In terms of procurement and engineering design...

Safety *must reign* Supreme

by

by Allan Morton and Roland Barrett

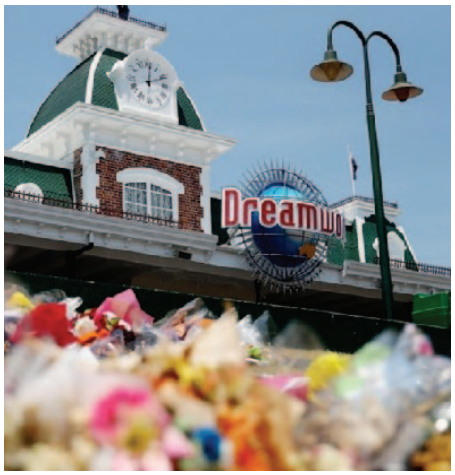
Simply 'meeting standards' should no longer be acceptable when designing or specifying and procuring products or services that directly impact public and employee safety and wellbeing.

It's time to adopt ***Safety*** as the new ***mantra***

It's time for Directors and Managers of all companies and organisations to acknowledge and adopt the mantra of insisting the safest option is always taken when purchasing products and services needed to conduct their business and operations. Particularly when safer, superior solutions that cost little more to adopt and implement are already known to specifiers and procurement staff and are readily available. Simply 'meeting standards' should no longer be acceptable when specifying and procuring products or services that directly impact public and employee safety and wellbeing. This should also apply to engineers designing new equipment and processes or updating and improving existing infrastructure and equipment. Safety in design priority should be about protecting people and assets into the future through state-of-the-art

SPECIAL REPORT

PTAS tested to the new AS/NZS 61439.1 standard and achieved a certified solution for outdoor switchboards (Stainless Steel and Aluminium) with certification on arc fault containment (IEC/TR 61641:2014) and ingress protection. (IP66). A first It's time to for Australia.



technology and innovation. It is essential for every organisation to understand its duty of care for the safety of employees and the general public. Not just 'ticking the box' to comply with today's standards. Consider for a moment Queensland's tragic Dreamworld incident in 2016. The subsequent inquest confirmed that when it comes to employees and public safety, reliance on meeting the minimum current standards is not passing the 'pub test' as a defence for decision makers. State-of-the-art products and solutions from innovative companies will always be further advanced than the technical standards which regulate them. Reviews of regulations will therefore consistently lag developments in technology. Safety should be by far the most crucial factor to consider.

Employer Obligations to Safety and Health

National and State legislation that sets decision making standards for directors and officers of organisations has paralleled increased community expectations of WHSE within and beyond the workplace. High profile incidents, such as the Dreamworld tragedy, raised the bar for protecting the public, by introducing "industrial manslaughter" into our governance consideration.

Legislation Standards for Decision Makers

Work Health and Safety Legislation

Clause 19 of the Queensland Work, Health and Safety Act 2011(5) (WHSA) states that a person conducting a business or undertaking (PCBU) must ensure as far as is reasonably practicable, the health and safety of workers and any other people who may be at risk. Reasonably practicable is defined in clause 18 of the WHSA as what was reasonably able to be done, or should have been done, to ensure health and safety considering the following matters:

- Likelihood of the hazard or risk
- Degree of harm of the hazard or risk
- Knowledge of the hazard and ways of eliminating or minimising the risk
- Availability and suitability of ways of eliminating or minimising the risk
- The cost of ways of eliminating or minimising risk is not grossly disproportionate to the risk

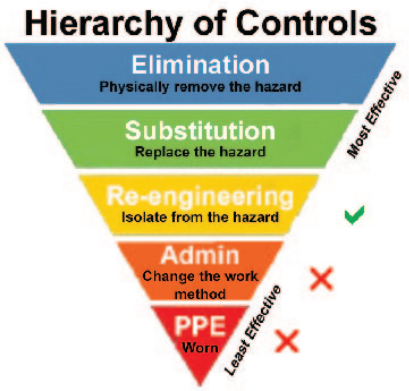
The Australian Institute of Company Directors Risk Management guide refers to Principle 7 of the ASX Recommendations that places "ultimate responsibility" for deciding the nature and extent of risks and ensuring that an "appropriate framework" exists for managing risk. Legislation puts the onus on directors and officers to make themselves aware of such methods and technology, not to rely on the say so of others. Guides published by Safe Work Australia detail offenses and penalties. Beyond the initial and direct cost of the incident, which for example may be $100,000, organisations also become exposed to operating losses, reputational loss, future litigation, and ongoing disability claims that can elevate the incident cost towards $1M per incident. When new technology comes into being that satisfies the above tests, liable decision makers should be erring towards safer outcomes.

