Meter

- Verify Meter on Energized Source Before & After Test
- Source Must Be Same Type (AC or DC) As The Equipment To Be Tested.

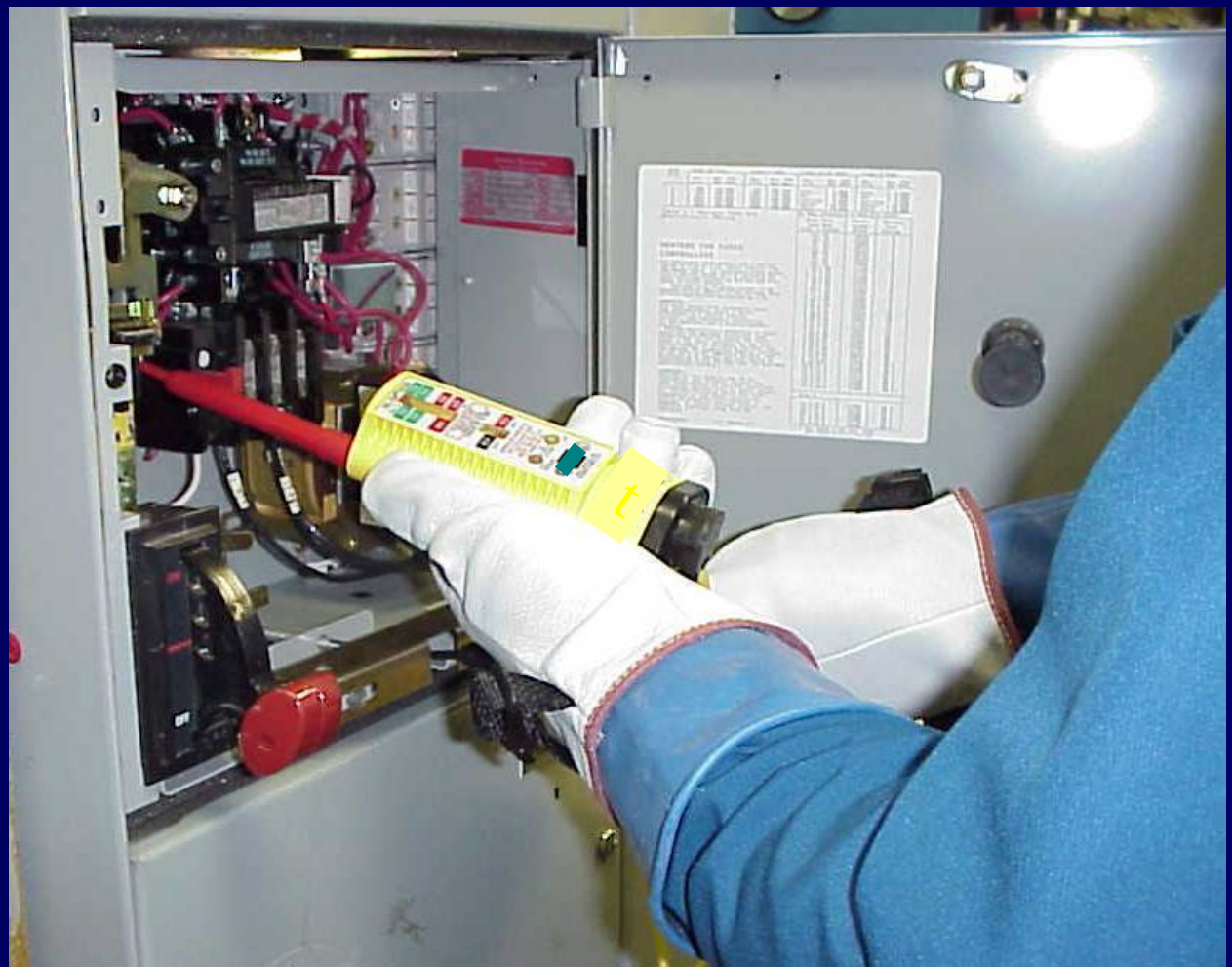
Step 3 - Verify Circuit Is “Off”

- Verify the Circuit Requiring Work is Turned "Off" And Any Disconnect Knife Blades Are Open

