jim phillips

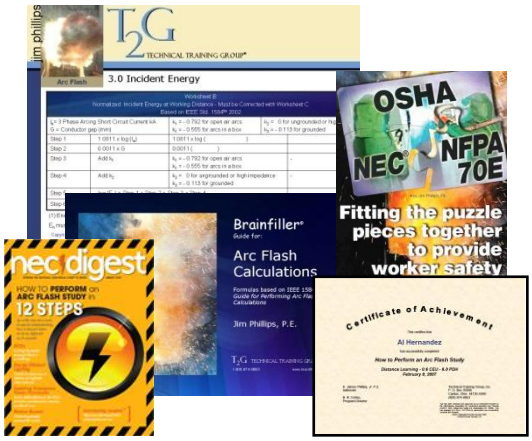
T2G TECHNICAL TRAINING GROUP®

Arc Flash Studies

How to Perform an Arc Flash Calculation Study

Based on IEEE 1584, NFPA 70E, NESC Standards, DC Research and Jim Phillips' Arc Flash Book and Guide

Jim Phillips, P.E. is author of the book: *Complete Guide to Arc Flash Calculation Studies* and the guide: *How to Perform an Arc Flash Study in 12 Steps.* His Arc Flash Training Courses have become the industry standard. Even instructors from other training companies have attended Jim's classes to see how it's done. He takes you well beyond the usual NFPA 70E and IEEE discussions to show you how to perform arc flash calculations and conduct the detailed arc flash study. You will perform calculations of incident energy, arcing current, arc flash protection boundary and DC arc flash calculations using Jim's calculation worksheets. **2 Days - 16 Hours**



What you *WILL* receive:

- Instructions on how to perform an Arc Flash Study
- Jim's AC ***AND*** DC arc flash calculation worksheets
- Training manual containing over 300 pages
- Jim's 30 page Arc Flash Calculation Guide
- Many calculation examples and problems
- 16 hours of Continuing Education Credit

What you ***WILL NOT*** receive:

- A commercial to sell you PPE or equipment
- A sales pitch to sell engineering study services
- A class that is just an overview or teaser

What is so special about Jim Phillips' Arc Flash Class?

Jim is not only one of the most popular and sought after instructors in the industry, he is also directly involved with the development of arc flash standards and practices. He is a member of the IEEE working group that develops *IEEE Std. 1584 [tm], IEEE Guide for Performing Arc Flash Hazard Calculations*. This enables him to go well beyond the "typical" arc flash and electrical safety class taking you behind the scenes with information about arc flash tests, interpretations, current research as well as a very candid discussion of holes in the current standard and the direction of future research.

Jim wrote the book: *"Complete guide to Arc Flash Calculation Studies"* due out later this year and he also wrote the guide: *"How to Conduct an Arc Flash Study in 12 Steps"* which was published by NFPA's NEC Digest in 2007.

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Biography

Jim Phillips, P.E.

Member of IEEE 1584 *IEEE Guide for Performing Arc Flash Hazard Calculations*

Co-Chairman of Task Group - *IEEE 1584.1 Guide for the specification of scope and deliverable requirements for an arc-flash hazard calculation.*

Member of IEC 61482-1-2 Determination of arc protection class of material and clothing by using a constrained and directed arc (box test)

Author of the book: *Complete Guide to Arc Flash Calculation Study* available later this year.

Has a regular column in Electrical Contractor Magazine *Arc Flash - Unplugged*

Founder of the internationally known website www.ArcFlashForum.com

For almost 30 years, Jim has been helping tens of thousands of people around the world understand electrical power systems design, safety, theory and applications. Having taught almost 2000 seminars during his career to people from all seven continents (Yes Antarctica is included!), he has developed a reputation for being one of the best trainers and public speakers in the electric power industry.

Jim does not just talk about arc flash and electrical safety - he is part of the development of the actual arc flash standards! He is also the instructor that has taught other instructors in the industry. Jim is a member of the IEEE 1584 Committee - *IEEE Guide for Performing Arc Flash Hazard Calculations* which is the predominant method for performing arc flash calculation studies. He is Co-Chairman of the IEEE Task Group - IEEE 1584.1 “Guide for the specification of scope and deliverable requirements for an arc-flash hazard calculation study in accordance with IEEE 1584”

He wrote "How to Perform an Arc Flash Study in 12 Steps" which was published by the NFPA. He just completed the book “Complete Guide to Arc Flash Calculation Studies” that will be released later this year. This book is a step by step approach for conducting the arc flash study and it answers many of the controversial questions about the codes and standards.

Jim created the internationally known website ***www.ArcFlashForum.com*** which is used by the global community for understanding arc flash and electrical safety.

