



# THE

# CONSULTANTS

# PERSPECTIVE

A SUGAR PUBLICATION

**FORENSIC ENGINEERING AND EXPERT WITNESS SERVICES**

**SUMMER 2007**

**PROPERTY/CASUALTY EDITION**

## **DETERMINING FAULT IN ELECTRICAL CONTACT INJURIES**

by  
**Curtis E. Falany, PE**

Electricity is a naturally occurring phenomenon which, if not properly controlled, can cause injury or death of the human body. Injury or death can be the direct result of the flow of electric current, such as when it disrupts the heart's normal rhythm, or indirectly, such as when a fall occurs as the result of electric shock, surprise, or paralysis. Electricity is present in almost every location in which human activity occurs. Contact with electrically energized conductors can result in sufficient current flowing to injure or kill a human.

Ohm's law, which is often stated  $I=E/R$ , says:

The higher the voltage, the higher the current.

The lower the resistance, the higher the current.

Translating Ohm's Law into more practical terms means that contact with a twelve volt car battery is not likely to injure you. However, if you climb out of the Gulf of Mexico after a brief swim, and contact that same 12 volt battery, it could hurt. The difference? Your skin, which is a natural insulator when clean and dry, is soaked with salt water and presents almost no electrical resistance. Working in a warm environment and sweating can have much the same effect.

Ohm's Law also means that if you contact a 13,000 volt utility company power line, dry skin isn't going to make much difference.

How much and where the current flows through the body greatly affects the results. Current flow through the body core is most likely to produce fatal results. The flow of electrical current occurs between two points of differing electrical potential. If you should happen to grab that 13,000 volt power line with one hand and you aren't touching anything else that is conductive, no current flows through you and you aren't injured. This is why birds can sit on power lines with relative impunity.

On the other hand, if the current flows into your right hand and out of your left foot, the possibility that your heart will stop or be permanently damaged, is much greater.

### What happens to the body as a result of electric current flow?

As the amount of current increases, the results range from no sensation to a tickle, pain, and paralysis. The sensation is different for direct current (DC,) such a battery produces, and alternating current (AC,) which is supplied by your electric utility. Sufficient large amounts of electrical current can interfere with the heart's natural rhythm, temporarily impair or permanently damage the central nervous system, or even burn body tissue.

### Determining Fault in an Electrical Contact Injury involves several steps.

- Determine that an electrical contact injury actually occurred.
- Determine the physical cause of the injury ( the source of the electrical current.)
- Determine what laws, rules, codes, or usual and customary practices might apply to the circumstances surrounding the event.
- Determine the party or parties responsible for code compliance and/or safety.

The source of a high current electrical contact injury is usually straightforward. A careful inspection of the site plus the testimony of the injured party and witnesses usually will suffice to demonstrate that the event involved electrical contact and to identify the source of the electric current.

When lower current electrical injuries are claimed, the determination of the source and the determination that electrical shock was involved become more problematic. Persons suffering heart attacks, strokes, and other seizures are sometimes mistaken for victims of electrical contact. In addition to an inspection and witness reports, a review of EMS, emergency room, and ME reports play an important role.

When mechanical injury or falls are involved, it becomes important to determine if electric shock caused the fall, and, if the fall or mechanical injury, instead of the electrical shock, was the cause of death.

### There are a number of rules and codes.

The more familiar ones include The National Electric Code (NEC,) The National Electrical Safety Code (NESC,) and OSHA regulations.

- NEC (also known as NFPA 70) Per the NFPA, the purpose of this Code is the practical safeguarding of persons and property from hazards arising from the use of electricity.
- NESC Per the IEEE: The purpose of the NESC is the practical safeguarding of persons during the installation, operation, or maintenance of electric supply and communication lines and associated equipment. The NESC contains the basic provisions that are considered necessary for the safety of employees and the public under the specified conditions. The NESC is not intended as a design specification or as an instruction manual.
- OSHA in general and in -
  - 1910.269 ... covers the operation and maintenance of electric power generation, control, transformation, transmission, and distribution lines and equipment.
  - 1910.333 "General." Safety-related work practices shall be employed to prevent electric shock or other injuries resulting from either direct or indirect electrical contacts, when work is performed near or on equipment or circuits which are or may be energized. The specific safety-related work practices shall be consistent with the nature and extent of the associated electrical hazards.
  - 1910.333 is also a source for the '10 foot exclusion rule' often quoted.
  - 1926.416 (a) (1) No employer shall permit an employee to work in such proximity to any part of an electric power circuit that the employee could contact the electric power circuit in the course of work, unless the employee is protected against electric shock by de-energizing the circuit and grounding it or by guarding it effectively by insulation or other means.