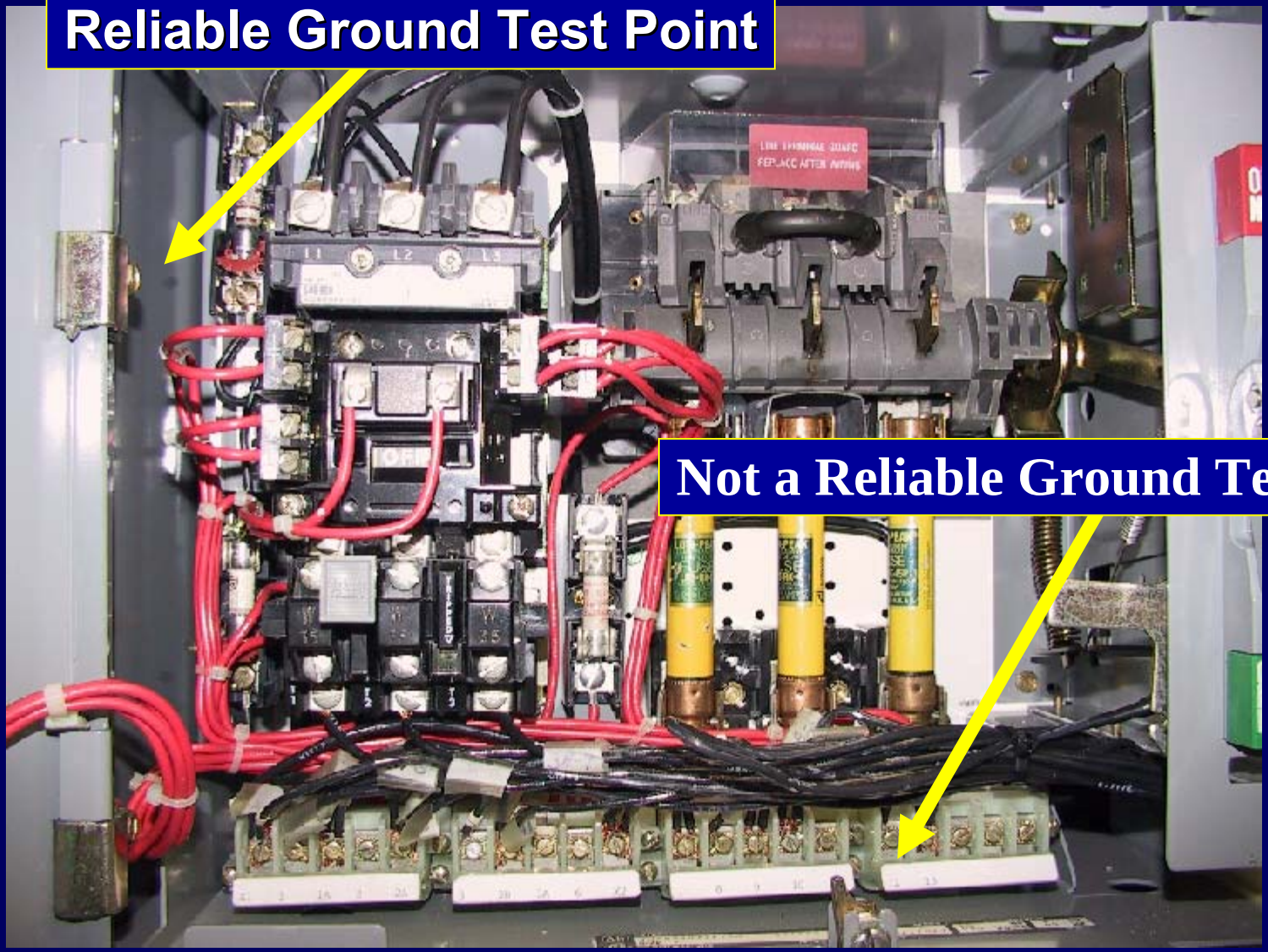


Step 4 - Ground to Phase Test

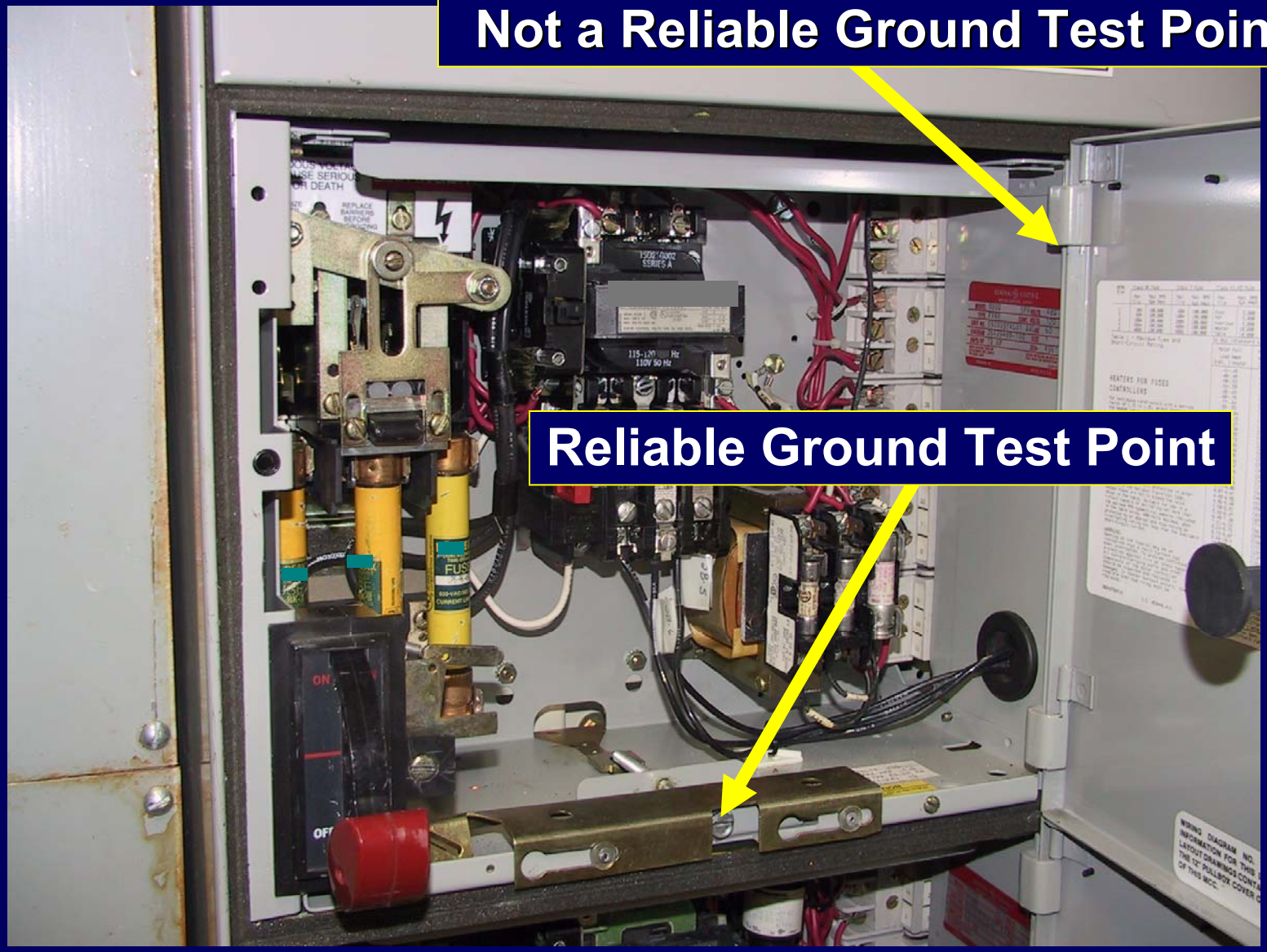
- *Must* be Absolutely Certain of a Reliable Ground
  - If Not Sure, Test Ground Point
- Reliable Ground Point Depends on Equipment



