# Why this information is important and must be provided

**OSHA 29 CFR 1910.269(l)(8) Protection from flames and electric arcs**
**1910.269(l)(8)(i) —**"The employer shall assess the workplace to identify employees exposed to hazards from flames or from electric arcs."
**1910.269(l)(8)(ii) —**"For each employee exposed to hazards from electric arcs, the employer shall make a reasonable estimate of the incident heat energy to which the employee would be exposed."

> **Excerpt from Note 1 to paragraph (l)(8)(ii)** : "Appendix E to this section provides guidance on estimating available heat energy. The Occupational Safety and Health Administration will deem employers following the guidance in Appendix E to this section to be in compliance with paragraph (l)(8)(ii) of this section."

**OSHA 29 CFR 1910.269 Appendix E** *(excerpts from Part A. Estimating Available Heat Energy)*
*"Calculation methods* . . . Table 2 lists various methods of calculating values of available heat energy from an electric circuit. . . ."

**OSHA 29 CFR 1910.269 Appendix E, Table 2**

**TABLE 2-METHODS OF CALCULATING INCIDENT HEAT ENERGY FROM AN ELECTRIC ARC**

1. *Standard for Electrical Safety Requirements for Employee Workplaces*, NFPA 70E-2012, Annex D, "Sample Calculation of Flash Protection Boundary."
2. Doughty, T.E., Neal, T.E., and Floyd II, H.L., "Predicting Incident Energy to Better Manage the Electric Arc Hazard on 600 V Power Distribution Systems," Record of Conference Papers IEEE IAS 45th Annual Petroleum and Chemical Industry Conference, September 28-30, 1998.
3. Guide for Performing Arc-Flash Hazard Calculations, IEEE Std 1584-2002, 1584a-2004 (Amendment 1 to IEEE Std 1584-2002), and 1584b-2011 (Amendment 2: Changes to Clause 4 of IEEE Std 1584-2002).*
4. ARCPRO, a commercially available software program developed by Kinectrics, Toronto, ON, CA.

**NFPA 70E® *Electrical Safety in the Workplace*® 2015 Edition, Informative Annex D** references IEEE Std. 1584, *Guide for Performing Arc-Flash Calculations* in Section 130.5 Information Note #5*.* This Standard is the industry standard for performing arc flash studies. The standard recommends obtaining specific information from the utility company.

**IEEE Std. 1584b™-2011 – 4.2 Step 1: Collect the system and installation data**
"Obtain the **minimum** and **maximum** available **fault (amperes or MVA)** and power angle or ***X/R* ratio** from the utility supplying service or for the separately derived power system. Do not use overly conservative bolted fault current values. Most utilities will readily supply information on the available fault level and *X/R* ratio at point of service."

**IEEE Std. 1584.1™-2013 – 5.3 Owner-supplied information**
"Electric utility company contact information. In many instances the owner may have to request the utility company data because utility companies may not provide that information to third parties without the owner's permission. This information may include nominal voltage; **normal, minimum, and maximum three-phase and single line-to-ground short-circuit currents; system *X/R* ratios; utility-provided overcurrent protection; or grounding configuration.** Depending on the utility service configuration, transformer size, winding configuration, and impedance for utility owned transformers may be needed."

**IEEE Std. 1584.1™-2013 – 6. Short-circuit Study**
"The arc-flash study should be based on an up-to-date short-circuit study that reflects existing conditions, alternate system configurations, and operating scenarios where applicable. In addition, **minimum and maximum short-circuit current conditions should be evaluated to determine the effect on protective device clearing times and incident energy exposures."**

**IEEE Std. 1584.1™-2013 – 6.2 Number of calculations (scenarios) needed**
"For simple systems, two sets of calculations are needed. One is for the **maximum available fault current from the utility** with all large motors running. The second is the **minimum available fault current from the utility** with no large motors running. Utilities should be asked to provide the maximum and minimum number based on an up-to-date study of their system."
"Some locations in the system will exhibit the highest incident energy at high fault currents, **while lower fault currents will result in higher incident energy values** at other locations." **NOTE:** Arc Flash Energy is a factor of fault current and tripping time. The Maximum Fault Current does not always represent the worst case Arc Flash (incident Energy). Lower fault currents can increase the upstream device tripping time which drives the arc flash higher.

*A NEMA Low Voltage Distribution Equipment Section White Paper*
*ABP 10-2015*

# Arc Flash Analysis—Utility System Parameters Critical for Accurate PPE

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# Foreword

This is an update to a NEMA white paper originally published in 2002.