Engineering Control of Hazards

Whilst the ultimate may be to 'Eliminate' or 'Substitute' the hazard, the reality is that our society increasingly utilises electrical controls. It is human nature to take risks. Crossing the road is a daily and well-known risk, electrical arc flash explosions don't happen often, but their consequences can be disastrous.

'Personal Protective Equipment' (PPE) has to be worn, and worn correctly, to protect maintenance personnel It offers nothing for the public.

Relying on 'Administrative controls' relies on people following instructions and being supervised to be effective.



'Engineering out' the risk is a higher order control that largely removes the human factor by isolating people from the risk.

It is both cost effective and desirable for responsible persons conducting a business or undertaking (PCBU's).

Designing and building safety into the equipment allows people to not be burdened with cumbersome PPE when working, and not needing onerous administrative supervision.

It is a more productive approach favoured by All stakeholders. In designing the ABCD modular outdoor switchboard, PTAS engineers' criteria was to make it safe with the outer weather protection doors open and not rely on protection systems or people to do the right thing.

FIRST CASE IN POINT

1: The design and manufacture of outdoor electrical switchboards that contain and mitigate arc fault incidents.

The safest modular outdoor low voltage switchboards available

Queensland-based electrical engineering services firm, P.T. Automation Solutions (PTAS), became the first in Australia to gain NATA certification for a safer outdoor switchboard design they developed, tested and now manufacture, supply and install. This will assist in reducing in the incidence of serious burn injuries resulting from hundreds of extremely dangerous arc fault explosions which currently occur throughout Australia each year.

The firm actually set out to challenge the underlying 'principles' they were aware of within some organisations which broadly, and somewhat provocatively perhaps, could be summarised as:

1. Energy intensity exposure needs only to be limited to survivable second degree burns
2. That which meets standards today holds true for the life of the asset
3. Smarter devices can reliably limit the incident energy
4. Arc flash incidents don't happen that often
5. People will do the right thing by following their safety rules and wearing their PPE

In a nutshell, PTAS has re-engineered the industry's generally accepted outdoor switchboard design to contain the arc-flash and blast energy of the explosion inside the switchboard, far exceeding current legislation that satisfies arc fault incident safety standards.

Photos taken during testing. Note major arc-blast.

The robust and highly detailed manufacturing design withstands extreme destructive conditions and provides safety for personnel with the outer doors open.

Their new IP66 / IP56 modular compact outdoor switchboard is the brainchild of electrical engineer Peter Taylor, who founded the firm in March 2000. Peter's inspiration for developing a safer outdoor switchboard was inspired by his own personal experience of being less than two metres away from a colleague who was consumed by an arc-blast incident. This patent-pending Arc-Blast Containment & Diffusion (ABCD) compact, modular design is ideally suited to switchboards in public spaces, like parks, footpaths and shopping areas. It meets and exceeds IEC TR 61641:2014 for personal protection for arcfault containment, and validation by testing fulfils new AS/NZS 61439.1 standards. Interestingly, PTAS has estimated a modest customer cost increase of only 3% compared to the standard, commonly-used more dangerous switchboards.

SECOND CASE IN POINT

2: The development of permanent access to switchboard drawings, data sheets, safety manuals via a simple QR code.

QR code gives instant, easy access to switchboard drawings and data sheets

In seeking safety and productivity innovations to improve efficiency, PTAS identified an opportunity to extend access to all as-built switchboard documents. It developed a unique support portal for its switchboard customers to always have instant and easy access to asbuilt drawings, data sheets, safety manuals. All switchboards are now delivered with a QR code that provides backup 'Installation and Maintenance Manual' documents hosted on a cloud portal accessible on the job by mobile devices or an office desktop. The firm has established a separate hosted switchboard data site for customers; a secure unpublished website managing the cloud- based information base.