He writes a regular column titled *Arc Flash - Unplugged* for Electrical Contractor Magazine and previously was one of the main contributors for the NEC Digest. He also authored several articles published in Europe as well as speaking at several European conferences about Arc Flash. You can download many of his articles at ***www.brainfiller.com*** library. Jim is also involved with arc flash testing and forensic analysis of arc flash accidents.

Throughout his career he has served on many committees including the Energy Policy Committee of IEEE in Washington DC. He is a member of The National Fire Protection Association - NFPA, The Power Engineering Society and the Industry Applications Society.

Jim earned a BSEE Degree in Electrical Engineering at the Ohio State University. After Ohio State, his first job was with Square D Company’s Power System Analysis Group where he was responsible for system studies, power system software development and training at their engineering training programs. Jim is a Registered Professional Engineer in Ohio and Kentucky.

Later, Jim worked for Ohio Edison Company where he headed up the studies group of the System Protection Section. While working for Ohio Edison, he was part of the adjunct faculty for Stark State College where he taught evening classes in electrical power systems.

Jim’s experiences have included everything from planning transmission systems, to design and analysis of industrial and commercial power systems and cogeneration plants. His teaching experience ultimately led to the creation of T2G Technical Training Group in the 1980’s which provides training programs, videos and continuing education on a wide array of electrical power system topics.

Jim, in the high power lab setting up an arc flash test on a pad mount transformer.

How to Perform an Arc Flash Study in 12 Steps [tm]

Jim Phillips, P.E.

Attend this class and see how to:

- **Comply** with OSHA, NFPA 70E, IEEE 1584 and NESC
- Perform many detailed AC and DC Arc Flash calculations
- Use Jim Phillips' worksheets to perform the calculations
- Simplify the Arc Flash Protection Boundary selection
- Simplify the PPE selection process using IEEE calculations
- Understand the IEEE 1584 and DC arc flash equations
- Understand the importance of the working distance
- Make recommendations to reduce incident energy
- Potentially **save thousands of dollars** in short cuts

Receive answers to these questions and more:

- How do I organize a study?
- What equipment really needs labeled?
- Where do I obtain the required data?
- How much information is really required on the arc flash label?
- Do I need all data such as conductor lengths?
- How do I calculate AC incident energy, arcing current & arc flash protection boundary?
- What is the difference between low voltage and medium voltage arc flash calculations?
- How do I calculate DC incident energy from an arc flash?
- How do I calculate DC arc resistance and what is a V-I characteristic?
- How accurate are the IEEE 1584 calculations?
- Can I mix NFPA 70E Tables 130.7(C)(9), (C)(10), & (C)(11) with arc flash calculations?
- What PPE should I wear when I am gathering data to study what PPE I should wear?
- Why do I also have to analyze arc flash during for minimum fault currents?
- What very important question do I ask the electric utility?
- Are time current curves a reliable way to determine arc flash clearing time?
- What if I have a low arcing current that causes a long clearing time?
- Is the 125 kVA 208V cutoff discussed in IEEE 1584 appropriate?
- Is the "2 second rule" appropriate?
- How long can an arc sustain itself? - ***discussion of recent test data***.
- How do I use the NESC Table 410.1 and 410.2 for electric utility systems?
- Why do I use a comparison of 100% and 85% of the arcing current?
- Does the type of equipment make a difference in the calculations?
- What about grounded vs. ungrounded systems?
- What about Arc Blast and the 40 Calories / cm^2 upper limit? – Is it realistic?
- How do I include motor contribution to the calculations?
- What are the Calculation Factor C_f and Distance Exponent Factor X?
- How do I greatly simplify the Arc Flash Protection Boundary and PPE selection?
- How can current limiting devices reduce the incident energy?
- Why use remote operation, arc resistant equipment, and maintenance switches?
- Why is selecting the correct working distance an important part of the calculations?
- What are Jim's latest tests and what are the plans for the next revision to IEEE 1584?
- Why is the *L/E ratio* [tm] so important?

How to Perform an Arc Flash Study in 12 Steps tm

Jim Phillips, P.E.

What is an Arc Flash?

An arc flash occurs when short circuit current flows across a gap creating an arc and can be anything from minor embarrassing sparks to a deadly explosion.

The Arc Flash is usually caused by accidental contact between energized conductors from events such as dropping a screw driver or touching a wire. It can produce temperatures in the thousands of degrees, create extreme blast pressure, launch projectiles at hundreds of miles per hour, produce ultra-violet light that can blind. It can and does kill people!

The IEEE 1584 Working Group has been studying the effects of Arc Flash through testing and analysis which lead to the development of:

IEEE Std.1584tm, IEEE Guide for Performing Arc Flash Hazard Calculations

which defines formulas and procedures used to calculate the amount of incident energy that can be released during an arcing short circuit.

Why perform an Arc Flash Study?