To ensure that a meaningful publication was being developed, draft copies were sent to a number of groups within NEMA having an interest in this topic. Their resulting comments and suggestions provided vital input prior to final NEMA approval and resulted in a number of substantive changes in this publication. This white paper will be periodically reviewed by the Molded Case Circuit Breaker Product Group of NEMA's Low Voltage Distribution Equipment Section for any revisions necessary to keep it up to date with evolving technology. Proposed or recommended revisions should be submitted to:

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This white paper was developed by the Molded Case Circuit Breaker Product Group of NEMA's Low Voltage Distribution Equipment Section. Approval does not necessarily imply that all members of the Product Group voted for its approval or participated in its development. At the time this document was approved, the Molded Case Circuit Breaker Product Group had the following members:

ABB, Inc.—Wichita Falls, TX
Eaton Corporation—Pittsburgh, PA
General Electric—Plainville, CT
Siemens Industry, Inc.—Norcross, GA
Schneider Electric USA—Andover, MA

## 1 Introduction

NEMA has long recognized that equipment short circuit current ratings and interrupting ratings are determined by the engineer or contractor after understanding the available fault currents to which they will be subjected. Utilities have longstanding practices to provide a conservatively high maximum level of available fault current based on their current and future power generation equipment, transmission, and distribution systems required to support their customers' electrical power demands. Once again, NEMA recognizes that this has been an accepted industry practice that ensures equipment is appropriately rated to control electrical energy safely. However, the introduction of arc flash protection in NFPA 70E, *Electrical Standard for Safety in the Workplace,* is changing industry needs to ensure a safe maintenance environment beyond safe operation of the equipment.

## 2 Arc Flash

NEMA member companies support the safe maintenance of electrical equipment and systems. NEMA strongly encourages de-energizing electrical systems before maintenance is performed. For service equipment, this typically involves contacting the utility. In order to support an electrical safety program in the workplace, it might be necessary to perform an arc flash study. Although NFPA 70E provides tables for determining the level of personal protective equipment (PPE) required, recognize that these tables were developed for use only within specific system parameters, and that an arc flash study would provide more accurate guidance for PPE selection. The arc flash study provides information necessary to establish the level of PPE needed for each specific location of the electrical system.

## 3 The *NEC* and NFPA 70E

The 2002 *National Electrical Code*® *(NEC)* introduced a new requirement in Article 110.16, which establishes a field-marking requirement to warn qualified persons of potential electric arc flash hazards. This requirement is driving awareness of the need to perform an arc flash analysis as a component of an electrical safety program, as outlined in NFPA 70E. This requirement has not changed significantly since that time.

The awareness of potential arc flash hazards has advanced electrical safety by causing the industry to review electrical safety programs and electrical safety training. Driven by NFPA 70E and the review of company safety programs, many companies are now performing fault current studies, which are necessary even to properly use the tables in NFPA 70E within their specific system parameters. The next logical step is to collect overcurrent device information and determine the potential arc flash hazard and PPE requirement by calculating the incident energy.

## 4 The Utility's Role

The increased number of arc flash studies being performed by industry and consultants is driving the need for information that has historically been beyond responses provided by the utility. The foundation for a proper arc flash study includes having access to the following accurate information from the utility:

- The actual available short circuit current for the existing installation.
- The parameters or settings for the final utility overcurrent protective device.

Note that a fault current value (which historically has been provided by utilities) may not provide the "worst case" arc flash condition. In many cases, calculations of arc flash hazard based on conservatively high available fault current values can underestimate the actual flash hazard at circuit locations. This is because overcurrent protective devices might not operate as fast at the actual fault current level as at the conservatively high fault current level. Therefore, having the actual available fault current is necessary in order to properly estimate the potential arc flash incident energy and thus determine the appropriate PPE.

Accurate overcurrent protective device parameters are also necessary to establish accurate arc flash calculations to ensure appropriate PPE. Keep in mind that appropriate PPE is typically required even for the process of placing the electrical equipment in an electrically safe working condition.

NEMA expects that utilities will recognize the need to have a system in place to provide, upon request, the necessary information for an arc flash analysis and that protective device plays a significant role in the potential arc flash hazard at the service. The utility distribution system periodically changes due to transformer replacement, temporary or permanent feeder reconfiguration, voltage conversion, or substation changes. These changes can impact the protective devices, available short circuit current, and the resulting potential arc flash hazard.

NEMA also expects that utilities will understand their customer's needs and will thus ensure that customer service policies and procedures are in place to support customer requests for the utility information necessary to perform a proper arc flash analysis. This will support accurate PPE requirements to protect qualified workers from potential arc flash hazards. We suggest that utility procedures will also need to consider a "notification system" to alert customers in the event that a utility system change impacts locations that are known to have requested information on the magnitude of the available short-circuit current.

Finally, NEMA encourages that electrical equipment be de-energized and subsequent maintenance be performed in accordance with NFPA 70E. Work on service equipment might require the utility to de-energize service conductors feeding the service. NEMA recommends that users contact their local utility to arrange a power outage before working service equipment.

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