The exterior QR code links directly to the PTAS website where the technician simply enters a switchboard ID login and access password for a specific switchboard's details. Technicians and supervisors can also access all details via the website before they even go to site. It provides a secure link to instantly obtain a specific switchboard's details. This reduces maintenance and unscheduled / emergency shutdowns. It also upgrades safety outcomes through totally accurate and immediate data retrieval.

The switchboard owner is required to have the board identified and the secure password to gain access to switchboard documentation.

If physical switchboard access if provided to maintenance or operation staff via key locks, then an internal QR code is provided with direct access to the switchboard portal. Further security and/or customer QR codes can be provided as required.

Field staff and managers have access to all switchboard info from a scan of the secure QR Code

Scan this QR code with your mobile device to link to our demo test site. Explore the menus to see what the QR Online Support System offers

Documentation Reduces Risk to Hazards

When field or job planning staff have the up to date information on hand, both now and throughout the switchboard's operating life, they are not unnecessarily exposing themselves to arc-flash and electric shock hazards. The QR-OCSS is another reengineering safety innovation.

As well as all the electrical and controls information, PTAS offers their customers additional capacity to include drawings, data sheets and documentation for mechanical and/or civil components of the project.

Major Customer Benefits:

- Safety enhancement
- Environmental benefit
- Service improvement
- Cost saving
- Reduced downtime

Additional advantages:

1. Backup for missing manuals
2. PTAS supplies backup to manuals on its secure support website
3. Customers can link or copy content as backup
4. Preparation before attending site
5. Callout staff can have PTAS website link for manuals
6. Replacement parts from BOM and GA's
7. Safer for employees
8. Information avoids dangerous mistakes from trial and error
9. Reduces dangerous onsite investigation necessary to identify parts, terminations, wiring logic
10. Updates of modifications can be kept current
11. Lower maintenance costs – better asset management
12. Less downtime/faster return to service
13. Reduced labour and material costs

Two Standards

Arc Flash Hazard studies, commonly performed in conjunction with a power system analysis (PSA) are usually centred around two standards, IEEE 1584 and NFPA 70E. Neither document is legislate within Australia. However, they are adopted by many Australian workplaces in lieu of Australian Standards, particularly in the highly regulated mining, energy and infrastructure sectors.

The first standard, IEEE 1584:2018 Guide for Performing Arc Flash Hazard Calculations is a widely adopted and industry accepted standard that includes procedures to calculate and predict arc flash hazard levels.

The second standard (NFPA 70E) forms part of the North America's equivalent to the Australian Wiring Rules, AS/NZS 3000. This standard focus is protection against arc burn injuries and does not consider the arc blast, flying shrapnel and pressure related injuries, nor does it consider equipment protection. IEEE 1584 quantifies the hazard based on testing, to provide the best prediction of the hazard. NFPA 70E uses this result to set out our administrative and PPE controls to protect against the calculated arc-burn hazard. Designs must be physically tested to prove and certify they work in the real world.

Two Testing Methods

Arc fault containment is the verification of increased security provided by a switchboard against the occurrence or effects of an internal arcing fault with all doors and covers securely closed and all covers and internal barriers in place.

There are two arc fault containment test methods for Australian switchboards, AS/NZS 61439.1 Appendix ZD and IEC TR 61641. Arc fault containment is the verification of increased security provided by a switchboard against the occurrence or effects of an internal arcing fault with all doors and covers securely closed and all covers and internal barriers in place.

Both standards carry out similar tests, however IEC TR 61641 has a greater focus on the entire switchboard requiring cotton indicators be located at the front, back and sides during testing whilst AS/NZS 61439.1 only requires indicators at the front.

A successful result complying to IEC TR 61641 will meet the following criteria:

- Doors and covers remain closed
- No parts are ejected
- No holes in external parts
- Cotton indicators do not ignite
- Protective circuit is still effective
- The arc was confined to the functional unit
- The remainder of the switchboard can be placed back into service

PTAS maintains the choice should be based on what's safest for the 25-year life of the asset, not what 'can be gotten away with' now, which also doesn't meet ethical duty of care considerations.

Consideration for people and public

Assessing what degree of burn is survivable and therefore acceptable certainly provides a baseline. In technical terms of incident energy exposure level, it's 1.2 cal/cm2, which defines the safe boundary where one only gets second degree burns. (Try holding a finger in the blue flame of a lighter for 1 sec).

