Current Reasons for Conducting an Arc Flash Assessment

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- **'Switched On' Management complying to E.A.W.R. 1989 & Early Adopters.**
- **Reaction to an Incident / Insurers Instructions**
- **USA Head Office or Management Involvement**

In USA - x 5-10 arc-flash injuries resulting in hospitalisation occur every day – Source Chicago-based Capelli Schellpfeffer, Inc.
According to IEEE research, more than 2,000 times per year, workers are admitted to burn centres for treatment of extended injuries caused by arc flash.

- OSHA 29 Code of Federal Regulations (CFR) Part 1910 Subpart S.
- NFPA 70-2002 National Electrical Code.
- NFPA 70E-2000 Standard for Electrical Safety Requirements for Employee Workplaces.
- IEEE Standard 1584-2002 Guide for Performing Arc Flash Hazard Calculations.

6 point plan for OSHA Compliance. **Companies will be cited and fined for not complying with these standards.**

- A facility must provide, and be able to demonstrate, a safety program with defined responsibilities.
- Calculations for the degree of arc flash hazard.
- Correct personal protective equipment (PPE) for workers.
- Training for workers on the hazards of arc flash.
- Appropriate tools for safe working.
- Warning labels on equipment. - provided by the equipment owners, not the manufacturers.

What is an Electrical Arc Flash ?

A fault between 2 conductors –
Phase to phase
Or
Phase to Earth
Or Any combination thereof…..

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An unwanted and unexpected release of energy.
This energy release can be as small as a flash of light with a popping sound to a major fireball explosion.
The concern is that energy released above a certain level will ignite non flame resistant clothing and cause major flesh burns to a person

Arc Flash Incident - Switchgear

Possible Causes

- Accidental contact by a worker or tool while working on energized equipment
- Mechanical breakdown, loose connections, and insulation failure – could be caused by unfinished or inadequate maintenance
- Dust build up between conductors
- Animals contacting energized components
- Current overload
- Voltage transients

- **Over 70 % of Arc-Flash incidents (in Europe) occur during or immediately after electrical maintenance, although NOT always**
- **Old legacy H.V. equipment, and high fault level L.V. equipment (that is frequently operated) is also at HIGH risk**

Electrical Safety Forum – About the Arc Flash Hazard

Arc Flash Injuries

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- **Blinding light to the eye-temporary blindness**
- **Thermal heat 4 times that of the sun (35,000 degrees F)**
- **2nd, 3rd, or 4th degree burns to unprotected skin caused by radiant and convective energy.**
- **Barotrauma – the effect of pressure waves on brain, nervous system and lungs.**
- **Sound at levels that could rupture ear drums.**
- **Molten metal that can splatter and burn into skin tissue.**
- **A toxic vapor cloud that can be inhaled into the lungs.**
- **Flying metal parts launched in all directions**
- **A pressure wave that will knock you down**
- **Equipment Damage /Loss of production**
- **Fire / Explosion Risks**

L.V. Arc Flash victim in USA

How could it affect you?

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If you have an H.V. or L.V. System –

An Arc Flash Incident is not sector specific!

- E.A.W.R. 1989 – Compliance to section 5
- IEEE 1584 – Standard for Arc Flash Calculations
- IEC 60909 – Electrical Fault Level Studies & Load Flow Analysis
- HSG 230 – Electrical Switchgear Safety

We all have a Duty of Care to recognise the hazard and take appropriate measures to reduce the risk to acceptable levels.

UK HSE - HM Principal Electrical Inspector.

"Eliminate, as far as possible, people in the line of a potential burn, barotrauma & inhalation"

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Engineer it out - fault level studies, load flow IEC60909, Establish & Set protection gradings, conduct arc flash study, update all distribution systems / records

Eliminate pre identify risks, implement procedures & label equipment correctly

Mitigate (moderate the dangers to make them less severe) -Procedures & training

Calculate thermal values required & protect with relevant levels of FR PPE

PPE – should be the last line of defence.

Cost objection = average £15 – 35 k for a full study + thermal value rating calcs for PPE. Cost of a life = £ millions – (includes litigation, production, corporate reputation & responsibility issues, replacements)

Steps to take

Activities 1 to 4 will ensure your compliance to E.A.W.R 1989 Section 5.

1. Site Surveys

2. Fault Level Studies (to IEC 60909)

3. Protection Grading Studies

4. Distribution Systems Records

5. Arc Flash Assessment (to IEEE1584 standards)

6. Results Interpretation

7. Switchgear Risk Assessment

8. Operations & Maintenance procedures – Creation & Development

9. Equipment Labeling & Identification

10. P.P.E Calculations & Recommendations

11. Safety Standard Training

12. Ongoing Analysis & Support

Arc Energy Assessment

- IEEE Standard 1584 & NFPA 70E

- Need to know

  Prospective fault current. - energy

  Fault duration.- time

  System X/R ratio.-distance

- Use Computer software e.g.. Power Tools

Typical Warning Sign After Assessment

!	WARNING
Arc Flash and Shock Hazard	
Appropriate PPE Required	
124 cm	**Flash Hazard Boundary**
25.8	**J/cm^2 Flash Hazard at 457 mm**
Category 2	**Cotton Underwear + FR Shirt & Pants**
433 VAC	**Shock Hazard when cover is removed**
00	**Glove Class**
1067 mm	**Limited Approach (Fixed Circuit)**
305 mm	**Restricted Approach**
25 mm	**Prohibited Approach**
Bus: MC-118 Prot: SG-118-B02	

Typical PPE

Light duty gloves

Polycarbonate face shield

Double Layer Overalls

Double Glazed Hood

Heavy PPE

Full Battle Dress

PPE in Action

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This FR suit may have saved a man's life…..

The suit sustained substantial flash fire damage and did what it was suppose to.

The brown portion of the garment sustained direct flash fire and heat impingement without continuing to burn.

The T-shirt in the upper right of each picture was not even scorched.

PPE Philosophy
Last line of defence
- particularly after maintenance work

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- Assess arc energy level.
- Define appropriate PPE.
- Label equipment to identify energy level. and PPE requirements.
- Have the necessary PPE available and launder to manufacturers guidelines.
- Training and awareness.
- Finally, audit compliance.

The Overall Process

1. Document system.
2. Fault current calculations.
3. Protection clearance times.
4. Arc energy assessment.
5. Engineering risk reduction
6. Procedural risk reduction.
7. Arc energy assessment (revised)
8. PPE philosophy.
9. Equipment labelling
10. Training
11. Audit

Conclusions

- Be clear about fault levels, document your system, and derive, then minimise Arc Energy Levels.
- Use remote switching for HV Systems.
- Use practical PPE on an advisory basis for LV Systems – Fire retardant overalls & balaclava, gauntlets, helmet and visor – particularly after Elec. Maintenance.
- Remember it is the upstream fault level that is key, not the size of the drive !