Step 4- Ground to Phase Test - Cont.
Ground Test Point Depends on the Equipment



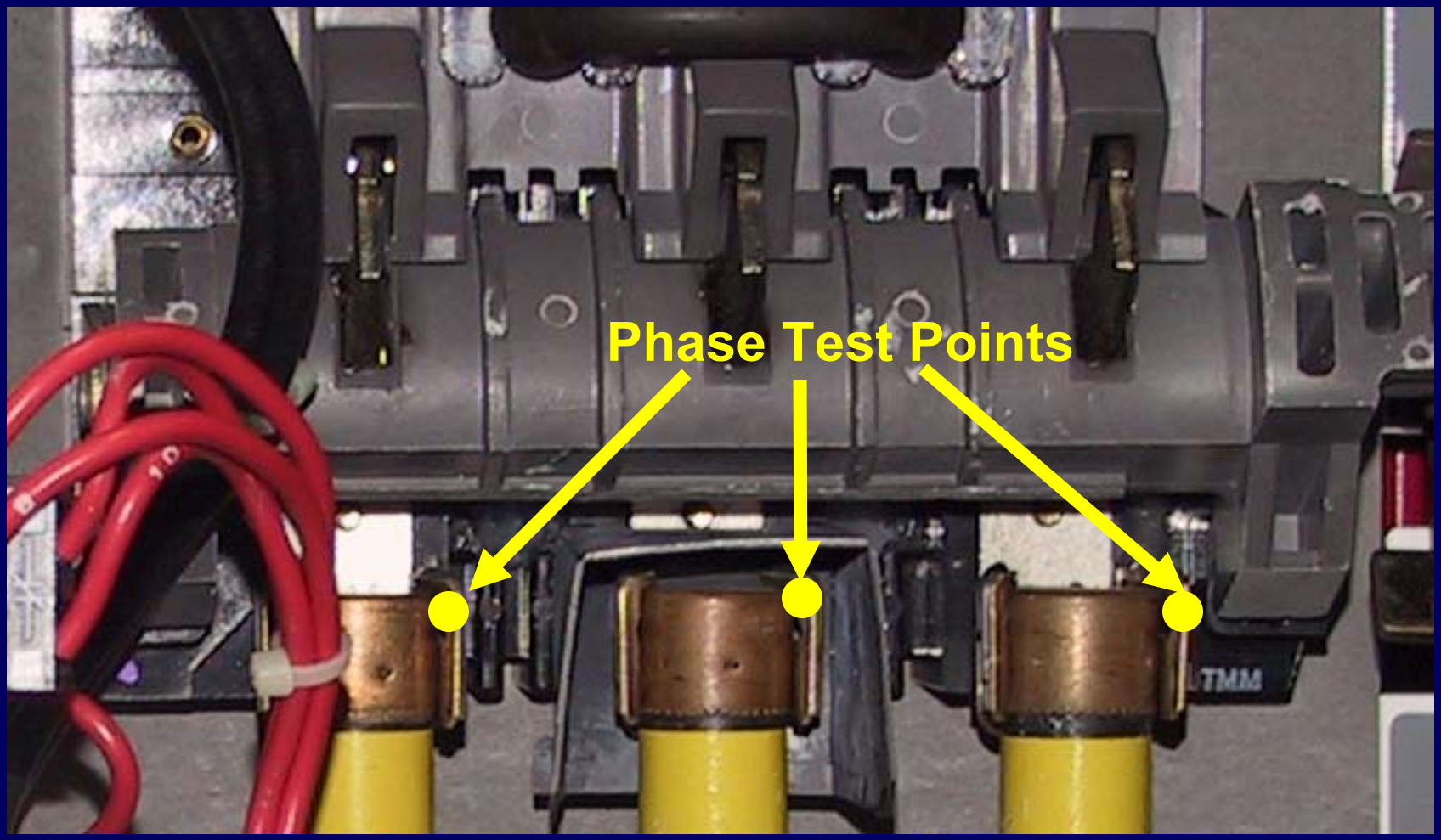
Step 4 - Ground to Phase Test - Cont.
Ground Test Point Depends on the Equipment



Test Points

- The Load Side of Switch Should be Tested First
- Never Use Fuse Caps (Ferrules) as a Test Point
  - Some Fuses Have Insulated Ferrules

Test Points (cont'd)

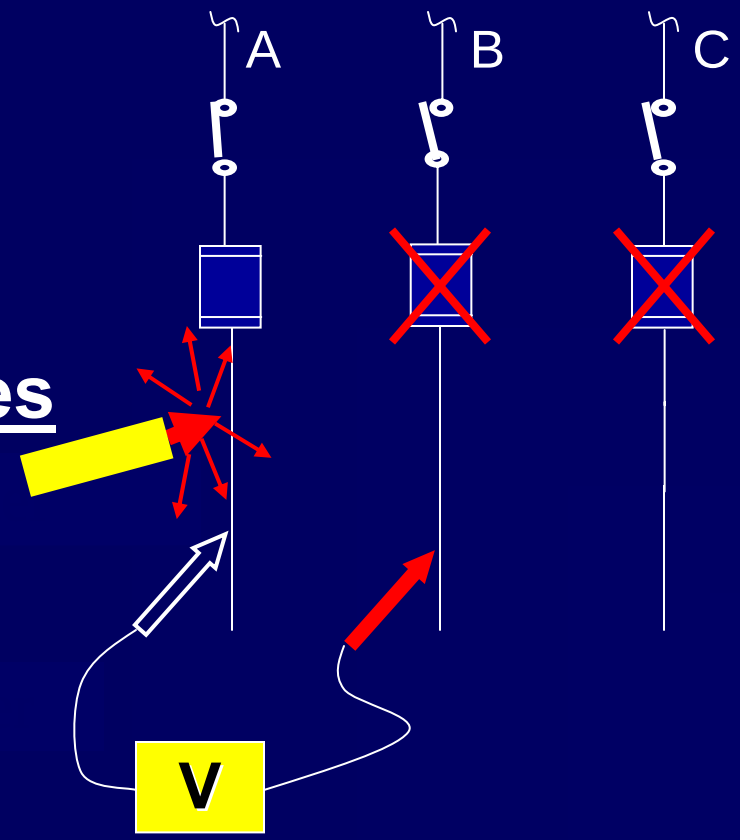


Test on the Fuse Holder Not the Fuse

Step 5 - Phase to Phase Test

- Check Phase to Phase Even if Ground to Phase Checks Indicate "0" Volts
  - Provides Backup Check
  - May Be Only Valid Test on Ungrounded Systems
- Phase to Phase Test Alone Is Not Sufficient