In humans a second degree burn causes damage deeper than the top layer of skin. It still represents intense pain and significant suffering from blisters and swelling. However, despite the mental health impact of a near miss incident, second degree burns are physically survivable injuries.

Under their duty of care, it is ethically unacceptable for engineers to be designing to just meet this standard of care for electrical maintenance personnel, operators and nearby public. More so when low, or no cost arc fault containment technology is known and readily available to asset owners. Accepting the minimum standards is akin to accepting personnel's exposure to second degree burns.

Incident energy 330% higher than standards.

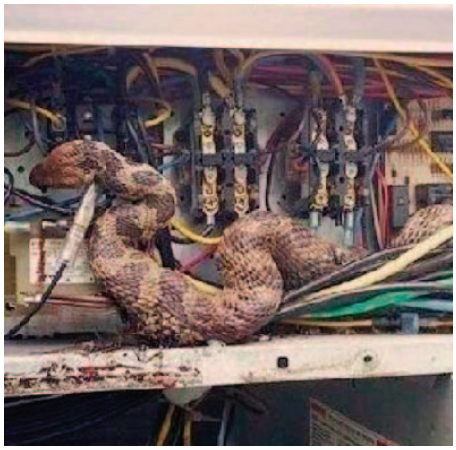
The IEEE 1584:2018 standard just released should trigger a reassessment of previous arc flash calculations, based on new learnings highlighted in the latest revision of the standard, which tested horizontal electrodes and revealed 330% higher incident energy levels. Calculations are based on laboratory tests using parameters that may not apply to real world, over time.

Selecting criteria for best results

The results from calculations and testing are sensitive to the input assumptions. In selecting their input data, engineers should deal with what's reasonable and representative.

For example, outdoor switchboards operating in a hot, wet, humid climate are highly exposed to environmental factors over a lengthy asset life.

Dust and impureness, corrosion, water condensation and water dropping are all factors which affect the reliability of calculations to represent risk over time.



So is the ingress of wildlife in outdoor switchboards.

The stochastic nature of arcs themselves also means they cannot be reliably modelled, they are mean numbers, not the upper end of the incident level distribution.

Also, the reliability of an engineer's PSA modelling is contingent on the reliability of the drawings to properly reflect the current configuration (versus as designed).

Arc flash calculations rely on probable input conditions rather than physical laws. Prudent engineers should be mindful of future social and physical conditions to select conservative input assumptions.

What is OK today is unlikely to be good enough in a decade.

What exists today will change with new technology and exposure. Over time the electrical network has and will continue to have many changes that may influence the intensity or risk of arc faults over the life of a switchboard; especially in outdoor infrastructure applications.

Growth in the electrical network may introduce unintended increased risks from equipment changeouts; an upgraded transformer upstream, upsized mains, changed protection settings in supply authority network. Also, co-generation, incorporating increased PV solar/battery generation, is ever evolving the risk.

There are other risks that will change over the life of the asset; number of staff that works on an asset; complexity of systems; system condition and maintenance; environment degradation.

It is unreasonable to assume there will be no future technologies to affect switchboard arc flash safety characteristics in the future.

Active and passive protection is now possible

Many new smart technologies are becoming available that can detect arcs developing and operate protection devices or detect the presence of personnel in proximity to switchboard to change protection device settings to operate quicker. These quicker operating times feed back into the arc flash assessment. However, these assessments are fundamentally based on all protection devices operating correctly and as predicted. It does not consider equipment failure. Protection devices have been known to fail under fault conditions well within their specifications (Ref, PTAS ABCD Testing).

Additionally, Australian businesses are adopting NFPA 70E standard to implement PPE requirements based the arc flash assessment to protect against the arc burn injuries. However, a non-arc fault contained switchboard presents additional hazards during an arc fault from the rapid increase in air pressure.

For example, a bystander or operator standing next to an operating switchboard are at risk of blunt trauma as an arc fault pressure wave ejects some door-mounted switchgear or a blown off/ open door strikes the bystander or operator. Arc fault contained switchboards provide a passive solution to these hazards.

By being engineered and physically tested to contain an arc fault whilst maintaining structural integrity, the risk to operators and bystanders is minimised without the reliance on a device operation. It is now reasonable and commercially practicable to have both active and passive protection.

