The Missing Link in Arc Flash Analysis - Risk Assessment

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In the fall of 2001 the 2002 National Electric Code (NEC) introduced a new requirement. Article 110.16 required electrical equipment to be field marked, to warn qualified persons about the arc flash hazard associated with exposed energized conductors. The equipment required to have this field marking (warning label) has been more clearly defined through subsequent editions of the NEC. Basically the only electrical equipment which is excluded from this requirement is in dwelling occupancies. Fine Print Note (FPN) no.1 to that article listed the NFPA 70E-2000 *Electrical Safety Requirements for Employee Workplaces* as a source of information that would aid in determining severity of potential exposure, planning safe work practices and selecting personal protective equipment. FPN no. 2 listed ANSI Z535.4-1998, *Product Safety Signs and Labels* as a guide for designing labels (field marking). Normally new requirements in the NEC are only applicable to installations built after the implementation of that edition. This is known as "grandfathering". In this case, because of the possibility of an imminent hazard in the workplace, the Authority Having Jurisdiction (OSHA) only allows a reasonable amount of time to get into compliance. According to the 2000 Edition of the NFPA 70E Part II Safety-Related Work Practices, Chapter 2 General Requirements for Electrical work Practices 2-1.3.3 The Flash Hazard Analysis must be done before a person approaches an exposed electrical conductor or circuit part. To perform a flash hazard analysis an electrical engineer must know the:

1. Short circuit current available at each piece of equipment
2. Clearing time of the upstream overcurrent device
3. The working distance for each task to be performed. (Usually the working distance at 600 volts and below is 18 inches and above 600 volts should be 3 feet.)

The information provided by the flash hazard analysis is the available incident energy at the working distance to allow selection of personal protective equipment (PPE) and arc rated clothing and the distance at which the incident energy is reduced to a level known as onset of second degree burn criteria. This information allows for the establishment of a boundary known as the arc flash boundary and PPE and arc rated clothing selection for working inside the arc flash boundary. The NFPA 70E-2000 introduced a new Article 3-3.9.1 to provide aid in selection of PPE and arc rated clothing. The article required the use of Table 3-3.9.1 Hazard/Risk Category (HRC) Classification and 3-3.9.2 Protective Clothing and Personal Protective Equipment (PPE) Matrix. The HRC Classification table was established by a task group, taking into account their collective experience and system criteria based on:

1. Voltage level of equipment to be worked on
2. Task to be performed
3. Notes which clarified fault current and clearing time criteria

The Table provides HRC, 0 through 4 and direction for selection of voltage rated gloves and tools. The article stated that for systems that did not fit within the HRC table criteria for available fault current and clearing time, an arc flash hazard analysis must be done. It should be noted that the Hazard/Risk category is based on two pieces of information the Hazard and the Risk. The hazard can be quantified by a hazard analysis but to quantify the Risk the specific task must be known. The reason for quoting the previous editions of the NEC and NFPA 70E is to make it clear that this requirement has been on the books for a long time. The introduction of these Articles in the NEC and the NFPA 70E have dramatically changed the way electricians face their tasks today. The level of awareness concerning the arc flash hazard and PPE to mitigate the hazard has increased exponentially.

The requirements for these articles have been clarified and expanded further and are in the current editions of NEC-2011 article 110.16 Arc Flash Hazard Warning and the NFPA 70E-2012 Article 130.5 Arc Flash Hazard Analysis. The clear definition of terms associated with the arc flash hazard are primarily found in the NFPA 70E. Tables 130.7(C)(15)(a) & (b) may still be used in lieu of an arc flash analysis and conversely an arc flash analysis can be used instead of the HRC tables. The missing element to the arc flash analysis is the Task. A typical arc flash label establishes the arc flash boundary and the PPE to be worn in that boundary but there is no specific direction concerning tasks performed.

The HRC tables describe tasks such as thermography, voltage testing and racking out equipment. It is clear in the tables that the PPE selections are different, based on the risk associated with the tasks. When arc flash labels are used, the qualified persons performing the work must still perform a risk assessment to determine the safest way to perform the work. It is imperative that qualified persons be trained in risk assessment skills. For example: An electrical worker that selects an 8 cal/cm^2 shirt and pants, 12 cal/cm^2 balaclava sock hood, 12 cal/cm^2 face shield and Class 0 gloves with leather protectors based on an arc flash warning label which states the available incident energy in a 600 volt class switchgear is 7.5 cal/cm^2 at the working distance of 18 inches may have adequate protection for voltage testing but if it is known that the switchgear has not had the circuit breakers racked out for many years the worker should not assume the same PPE will provide protection for racking out the circuit breaker. Finally it must be pointed out that the arc flash label or field marking based on an arc flash analysis only provides information for when the equipment is open and the energized conductors are exposed. An electrical worker that is operating a switch with the door closed on metal clad switchgear 1 kV to 38 kV is required by the HRC table to use HRC 2 PPE. In this case the PPE is based on risk assessment associated with the task. In conclusion it must be emphasized that even though the arc flash analysis has been performed and the equipment is labeled correctly, specific risk assessments for the tasks to be performed are still required to work safely.