

Session Number Thirteen: Arc Flash Protection – What More Can Be Done?

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Abstract

What more can be done to mitigate the risks of arc flash related injuries? This paper explores two aspects that already mitigate arc flash risks and poses questions as to why they may be less effective than anticipated. Why do fatalities still occur given the effort placed on proper procedures and clothing during switching? The paper also looks at the term 'human error' and what it means for the future of electrical arc safety.

Introduction

Many hours have been spent in mitigating the risks of high voltage switching and operating, yet fatalities still occur. How is it possible to still have fatalities when the risks have been reduced to the absolute minimum? What more can be done and why does it not always work? The way the operator/person perceives Task Risk Assessment/Procedures and Arc Flash Suits will be discussed briefly. Then the major "contributor" to accidents, human error, will be discussed and explained. Human Error has been found to be at least one part of the domino in a major event/disaster. Be that lapse of judgment, lack of sleep or just lack of experience, human error is still the one element of risk that cannot be mitigated completely.

Operator Perception

I will briefly dwell on the possibility of errors being inadvertently introduced due to the perception of the operator in task risk assessment and procedures as well as why arc flash suits are not always worn and the risk related behaviour behind it.

- **Task Risk Assessment and Procedures**

You often hear that the risk we take to operate switchgear is "part of the job". Each and every job is properly defined and stipulated, and yet there are still accidents, which are preventable. So what is so bad about what we do and what role does Task Risk Assessment (TRA) and procedures have on a person's ability to perform his/her job correctly?

If a person is not fully focused on the task at hand, then errors occur. If your TRA does not meet certain standards, then errors occur. All working conditions in South Africa are not the same, thus the need (for each company) to stipulate each and every task in its (own) environment is essential. The task has to

correlate with the environment it is associated with, since more than one factor affects a person's ability to judge danger and that, in turn, affects performance.

Once the task is isolated and properly defined, the person performing the task has to make sure that the outline of how the task is to be executed is interpreted correctly. Let me explain: As with any form of communication, a message is sent and received by the intended recipient, then decoded, processed, and then an answer is formed and sent back (verbal or non-verbal) to the originator of the message, who in turn processes and decodes the message. A good example is the following.



Figure 1: A classic example of misunderstanding, or is it?

So what more can be done? Asses the working conditions and determine whether the person can not only perform the task, but truly understands what is to be expected and how it is to be done. Given the procedures and how the person understands what is said, certain situations warrant discussion before switching commences. That is why a person is not only declared capable to do the task at hand but also competent.

- **Arc Flash Suits**

Arc Flash Suits need to meet certain requirements as stipulated by the NFPA 70E. Given this, they are warm at the best of times and uncomfortable (bulky) to move in. Employers must always ensure that the suit used is appropriate for the task. Do not discourage any operator to wear the suit, since the suit is so uncomfortable that the risk of making a mistake while wearing the suit outweighs the risk of switching without it.

How humans perceive risk and how that perception affects their actions. Sigmund Freud believed that dare devil stunts arise out of humans' innate "death drive", where modern psychologists believe that at risk behaviour gives the partaker a form of stimuli [1], be that pleasure or fear. If their environment is perceived as low risk, then the chances of unsafe actions are raised. Figure 2 indicates the safety pyramid often used, with enough unsafe acts and conditions a fatality is a guaranteed result.

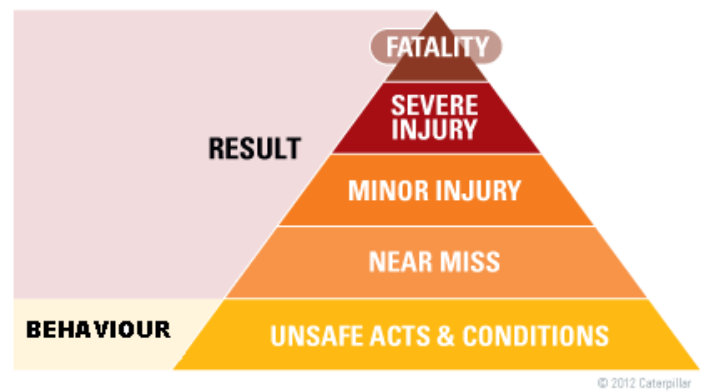


Figure 2: Safety pyramid (credit to Caterpillar).