Arc flash is 50% of electrical incident costs

Arc flash incidents represent about 50% of all electrical injury costs In November 2018, Workplace Health and Safety Queensland published that since 2013 there were 32 reported incidents involving an arc flash. Of these, 20 resulted in injuries requiring hospitalisation. It's generally known many incidents remain unreported, being treated as outpatients.

NSW reported that between 2005 and 2015, that there were on average 11.6 people burned working on or near electrical apparatus each year from arc faults. 81 of the 129 reported incidents for the period involved switchboards. Burns to the head/ face area was the second most common burn site, involved in 57% of injuries.

A report published in Industrial Safety and Hygiene News estimated that, on average, there are 30,000 arc flash incidents in the USA every year. The report went on to estimate that those incidents resulted in average annual totals of 7,000 burn injuries, 2,000 hospitalizations, and 400 fatalities.

Arc flash incidents have low representation in electrical accidents (about 5%), but cost about 50%, so risk mitigation requires deeper consideration.

Ensuring lifetime reliable protection

Managers correctly assume that their personnel will choose to work safe and in the organisation's best interests. However human nature too often kicks in to take a short-cut or avoid an onerous activity like wearing hot, uncomfortable, productivity-sapping PPE.

Most accidents can be traced back as multiple factor failures, where different levels of decision risk have arrived in the 'swiss cheese effect' - where a significant incident has occurred to seriously injure personnel.

Well-designed outdoor switchboards will have an operating life of 20 -25 years, 99.5% of the time in remote operating mode. The highest risk of an arc fault incident occurs when an operator opens the outer doors, or electrical staff may do maintenance. Multiple failure factors are all then present for an incident.

When an active protection device is the only protection, it is required to operate under a real fault scenario. This is usually the first opportunity for the asset owner to know if it works or not. The bathtub curve model, widely used in reliability engineering, shows that the failure rate is significantly higher at the beginning and end of life. Whereas, passive arc fault containment protection is always there to mitigate risk. Ideally that protection operates at escutcheon level so that operators (and public) are kept safe during maintenance. The risk is heavily mitigated, even when good people make mistakes. When long-term safety relies on actions of smart aging equipment or people, risks are elevated.

ALLAN MORTON
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Allan is an experienced active company director and previously ASX listed company board chairman. He's an engineer, with substantial senior manager and executive roles in a number of industries and business sectors. He's led PTAS's new strategic plan, developed SEQCD | P, supported 5S lean manufacturing processes and enhanced corporate governance.

ROLAND BARRETT
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Roland is a highly regarded, well-qualified Electrical Design and Project Engineer grounded on an electrical fitter mechanic trade background, which provides a unique viewpoint to ensure solutions are practical and readily delivered by construction teams. He's worked closely with PTAS on the R&D of the 'ABCD' Arc Fault modular outdoor switchboard.

Some salient points about switchboards and the safety of employees and the public

• Arc faults hazards cannot be eliminated within electrical switchboards. Everyone in the process has a duty of care in minimising the risk to themselves and others

• Accepting second degree burns as applies in today's standards is unlikely in the future

• Industry innovation has now proven that hazards can be engineered-out during normal operation of a switchboard by passive arc fault contained switchboards. Superior protection at very low cost

• Arc flash assessments are vital to workplace safety to determine the level of PPE to be worn when switchboard maintenance is undertaken. Administrative controls must remain, but higher order engineering controls are both cost effective and desirable

• Designing safer equipment also reduces total cost of ownership. It makes employees more productive because equipment can be operated easily without reliance on properly worn bulky PPE. Additional staffing or onerous administrative controls are also reduced

• The challenge for engineers, specifiers and executive decision makers comes down to long-term cost-effective risk mitigation

• No-one wants to reflect on decisions that have little or no commercial impact on current projects, yet accepted a lower safety benchmark which has led to maiming of personnel, or a fatality

• The 'state of the art' is generally more advanced than the 'technical standards'

• Courts in many jurisdictions now view work injury culpability as intentional or negligent behaviour of the employer. It is particularly important that 'state of the art' in the sense of regulations for employee safety is not mistaken for the 'state of technical standards'

• While arc flash incidents are relatively rare, their long-term cost to an organisation is very high. The risk is avoidable. Prudent decision-making by responsible engineers and leaders ultimately demonstrates good corporate governance

• Well-engineered designs are preferred by, and essential for organisations that understand and embrace their duty of care for the safety of employees and the general public