Phase-to-Phase Test Limitations



Proximity Tester Does Indicate Voltage

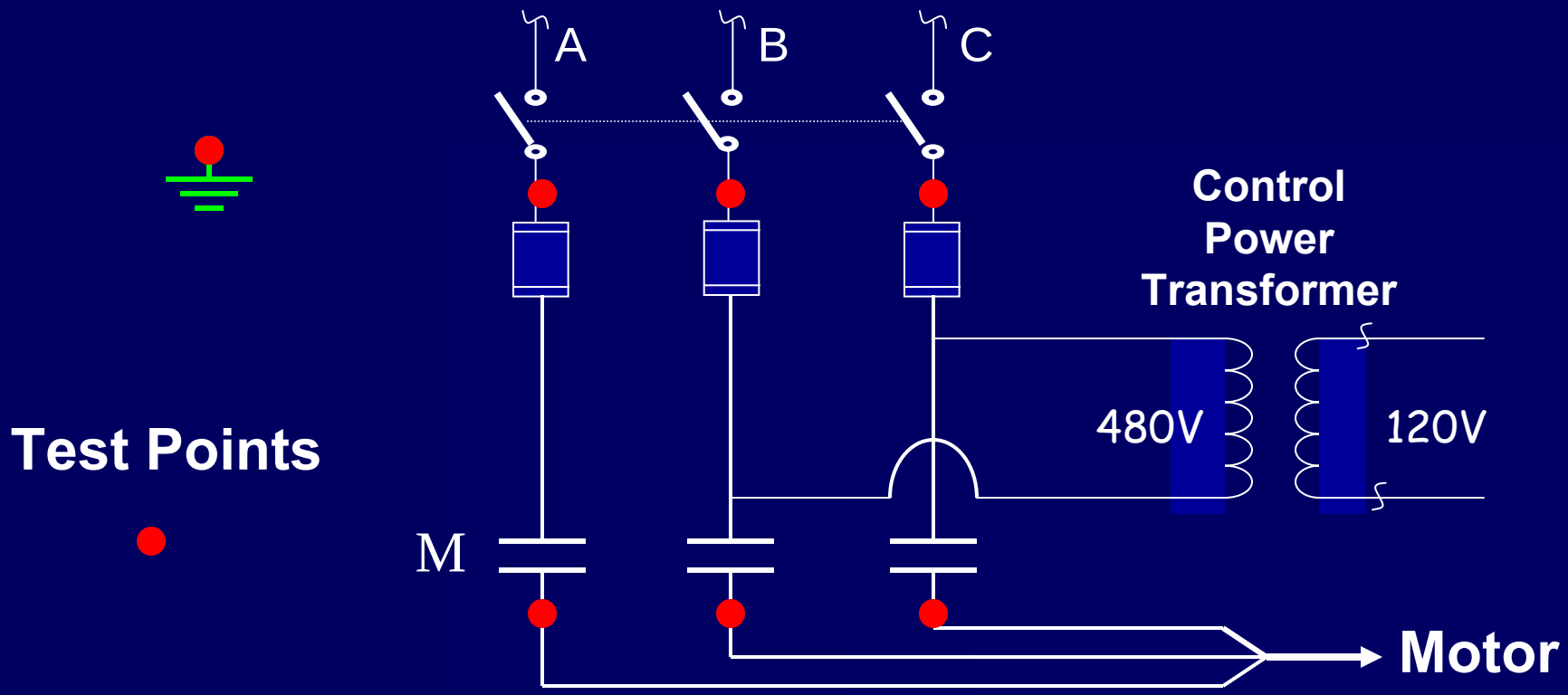
Blown Fuses or faulty switch

Meter Does Not Indicate Voltage

Task: Replace Motor T-Leads in a 3 Phase Motor Starter

What Are The Minimum Number of Tests Required?

