

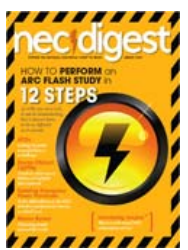


Arc Flash Studies



How to Perform an Arc Flash Study in 12 Steps™
 using IEEE 1584, NFPA 70E and NESC Standards
 Based on Jim Phillips, PE's guide published in NFPA's NEC Digest

Jim Phillips, P.E. is author of 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 and flash protection boundaries using Jim's worksheets that are based on IEEE 1584. **Learn how to perform the detailed study yourself and save tens of thousands of dollars. Get your company into compliance today!** 2 Days - 1.6 CEUs or 16 PDHs



What you WILL receive:

- Instructions on how to perform an Arc Flash Study
- Jim's arc flash calculation worksheets
- 2 training manuals 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™*, *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 guide: "*How to Conduct an Arc Flash Study in 12 Steps*" which is published by NFPA's NEC Digest. He also serves on the Electrical Safety Week Conference Committee which is held early each year.

How to Perform an Arc Flash Study in 12 Steps™

Jim Phillips, P.E.



Attend this class and see how to:

- **Comply** with OSHA, NFPA 70E, IEEE 1584 and NESC
- Perform the detailed Arc Flash study yourself
or ...
- Know what questions to ask Arc Flash consultants
- Define the Arc Flash study scope
- Develop your Electrical Safety Program
- Determine required PPE from IEEE calculations
- Potentially **save thousands of dollars** in short cuts

Receive answers to these questions and more:

- Can I use NFPA 70E Table 130.7(C)(9)(a) for the study?
- Is it better to use detailed IEEE 1584 calculations?
- How do I organize a study?
- What equipment really needs labeled?
- Where do I obtain the required data?
- Are detailed arc flash labels with incident energy and boundaries required?
- Do I need all data such as conductor lengths?
- Are the IEEE calculations accurate?
- What PPE should I wear when I am gathering data to study what PPE I should wear?
- Do I base the study on maximum 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?
- Why was the 125 kVA 208V cutoff discussed in IEEE 1584?
- Is the "2 second rule" appropriate?
- How long can an arc sustain itself? - **discussion of recent test data.**
- What about the **NESC's January 1, 2009** deadline?
- How do I use the NESC Table 410.1 and 410.2?
- Why does IEEE 1584a 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?
- Is 40 Calories / cm² really an upper limit?
- Do I include motor contribution?
- What is the Calculation Factor C_f and when do I use it?
- How do I handle emergency generators?
- How can current limiting devices reduce the incident energy?
- Should I specify arc resistant equipment?
- How can I convince electrical workers and management of the study's importance?
- What tests are planned for the next revision to IEEE 1584?
- Why is the L/E ratio™ so important?



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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.1584™, 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.

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What is a Detailed Arc Flash 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."

 WARNING	
Arc Flash and Shock Hazard Appropriate PPE Required	
2' - 0" 2.3 #1	Flash Hazard Boundary cal/cm ² Flash Hazard at 18 Inches PPE Level FR shirt and FR pants or FR coverall
0.48 3' - 6" 1' - 0" 0' - 1"	kV Shock Hazard when cover is removed Limited Approach Restricted Approach - Class 00 Voltage Gloves Prohibited Approach - Class 00 Voltage Gloves
Equipment Name: PNL-3 (Fed by: BL-2) www.brainfiller.com	

NFPA 70E also requires determining the flash protection boundary, which is the distance from a potential arc source where the incident energy falls to a value of 1.2 cal/cm². 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 Study in 12 Steps™

Jim Phillips, P.E.

Course Schedule - Open Enrollment Classes

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

La Jolla, CA
Orlando, FL

December 15 - 16, 2008
January 29 - 30, 2009



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!

Hold this class at your location for a greater savings. For an all inclusive fee you receive the following for each attendee:

- Jim Phillips, P.E. as the course instructor
- Details on how to perform an Arc Flash Study
- Jim's arc flash calculation worksheets
- 2 training manuals 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

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How to Perform an Arc Flash Study in 12 Steps™

Detailed Agenda

HUMAN EFFECTS

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

CODES AND STANDARDS

OSHA 29 CFR - Part 1910, Subpart S, NFPA 70, National Electrical Code®, NFPA 70E, IEEE Standard 1584™

CATEGORIES OF ELECTRICAL HAZARDS

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

ELECTRICAL CIRCUIT DYNAMICS

Arcing Faults vs. Bolted Faults, Effect of Current on Overcurrent Device Clearing Time, Current Limitation

NFPA 70E REQUIREMENTS

Shock and Flash Hazard Analysis, Creating Energized Work Permits, Electrically Safe Conditions

APPROACH BOUNDARIES

Limited, Restricted, Prohibited & Flash Protection Boundary

HAZARD/RISK CATEGORY

Defining the HR Category by cal/cm² Class 0, 1, 2, 3, 4 Requirements, Table Footnote Limitations

PERSONAL PROTECTIVE EQUIPMENT PPE

Protective Clothing Characteristics, ATPV Ratings, ASTM Testing

NESC AND UTILITY REQUIREMENTS

Table 410-1 and 410-2, January 1, 2009 Compliance Deadline, Study Requirements.

PERFORMING THE DETAILED ARC FLASH STUDY

Study Requirements, Methodology, Standards, Organization of the Study

STEP 1 - DATA COLLECTION

Transformer, Conductor, Utility Company, Motor, Overcurrent Device and Generator Data

STEP 2 - DEVELOP THE SINGLE LINE DRAWING

STEP 3 - SYSTEM MODELING FOR ARC FLASH STUDY

High vs. Low Fault Current, System Configuration, 125 kVA Transformer Limit

STEP 4 - IEEE Std. 1584™ - ARCING CURRENT CALCULATIONS

Arcing Current Calculations, Defining the Arc Gap Based on Equipment Type, K1 for Arc in Box vs. Air

STEP 5 - TIME CURRENT CURVES

Determining the arcing current clearing time, 85% vs. 100%, 2 Second Cut Off Interpretation

STEP 6 - IEEE Std. 1584™ - INCIDENT ENERGY CALCULATIONS

Incident Energy Calculations, K2 and Effect of Grounding, Impact of Device Settings

STEP 7 - IEEE Std. 1584™ - FLASH PROTECTION BOUNDARY CALCULATIONS

Flash Protection Boundary Calculations Based on Incident Energy, Calculation Factor Cf, Distance Factor X, 4 ft. rule vs. Detailed IEEE Calculations, Unusually Large Boundaries

STEP 8 - DETERMINING PPE REQUIREMENTS

Using calculated incident energy to determine PPE. Comparing this method to NFPA 70E Tables.

STEP 9 - ARC FLASH WARNING LABELS

Labeling Requirements, Approach Boundaries, Class of PPE, Standardizing Labels

STEP 10 - REPORT AND RECOMMENDATIONS

Reducing Incident Energy, Arc Resistant Switchgear, Design and Operating Changes, Current Limiting Devices, "Holes" in Present Standards.

STEP 11 - INTEGRATE THE STUDY INTO THE ELECTRICAL SAFETY PROGRAM

Interpreting the Arc Flash Labels, PPE and Boundaries for Simplified Electrical Safety Practices.

STEP 12 - TRAINING AFFECTED PERSONNEL