According to OSHA 1910.132(d) The employer is responsible to assess the hazards in the work place, select, have, and use the correct Personal Protective Equipment (PPE) and document the assessment. The use of NFPA 70E and other related industry consensus standards has been used to demonstrate whether an employer acted reasonably when there is a possible OSHA enforcement action taken.

So although NFPA 70E is not directly part of OSHA standards, it can be used as evidence of whether an employer acted reasonably in complying with OSHA standards and addressing "recognized hazards".

There are more specific links within the OSHA standards as well. A typical example is found in 1910.335, Safeguards for personnel protection which requires:

> *"(a)(1)(i) Employees working in areas where there are potential electrical hazards shall be provided with, and shall use, electrical protective equipment that is appropriate for the specific parts of the body to be protected and for the work to be performed."*

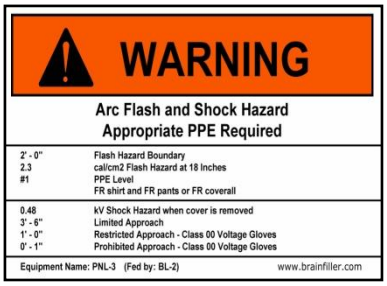
This regulation requires that employees must be properly protected from potential electrical hazards, by using adequate PPE, but it does not provide specific detail of what specific personal protective equipment is necessary to achieve the objective. It might be considered that based on this generalized statement, the selection of the correct PPE is open to interpretation however, this would be incorrect and an Arc Flash study should be performed.

How to Perform an Arc Flash Calculation Study

Jim Phillips, P.E.

What is an Arc Flash Calculation Study?

NFPA 70E Section 130.3(B) requires that an Arc Flash Hazard analysis "shall determine, and the employer shall document, the incident energy exposure of the worker (in calories per square centimeter). The incident energy exposure level shall be based on the working distance of the employee's face and chest areas from a prospective arc source for the specific task to be performed. It further states that "…flame-resistant (FR) clothing and personal protective equipment (PPE) shall be used by the employee based on the incident energy exposure associated with the specific task."



NFPA 70E also requires determining the arc flash protection boundary, which is the distance from a potential arc source where the incident energy falls to a value of 1.2 cal/cm^2. This value is considered to be the point at which the onset of a second-degree burn occurs. Live work performed outside of the flash protection boundary does not require PPE, although the risk of some injury still exists.

The concept of these requirements is simple. At each location, the arc flash study is used to determine:

- The incident energy exposure for a worker's chest and face if an arc flash occurs.
- The level of PPE a worker must wear based on the possible incident energy exposure.
- The flash protection boundary.

Although NFPA 70E provides more generalized hazard risk tables as a simplified alternative for PPE selection, a detailed arc flash study requires performing calculations to estimate the magnitude of incident energy exposure. These calculations are based on specific details of the equipment, including its location, available short circuit current, device clearing time, grounding, arc gap distance, equipment type, and many other factors. The results are used to determine the flash protection boundary and required level of PPE.

This information, as well as data regarding electric shock protection and approach limits, is included on the detailed arc flash warning label placed on the equipment under study. Before conducting live work, a qualified worker can refer to the label and obtain all of the data necessary for the shock hazard and flash hazard analysis NFPA 70E requires.

Although an Arc Flash study can appear to be an overwhelming project, it can be more easily managed when broken down into the 12 basic steps listed at the bottom of the next page.

How to Perform an Arc Flash Calculation Study

Jim Phillips, P.E.

Course Schedule - Open Enrollment Classes

The 2 Day program is presently scheduled for the following dates and locations:

Scottsdale, AZ	March 28 - 29, 2011
Orlando, FL	July 28 - 29, 2011

Registration fee is $ 695 per person for both days. Send 3 people together and the 4th person goes for FREE! Call 800-874-8883 or visit **www.brainfiller.com**

On Site Training - Have This Course at Your Location!

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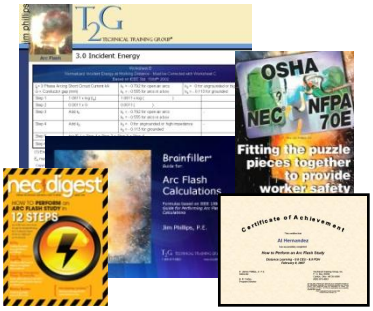

- Jim Phillips, P.E. as the course instructor
- Details on how to perform an Arc Flash Study
- Jim's AC and DC arc flash calculation worksheets
- Training manual containing over 300 pages
- Jim's 30 page Arc Flash Calculation Guide
- 16 hours of Continuing Education Credit

Call Brenda at 800-874-8883 ***today*** for an On-Site Training Proposal! Jim's schedule fills up early!