Testing to Remove Motor Leads for 480V Starter



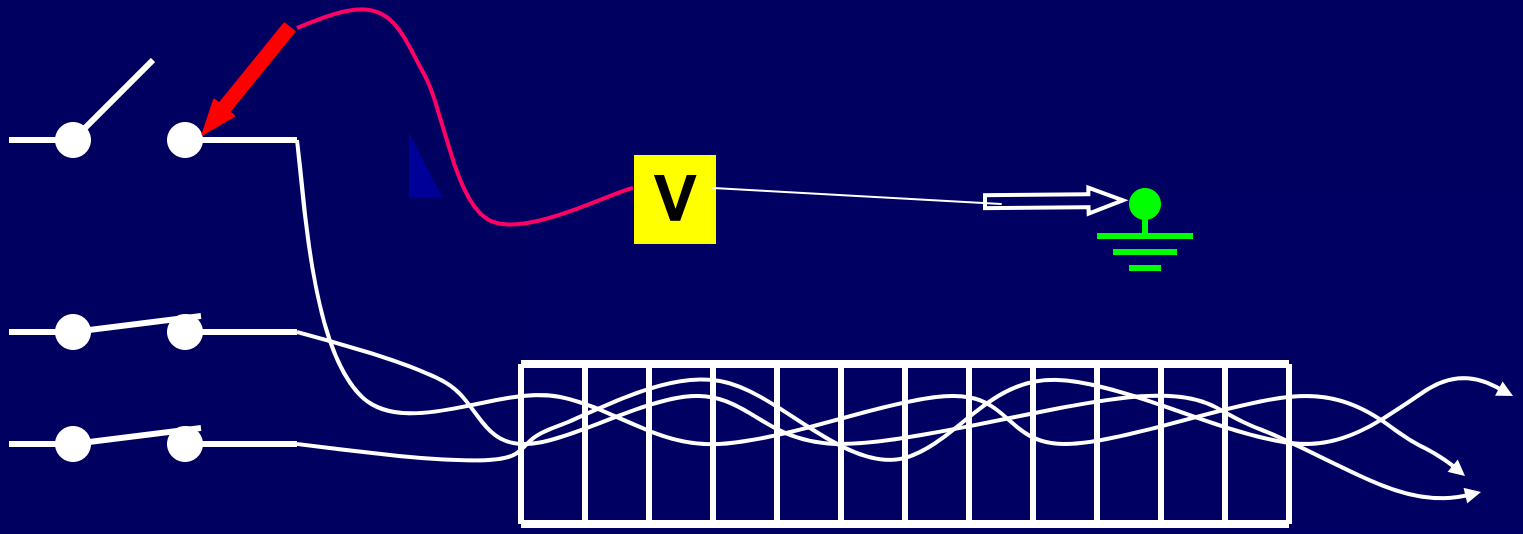
A Total of 12 Tests Are Required

6 Ground To Phase & 6 Phase to Phase

Voltage Measured on "De-energized" LV Circuit, What Do You Do?

- Verify Proper Circuit & Equipment
  - Check Prints, Labels, Resources
- Determine if Voltage is Induced
  - Detected by Meters With High Input Z ~ 10 M Ω
  - Low Input Z Meters Collapse Induced Voltage Z~ 2 kΩ
  - Verify Voltage Collapses to "0" With Low Z Tester
- Voltage Still Present After Loading Circuit
  - Check for Backfeed, Equipment Failure

Induced Voltage Value Depends on Meter Impedance



Close Coupling in Cable Tray

High Z Digital Meter Reading	95V
Analog Meter Reading	80V
Low Z Digital Meter Reading	0V

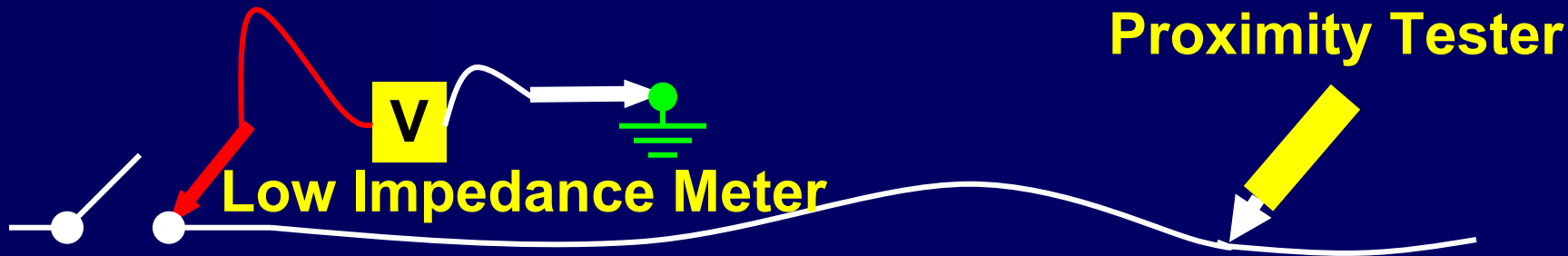
Testing Insulated Conductors

Testing Insulated Conductors

- Use a Proximity Tester for a First Test
- Should Not Be Used as the Only Test
- If No Voltage Indicated
  - Wearing PPE, Expose Conductor For Testing
  - Verify “0” Volts With Contact Meter
- Voltage Indicated with Proximity Tester
  - Verify Proper Circuit is Locked out
  - Re-Check source for Induced Voltage Using a High Impedance Meter
  - If Voltage is Present, Load Circuit at Switch with a Low Impedance Meter and Re-check Insulated Conductor