Given that most of the risks are mitigated, why do some operators not wear their suits? Could it be that for some operators the perception of the task itself has become "low risk", since "nothing has happened yet" or their mind purposefully forces the activity into the "low risk" category in order to cope with the actual risk taken.

In a high risk situation, the endorphins and adrenaline act on the nervous system to produce an exhilarating high. Your body starts to anticipate that high and then starts to crave it. Scientists generally agree that the genetic makeup of a typical risk taker exhibits certain characteristics such as an enhanced capability of dopamine uptake [1]. The personality characteristics of a risk taker can be summarised as:

- Erratic
- Impatient
- Exploratory
- Extravagant
- Impulsive

So what more can be done? Introduce risk profile personality tests in high risk activities in order to ensure that the best candidate is chosen for the type of work? Not every person will react on the risk taking impulse, but by profiling the potential candidates, a better overall understanding of their behaviour can be found.

Human Error

The term human error refers to human activity, such as a mistake, or an omission/the absence of activity, such as oversight, resulting in dire consequences. Simply put, human error refers to the performed human action as the cause of an unwanted outcome [2]. Human error has been cited as the primary cause or contributing factor in disasters and accidents in industries and medicine [3]. Given this information, the term is used a lot and quite loosely. What does it mean that human error caused the unwanted outcome and once used, how is the risk mitigated?

When referring to human error, one has to distinguish between the terms “error-as-action”, “error as outcome” and “error-as-cause.” Figure 3 explains [4]:

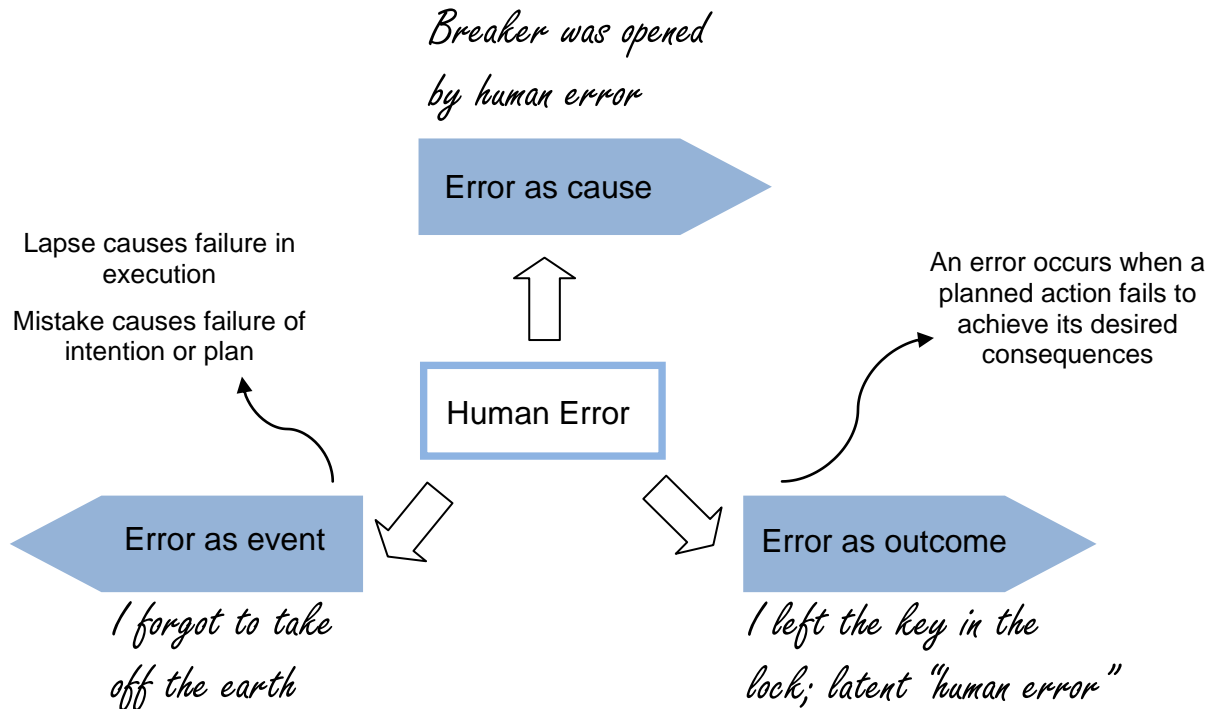


Figure 3: Human error and its three elements.