roof prior to installation, an employee turned with a piece of the metal in his hands and contacted a local electric utility overhead conductor. The metal provided a circuit between the overhead conductor and earth ground through the trim metal, aluminum ladder, and concrete structure of the building. Minimal current flowed through the employee but the surprise and, possibly, the electrical shock, caused the employee to fall and suffer permanently disabling mechanical injury.

Since this was a workplace injury, the OSHA rules may be applicable. The local utility company overhead power lines were constructed first. The building was constructed later and was designed to be a safe distance from the overhead power lines. However, measurements and site inspection showed that the employee was working closer to the power lines than OSHA rules permit. Further, the contact of the roof metal with the power line was accidental, but, it still violated the OSHA rules.

The fault was the employee and the employer.

**Case Study #2: Swimmer Using Soft Drink Vending Machine**

A swimmer at a private pool in a resort alleged that he received a serious shock when attempting to insert coins into a soft drink vending machine. There were no witnesses and the injured party did not immediately report the injury or seek medical attention.

The owner of the vending machine retained the machine and made it available for inspection. On inspection, I found that the vending machine did have a phase to ground internal fault in its compressor which energized the metal frame and box of the vending machine. Since the vending machine was supplied with a 3 wire, 120 volt cord and cap, the question then became 'Why didn't the ground conductor protect the equipment and the victim?'

My inspection of the clubhouse at the swimming pool found that the ground was not sufficient to make the vending machine safe in the event of an internal fault.

Some fault lay with the vending machine company for failing to maintain their equipment. The greater fault lay with the swimming pool owner whose remodeling did not meet Code. Had the electrical wiring met Code, the fault in the vending machine would have been rendered harmless. In addition, the swimming pool owner had not used a licensed contractor for the remodeling but had used its own employees.

There are numerous other codes and publications on topics such as Electric Machines, Electrical Grounds & Grounding, etc. Depending on the circumstances, any and all of these codes and publications may be researched.

**The parties that might be at fault include:**

- The owner or manufacturer of the source of the offending electric current.
- Anyone who owned the offending source in due course.
- The person or company that installed or serviced it.
- In one case, the importer who imported the offending equipment.
- The injured party's employer or any employer on the workplace.
- The local electric utility.
- Engineers or inspectors who were involved prior to the event.
- The list is nearly limitless....

**Case Study #1: Employee Injury**

A mechanic was working for a subcontractor installing trim metal on the exterior of a multi-story building. The individual pieces of metal were fairly long. As the metal was passed up to be stacked on the

---

**ABOUT THE AUTHOR**

---

Curtis E. Falany has over 35 years of professional experience in the fields of electrical, computer and communications engineering and construction. For the last 13 years, he has been associated as a forensic consultant and expert witness with Forcon's Tampa office and has investigated over 100 electrical contact injuries.

Mr. Falany is licensed as a Professional Engineer, Electrical Contractor, and Building Contractor in the State of Florida and has recently served as a member of the Florida Electrical Contractors' Licensing Board.

He can be contacted through Forcon's Tampa Office.



**Forcon's Marine Division headquarters all decked out for the 4th of July.**

---

**FORCON International Offices**

<b>Amherst, VA</b>	(804) 946-0855	<b>Atlanta, GA</b>	(770) 390-0980
<b>Pentwater, MI</b>	(231) 869-2017	<b>Richmond, VA</b>	(804) 285-7870
<b>Tampa, FL</b>	(813) 684-7686	<b>Red Hill, PA</b>	(215) 541-1450

---

**FORCON's Areas of Expertise**

Accident Reconstruction	Architecture
Automotive Fires, Failures & Theft	Biomechanics
Boat Accident Reconstruction	Catastrophe Engineering
Chemical Engineering	Chemistry
Civil Engineering	Codes & Standards
Construction	Electrical Engineering
Electronics	Environmental Engineering
Fire Protection Engineering	Geohydrology
Geology	Geotechnical Engineering
Highway Engineering	Industrial Hygiene
Injury Causation	Materials Engineering
Marine Engineering	Mechanical Engineering
Metallurgy	Roofing
Safety/OSHA	Soils Science
Structural Engineering	Toxic Torts
and more!	