Verifying Induced Voltage on Insulated Conductors

Proximity Tester Indicates Induced Voltage on Insulated Conductor

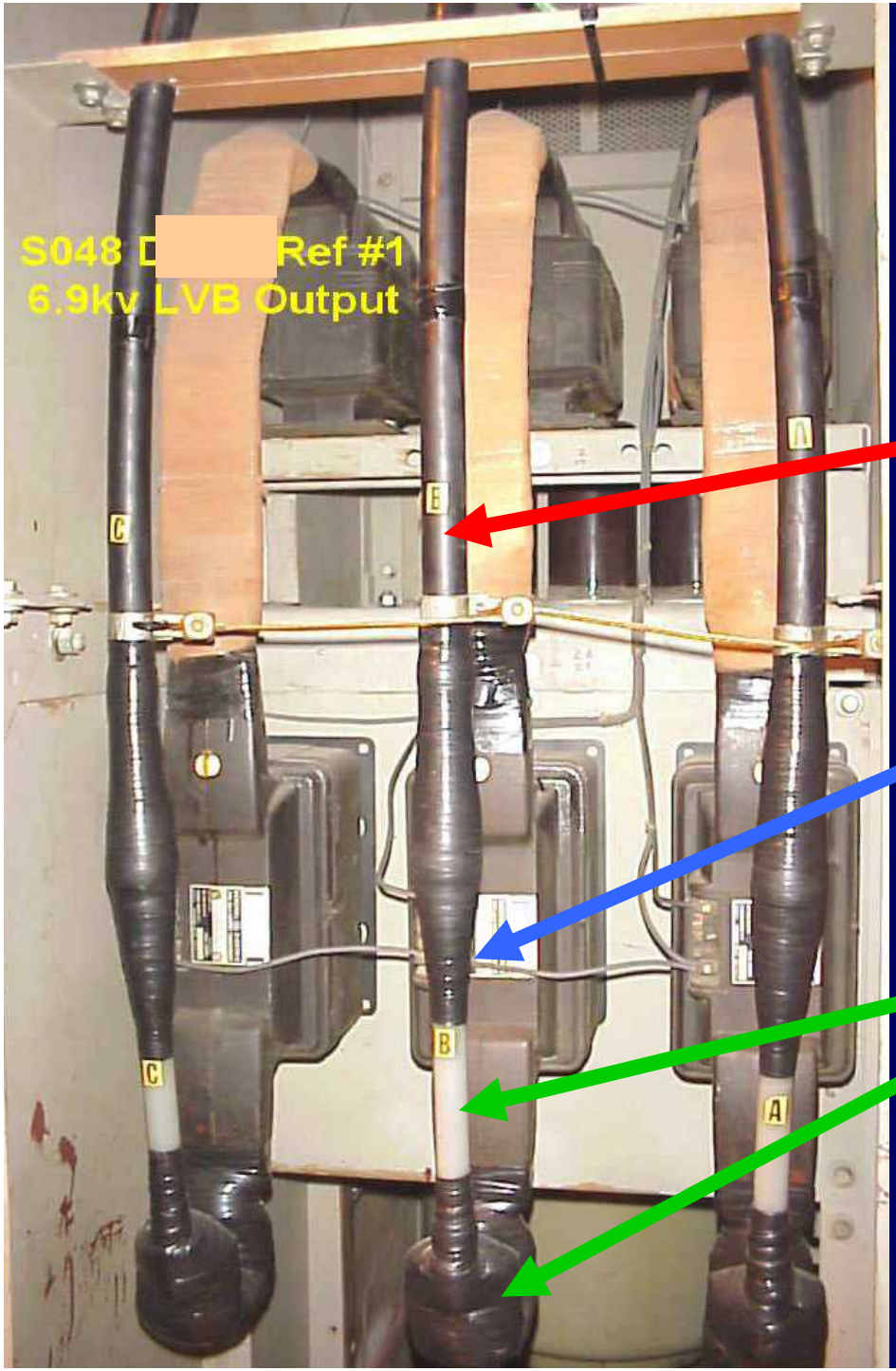


Proximity Tester Does Not Indicate Voltage Due to Circuit Loading by Low Impedance Meter

Testing Medium Voltage Circuits

Considerations in Testing Medium Voltage Systems

- Proximity Testers Often Preferred Due to Strong Electric Fields
  - Direct Contact Not Required
  - Only One Probing Stick Needed
  - Can Test Taped Connections
- Shielded Conductors Cannot Be Tested Except at Terminal Connections
  - Spiking Tool May Be Necessary to Verify Shielded Conductors Are De-energized