How to Perform an Arc Flash Study in 12 Steps ™

1. Data Collection Process
2. Develop Single Line Diagram
3. System Modeling
4. Arcing Short Circuit Calculations
5. Time Current Curve Evaluation
6. Incident Energy Calculations
7. Flash Protection Boundary Calculations
8. Determine Personal Protective Equipment Requirements
9. Create Arc Flash Warning Labels
10. Develop the Report and Recommendations
11. Integrate the Study into the Electrical Safety Program
12. Training Affected Personnel

How to Perform an Arc Flash Calculation Study

Detailed Agenda

HUMAN EFFECTS
Physiological Effects, Tissue Damage, Internal Organ Damage, Burns Fibrillation, "Curable" 2nd Degree Burn

CODES AND STANDARDS – WHICH ONE DO I USE?
OSHA 29 CFR - Part 1910, Subpart S, NFPA 70, National Electrical Code®, NFPA 70E, IEEE Standard 1584™

ARC FLASH HAZARDS
Electric Shock, Arc Flash, Arc Blast, Ultraviolet Light, Sound Pressure, Categories of Burns

ARC FLASH CIRCUIT DYNAMICS – FAULT CURRENT, ARC DURATION, PLASMA
Arcing Faults vs. Bolted Faults, Effect of Current on Overcurrent Device Clearing Time, Current Limitation

NFPA 70E REQUIREMENTS
Shock and Arc Flash Hazard Analysis, Creating Energized Work Permits, Electrically Safe Conditions

APPROACH BOUNDARIES
Limited, Restricted, Prohibited & Arc Flash Protection Boundaries for AC, Proposed boundaries for DC

HAZARD/RISK CATEGORIES vs. ARC FLASH CALCUATIONS
Defining the HR Category by cal/cm^2 Class 0, 1, 2, 3, 4 Requirements, Table Footnote Limitations, Limitations of Tables, Using Calculations Instead, Proposed HR Category tables for DC arc flash

PERSONAL PROTECTIVE EQUIPMENT PPE
Protective Clothing Characteristics, Selection of PPE, ATPV Ratings, ASTM Testing Methods

ELECTRIC UTILITY ARC FLASH STUDY REQUIREMENTS AND THE NESC
Using Table 410-1 and 410-2 for Electric Utility Transmission and Distribution Systems

PERFORMING THE AC ARC FLASH CALCULATION STUDY USING IEEE Std. 1584™
Study Requirements, Methodology, Calculation Standards, Qualifications and Methods

DATA COLLECTION PROCESS – HOW MUCH IS ENOUGH?
Transformer, Conductor, Utility Company, Motor, Overcurrent Device and Generator Data

THE SINGLE LINE DIAGRAM AND SYSTEM MODELING FOR THE ARC FLASH CALCULATION STUDY
Importance of the Diagram, , System Configurations, High vs. Low Fault Current, 125 kVA Transformer Limit

ARCING CURRENT CALCULATIONS, WORKSHEETS, EXAMPLE AND PROBLEMS
Arcing Current Calculations, Defining the Arc Gap Based on Equipment Type, K1 for Arc in Box vs. Air

ARC FLASH DURATION - TIME CURRENT CURVES
Determining the arcing current clearing time, 85% vs. 100%, 2 Second Cut Off Interpretation

INCIDENT ENERGY CALCULATIONS, WORKSHEETS, EXAMPLES AND PROBLEMS
AC Incident Energy Calculations, Calculation Parameters, Calculation Factor Cf, Distance Exponent X

ARC FLASH PROTECTION BOUNDARY CALCULATIONS, WORKSHEETS, EXAMPLES AND PROBLEMS
Arc Flash Protection Boundary Calculations Based on Normalized Incident Energy, 4 ft. rule vs. Detailed IEEE Calculations, Unusually Large Boundaries, Calculation Worksheets and Examples

DC ARC FLASH CALCULATIONS, WORKSHEETS, EXAMPLES AND PROBLEMS
V-I Characteristics, DC Arc Resistance Calculations, DC Incident Energy Calculations, Calculation Worksheets

DETERMINING PPE REQUIRMENTS FROM INCIDENT ENERGY CALCULATIONS
Using calculated incident energy to determine PPE requirements. Comparing calculations to NFPA 70E Tables

ARC FLASH WARNING LABELS
Labeling Requirements, Label Locations, ANSI Z535 Requirements, Signal Words and Colors

RECOMMENDATIONS TO REDUCE THE INCIDENT ENERGY AND ARC FLASH HAZARD
Increase Working Distance, Remote Operation, Maintenance Settings, Arc Resistant Equipment, Current Limiting Devices, "Holes" in Present Standards, The Electrically Safe Paradox.

STEPS TO SIMPLIFY THE ARC FLASH CALCULATION STUDY
Jim's "What would you like the answer to be?" Approach, Simplify PPE & Arc Flash Protection Boundary