Principles

Introduction

It is usually the case that before working on or near high energy electrical sources that they are isolated, see: http://www.theiet.org/factfiles/health/hsb51a-page.cfm and http://www.theiet.org/factfiles/health/hsb51b-page.cfm.  But if a risk assessment results in the requirement for the use of Personal Protection Equipment (PPE) then care should be taken to ensure that it is specified, used and maintained properly.

Personal Protective Equipment

The PPE selected should be capable of withstanding the arc’s incident energy.

Before using the PPE training must be provided, which should ensure that workers know how to use the PPE.

Information should be provided such as how to clean or launder the PPE so that its protective effects are not reduced. The effectiveness of the PPE will be reduced with poor use or care.

PPE will probably restrict the wearer’s movement and impair their senses (vision, smell, hearing and touch).

It is important that anything worn inside the PPE should not melt or burn onto the skin. Any outerwear should not burn. Typical PPE risks would be wearing high-visibility outer clothing over flame retardant PPE, or the wearing of polyester underclothing.

Any PPE that is selected should cover all of the danger at the point of use.

The limitations of using PPE must be carefully considered. Very high temperatures occur in an arc as well as generating explosive forces. Consider the person suited up in-all-body PPE and wearing a full head helmet with no exposed skin. The question must be asked can it be justified putting someone into a work activity where there is such a risk?

The types of risk such as thermal effects of arc flash to face, chest, arms and hands, may be mitigated by the use of PPE, but there may be accompanying physical risks, such as the ballistic effects of shrapnel, that would not be controlled by the PPE. Adequate competent supervision will be necessary.

Stages in the PPE Assessment Process

In North America there is a greater emphasis on wearing PPE as opposed to reducing the risk by elimination.

An arc flash hazard analysis should determine:

- The maximum duration of a potential arc (dependent on the 3-phase fault detection and clearance time of the system)
- The incident energy level from a potential arc flash (proportional to the prospective short circuit current from the system being worked on or near)
- Whether the work will take place with any enclosure closed or open
- The flash protection boundary within which PPE will be required

The PPE assessment will then use the determined incident energy level which could be received by the worker carrying out the specified task and equate this to a level of PPE that will protect against that arc energy level in cal/cm² if it is above the accepted minimum level of: 1.2cal/cm². Below that level (Hazard Risk category 0 - see Table 1. below), normal PPE assessment should identify any requirements to protect against 2nd degree burns at close proximity, such as a face shield, eye protection, non flammable gloves and single layer non-flammable work wear.

An incident energy table similar to that in the National Fire Protection Association - NFPA 70E “Standard for Electrical Safety in the Workplace” (the standard adopted in much of North and South America for arc flash PPE determination) is shown below (Table 1.) to illustrate hazard categories. It also shows typical examples of PPE for each category. It will be important to specify PPE type details to suit current applicable standards and materials for a specific organisation’s systems and identified risks.

At all levels of potential arc energy, hearing protection should be worn, skin should not be exposed and head and eye protection should be worn. Work wear and under garments should be flame retardant, the number of layers being dependent on the potential arc energy calculation.

The PPE Details column in Table 1. can be developed to specify exactly, what is required for a particular organisation in terms of undergarments, layered flame retardant work wear, eye protection, hand and foot protection and head protection. These details along with methods of managing the PPE and live work can be included in a local management policy giving clear support for such ‘at risk’ activities.

Flash hazard analysis and PPE assessment against electric arc is complex and cannot be examined here in detail so a specialist
approach will be required. The Further Information below will help the reader access the necessary standards and information to determine the level of PPE for work on energised electrical systems.

<table>
<thead>
<tr>
<th>Incident Energy Level (cal/cm²)</th>
<th>Hazard Risk Category</th>
<th>PPE Type</th>
<th>PPE Details (basic examples)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 1.2</td>
<td>0</td>
<td>0</td>
<td>1 layer untreated cotton (covering all body), polycarbonate safety spectacles, lightweight cotton gloves.</td>
</tr>
<tr>
<td>1.21 - 4</td>
<td>1</td>
<td>1</td>
<td>Cotton undergarments, 1-layer flame retardant (FR) work wear, helmet, polycarbonate safety spectacles, lightweight FR gloves.</td>
</tr>
<tr>
<td>4.1 - 8</td>
<td>2</td>
<td>2</td>
<td>As above but with 2 layer FR outer work wear that has wrist closures, and a full face polycarbonate visor. A FR single-layer balaclava may also be worn to protect the face.</td>
</tr>
<tr>
<td>8.1 - 25</td>
<td>3</td>
<td>3</td>
<td>3 layer FR outer work wear with cotton under garments and FR shirt, a full-face hood or visor with safety spectacles underneath, chrome leather gauntlets.</td>
</tr>
<tr>
<td>25.1 - 40</td>
<td>4</td>
<td>4</td>
<td>Typically 4 layer FR outer work wear (as illustration), FR and electrically insulated footwear and suitable FR material spats to close off the ankle area, FR gloves or chrome leather gauntlets, a hood constructed from a triple layer of FR material with a sewn-in polycarbonate face shield with a minimum of 2 panels of suitable thickness with one coated with a gold film for UV protection.</td>
</tr>
</tbody>
</table>

Table 1. Example Incident Energy and PPE Type requirement

**UK Legislation and Implementation**

Further information

The following publications are available from Health and Safety Executive (HSE) Books:


The above linked HSE documents may also be obtained by mail order (for which there may be a charge) from:

HSE Books,  
PO Box 1999,  
Sudbury,  
Suffolk CO10 2WA  
Tel: 01787 881165  Fax: 01787 313995  

HSE priced publications are also available from bookshops and free leaflets can be downloaded from HSE’s website: [www.hse.gov.uk](http://www.hse.gov.uk)

For information about health and safety see the HSE Website [http://www.hse.gov.uk](http://www.hse.gov.uk) or write to:

HSE Information Services,  
Caerphilly Business Park,  
Caerphilly  
CF83 3GG.
Information from other organisations:

- Standard Performance Specification for Flame Resistant Textile Materials for Wearing Apparel for Use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards. This performance specification covers the flame resistance of textile materials to be used for wearing apparel for use by electrical workers exposed to momentary electric arc and related thermal hazards: [http://www.astm.org/Standards/F1506.htm](http://www.astm.org/Standards/F1506.htm)


- An online Forum for Registered people to use to discuss all aspects of arc flash safety: [http://www.arcflashforum.com/](http://www.arcflashforum.com/)

- IEC Standard - High-voltage switchgear and control gear - Part 200: A.C. metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV [http://webstore.iec.ch/webstore/webstore.nsf/Artnum_PK/31242](http://webstore.iec.ch/webstore/webstore.nsf/Artnum_PK/31242)

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