Medium Voltage Shielded Cables Require Special Attention

Shielded Cable - Proximity Tester Will Not Indicate

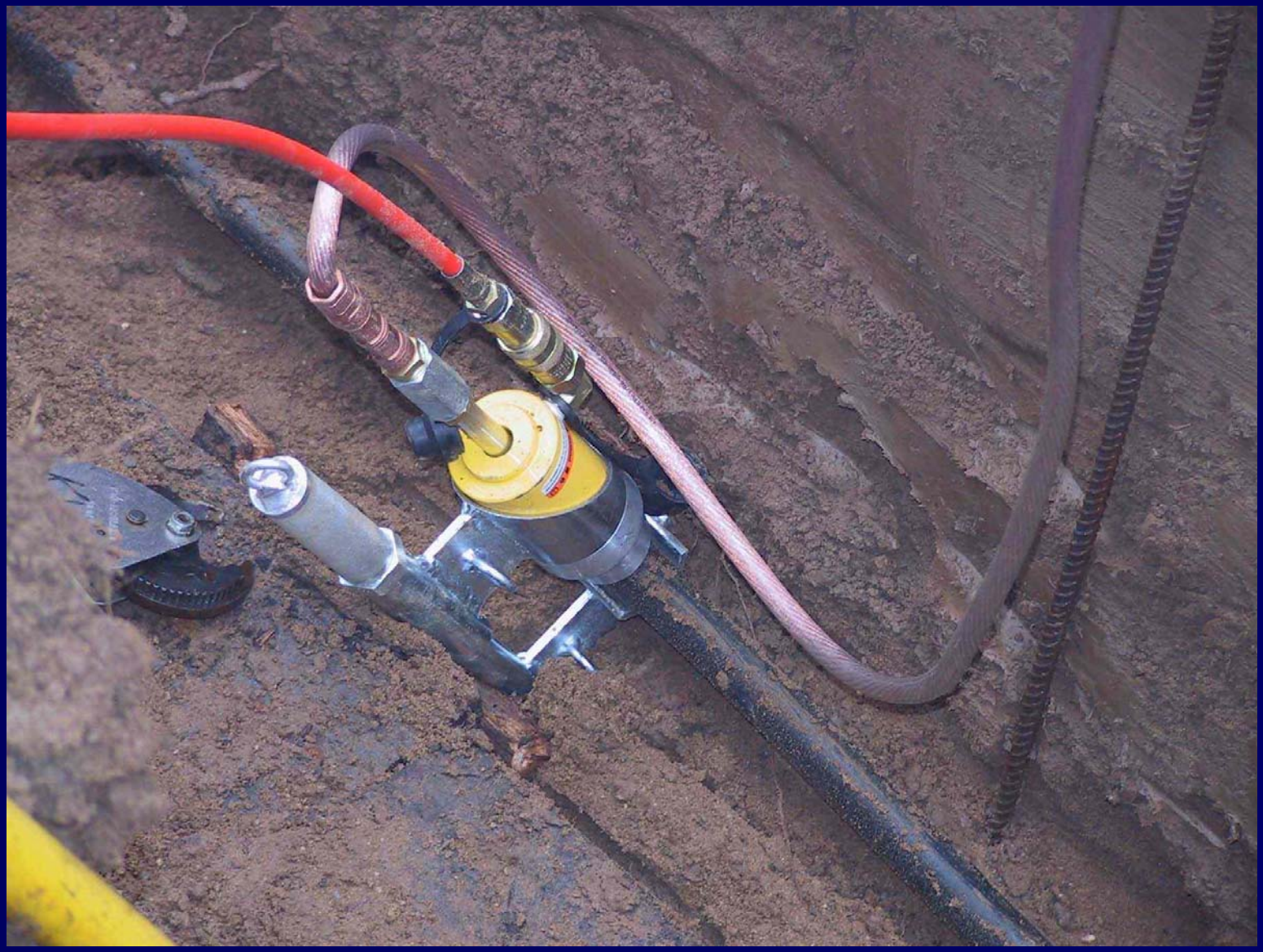
Cable Shield Terminates Here

Proximity Tester Will Work Here

Which Shielded Cable Is De-Energized?

Gauss Meter For Cable Identification

Spiking Tool




HI-RANGER

Summary & Conclusions

- Consider All Circuits Energized Until Tested
- Training and Knowledge Required
- Plan for Testing
- Use Proper Voltage Tester
- Use Appropriate PPE
- Test Before Touch Not Always Simple

Test
Every Circuit, Every Conductor, Every Time *Before* You *Touch!*

It Could Save Your Life!

“Test Before Touch” Easier Said Than Done

Questions?