---

**FORCON "CUTTING EDGE" EDUCATIONAL SEMINARS HAVE BEEN WELL RECEIVED**

The seminars listed below have been approved in several states for adjuster, agent and attorney continuing education credits. Contact Bob Dwyre at 727-409-5701 to discuss the feasibility, timing and logistics of having a Forcon educational seminar at your facility.

**"CRASH SCENE MANAGEMENT TECHNIQUES FOR COMMERCIAL VEHICLE LITIGATION SUPPORT"** - 4 Hours - This seminar deals with the importance of early documentation of the crash scene evidence and facts focusing on the accident reconstruction process to determine how the accident happened and who was at fault. Completed accident reconstructions are utilized to show how law enforcement investigations can be wrong when the evidence and facts are overlooked.

**"ANALYZING AND EVALUATING SAME LEVEL FALL CLAIMS USING FORENSIC BIOMECHANICS"** - 2 Hours - This seminar deals with the intrinsic analysis (biomechanical investigation) of the slip and fall claim that plagues "premises liability" litigation and spawns the potential for fraud. There are five categories of same level falls each having their own "finger prints" with respect to occurring and non-occurring injuries. They are the Slip, Trip, Stumble, Tumble and Crumple. Understanding the mechanics of the fall categories may take the "premises liability" problem out of the slip and fall claim and give the tools to recognize potential fraud.

**"EVALUATING SLIP AND FALL CLAIMS USING FORENSIC BIOMECHANICS"** - 3 Hours - This seminar includes the above 2 hour intrinsic analysis with an additional hour addressing the extrinsic analysis (physical investigation) focusing on the slip and fall site documentation requirements. Various equipment to test the friction coefficient and slip resistance of surfaces will be discussed with a demonstration of the "cutting edge" English XL™ Slip-Resistance Tester.

**"PRODUCT FAILURES AND SUBROGATION"** - 1 Hour - Insurance claims adjusting in the General and Products Liability arena requires a thorough working knowledge of products liability and the legal elements required to maintain such a cause of action, the reasons and causes of loss or damage, and, the potential loss exposures presented therein. This seminar covers the various causes of product failure, the elements of liability that must be proven for defects in design, manufacture or warranty to support a strict [or absolute] liability cause of action, and how to investigate and advance a subrogation claim based upon these theories.

**"A CURSORY LOOK AT FAILURES IN ENGINEERED MATERIALS"** - 1 Hour - The accepted theory regarding mechanical failures of engineered components or parts is that fractures initiate and propagate from internal or external flaws or defects in the material from which the component is made. These defects can be introduced into a component in any number of ways. This seminar is a cursory look at what the analyst requires and needs to do to answer the question of root-causation illustrated by case studies in which both proper and improper failure analyses were performed.

**"IN-DEPTH EXAMINATION OF INJURIES ALLEGED IN LOW SPEED REAR-END COLLISIONS"** - 2 Hours - This seminar is an in-depth examination and analysis of the low speed rear-end collision and some commonly alleged injuries from this event. Most of these injuries have neither a rational or reasonable underlying bases, nor, the mechanics or mechanism for causation to substantiate the injury. The seminar focuses attention to the means and methods for uncovering baseless, ill-founded, and unsupportable alleged injuries in low speed rear-end collisions.

---

**PROPERTY / CASUALTY ASSIGNMENT HOTLINE**

**1-800-390-0980**

**OR ASSIGN IT ON LINE AT**

[www.forcon.com/pcwrf.htm](http://www.forcon.com/pcwrf.htm)

---

**ACCIDENT RECONSTRUCTION ASSIGNMENT HOTLINE**

**1-800-877-3260**

---

**FORCON INTERNATIONAL CORPORATION**

PRESENTS

**THE CONSULTANTS PERSPECTIVE**

IN THIS ISSUE ! - AN ARTICLE ON

***DETERMINING FAULT IN ELECTRICAL CONTACT INJURIES***

FORCON INTERNATIONAL CORP.  
1216 Oakfield Drive  
Brandon, Florida 33511