Given that each term in figure 2 indicates human error, then how do we as engineers determine the root cause of human error. Some examples that come to mind are:

- Did the operator forget to follow step x in the procedure due to fatigue, distraction, pressure, oversight, stress?
- Did the operator not isolate the switch due to lack of training, forgetting how to isolate the switch, distraction, pressure, stress?
- Did the operator not wear his suit due to ergonomics, rebellion or pressure from management to get the power supply back on?

All the above examples are lumped under human error, but the root cause of it is not known. If the root cause is not known, then how do we out engineer the risk?

So what more can be done? Introduce a central database where all arc flash related injuries are recorded. Ensure that the a person’s injuries are listed as “burns due to electrical arc flash” and not just burns, since that description skews the information. Also in this database, capture the root cause (especially when it comes to human error), since that is the one element which has not been engineered out and is worth protecting.

Once this database has been established, a safety pyramid for electrical shock and electrical arc flash related injuries can be drawn up. Using that pyramid, the risk can be measured and mitigated. If the risk behaviours lessen and it does not result in less fatalities, then it is a good point of origin to ask if the base is addressing the correct issues at hand.

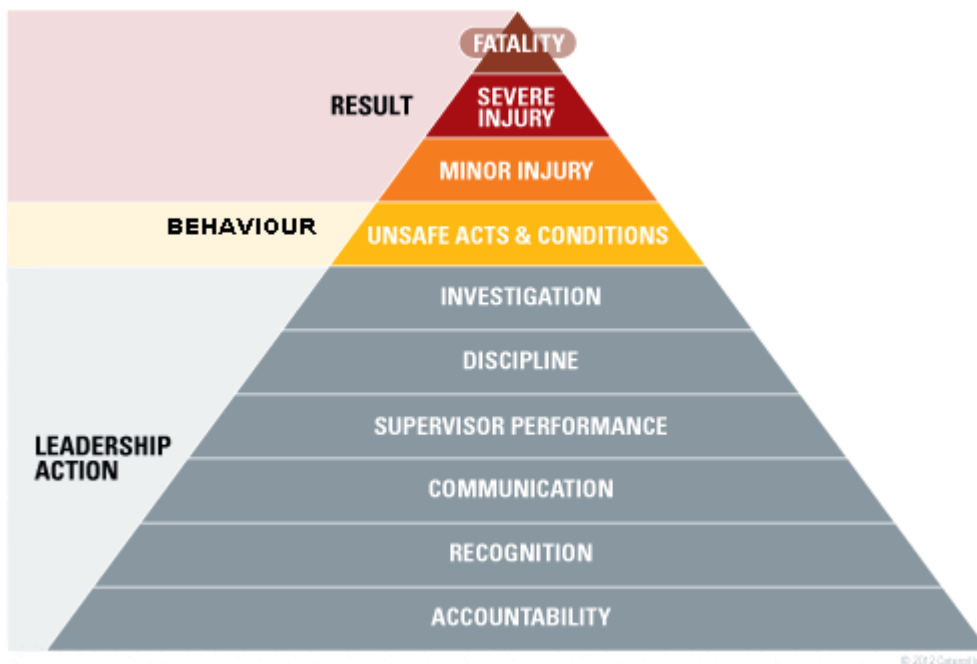


Figure 4: Broadening the foundation of the safety pyramid.

Caterpillar indicated that when they broadened their foundation, the following sub-foundation fundamentals significantly reduced injuries [5].

- Visible upper management leadership in safety
- Noticeable involvement of middle management
- Focused supervisory performance
- Active participation of hourly employees
- Training that both teaches and reinforces this type of foundational excellence

CONCLUSION

It is clear that there are plenty of parties willing to mitigate the risks involved in arc flash related injuries. Once all the obvious risks have been mitigated it may be beneficial to employers to either out engineer the human factor or to properly determine the effect that a high risk job has on the perception of risk and risk taking behaviour of the individual responsible for executing the tasks.

References

- [1] <http://www.faqs.org/health/topics/15/Risk-taking-behaviors.html>
- [2] Handbook of Applied Cognition, Francis T. Durso, p234.
- [3] Wikipedia, http://en.wikipedia.org/wiki/Human_error
- [4] Handbook of Applied Cognition, Francis T. Durso, p226
- [5] http://safetycultureworld.blogspot.com/2012_09_01_archive.html