J L Ainsworth
[redacted]

21 April 2020

[redacted]

To: rr.feedback@planning.nsw.gov.au

Submission to Independent Review of NSW WHS (MPS) Laws

Following is my submission to this Statuary Review as requested in the NSW Government's invitation for feedback and proposals with a closing date of 1 May 2020.

1. The nature of Power System Protection.

Electrical protection of power supply systems is a critical function which is required to detect failures and interrupt the resulting fault current quickly, usually in a small fraction of a second, so as to prevent or minimize severe hazards to staff and public, (explosions, burns, electrocution), and so as to disconnect the failed equipment and prevent the power system from crashing.

The electrical protection system is a prime and essential safety system.

Electrical failures usually occur without warning as a result of insulation failure, mechanical failure, or damage from external means such as vehicles, lightning, or human errors such as incorrect operating or overloading. We are dealing here with High Voltage systems, from 3.3 kV up to 132 kV, as well as Low Voltage systems.

The electrical protection is complex, comprising measuring relays, these days digital electronic types with complex software, circuit-breakers to interrupt the high fault currents, these being complex mechanical devices, current transformers and voltage transformers, secure battery supplies or other secure power sources to operate it all, and secure protection communications

between substations. To add to the complexity, within each of these equipment classes, each manufacturer has their own version and technology.

Co-ordination of protection systems throughout the whole power supply system is essential, from the power stations right down to the lowest level in a user's installation. This co-ordination applies not just to relay settings, but more fundamentally to co-ordination of policies and concepts, and to types of equipment, circuitry, and software. Those responsible must therefore be able to understand not just their own part, but also the many other parts, and be prepared to work with those in other organizations responsible for other parts.

This electrical protection is a specialized field of electrical power engineering, requiring further post graduate education and experience beyond the Bachelor Degree level. Several years of further study is necessary and at least 5 years of guided experience by working within a group of experienced protection engineers in order to reach the required level of competence. Similar requirements apply at the trade level, where electrical technicians need to have additional education and guided training to become a competent protection technician. Power supply utilities usually have a trade classification called Technician/Protection or similar with a higher award pay classification and in-house training and experience requirements.

All of this applies to the large statewide power systems, to electrical distribution systems, to factories and industrial systems. However, in the case of mining, there are additional hazards and there are some additional requirements of the protection which are specialised to mining.

The protection engineer also has to have the ability and motivation to make and defend sound business cases for expenditure on protection. The managers and financial people in most organizations have these days limited technical understanding and continually challenge expenditure on protection because they don't see it as productive.

The protection engineer also has to thoroughly understand the power system itself and its behavior under fault conditions, transient conditions, and a variety of abnormal conditions. In particular he or she must be competent in calculating system fault levels (fault current magnitudes) under all conditions and at all places on the system, because this underpins all protection work.

2. Education, training, and qualifications.

My observations are that in the mining industry the level of competence in the electrical protection field is generally not adequate and that there is almost no recognition of the need for competent specialists. The result is that on many mine sites the protection work and decisions are carried out by the 'general' electrical engineer who has no particular expertise in the protection field.

This even extends to the mines electrical inspectors who are given no specialist training in electrical protection and where there are no requirements for qualifications in it.

Of course, there are some individuals who take it on themselves to educate themselves and gain their own experience, but there is no formality to this.

The electricity power supply industry has in the past done much better in terms of education and training in protection, but this has been in decline for the last 25 years. Still, what is currently available is the best place for mining people to start, even though additional courses or material would be necessary to cover mining situations.

Many universities used to provide post graduate courses in power system protection, typically a one or two year part time course with class work, assignments, and exams. These were often called post graduate certificate qualifications. In the last 25 years most universities pulled back from this and the various expert lecturers moved on or retired, so that at the present time very little is available, and difficult to sustain.

At the same time the large power supply utilities have slackened their previous efforts to sustain viable groups of expert specialists in protection and other specialist areas, and consequently the gaining of practical experience aspect of competence has been declining.

The people in control of the utilities are now mostly managers and economists who think that these expert specialist functions can be outsourced to consultants and contractors. But where do these companies get their training and experience ? Very few have the necessary level of competence now.

A definition of the content of formal qualification in electrical protection would be a good place to start.

An old saying quite properly says “do not attempt a task for that you are not trained or qualified for, leave it to the expert”. But what we are talking about here is where do the experts come from.

3. Guided Experience including “ What went wrong ? ”.

A necessary part of attaining competence is ‘ on the job ‘ training where the person works within a group of already competent protection engineers to gain the guided experience needed. This usually takes from 5 to 10 years to become fully experienced.

Another consideration is that such a specialist group is needed to feed off each other and learn new technologies and applications as well as to drive improvements and economies. It just does not work to try to gain this type of experience on your own without the backing of a group of experts. The expert group may have to be made up of single individuals in different small undertakings but this needs to be set up formally.

Safety, once again, is a key part of this learning experience, remembering that the electrical protection system is a prime safety measure.

A further essential part in gaining the experience is investigating system occurrences to make sure the protection worked properly or alternatively to determine what went wrong. Analysing what went wrong is a very effective learning exercise and exposes you to what can happen in real situations, across the whole range of functions from concept, design, equipment, settings,etc.

A great deal can be learned by careful study of videos of actual system failures. It is unusual to get a video of the fault actually happening, more usually just photos of the damage after the event. However, these days everyone has a phone with a camera and we sometimes get videos from the public of failures as they occur, and they are often a mine of information about the protection system if you know what to look for. For example, following are links to two sets of videos of a fairly recent system fault where the electrical protect failed to do its job. They are big explosions and sustained for a long time and would be very hazardous to the public. The large explosion and arcing would not have occurred if the protection had worked correctly, and you would see only a minor arcing for a fraction of a second. When information like this becomes available it is important that it be shared within the expert protection groups and between groups as widely as possible for the learning it provides and for the overall good of the industry.

https://www.youtube.com/watch?v=IIMlHjfhb6U

https://www.youtube.com/watch?v=i82WIATHXNY

4. What protection courses are currently available.

The following courses in power system electrical protection are currently available:

- A one or two year correspondence course provided by the Electricity Council of the UK based on their set of four textbooks "Power System Protection" ISBN: 0-906048-53-2. Volumes 1 to 3 were revised in 1995 and Volume 4, "Digital Protection and Signalling" added in 1995.
- QUT, Queensland University of Technology, is I think, the last remaining Australian Uni still providing some courses in Power System Protection. Also available as correspondence courses.
- I have been providing a three day course called " Advanced Power System Protection " for the last 15 years, several times a year around Australia. This is done under the auspices of CPD International Pty Ltd, who provide a range of specialist post graduate courses in electrical power system engineering. www.cpdint.com.au. These have been valuable to the industry in helping to fill the gap left by the universities.
- Areva have for many years run a one or two week course in Australia about once a year on power system electrical protection.
- A handbook, HB 119 – 2019 "Mines and Quarries Electrical Protection", has been recently produced to provide a reference text and training document in this subject. It covers all of the fundamental principles which would apply to any power system protection as well as those matters specific to mining. It has been produced by the Standards Australia committee responsible for mining standards and is available from Standards Australia. The statements in this submission to the Independent Review are consistent with the content of HB 119.

The four courses above are aimed at the power supply industry and do not cover the further requirements of protection in mines.

5. Recommendations / suggestions as to what might be done by way of legislation.

It is clear and obvious from experience that self- regulation does not work. It is too often abused. It is too often (incorrectly) seen as an extra cost which is unproductive. It is a cop-out on the part of governments to avoid responsibility.

There is a need for a regulatory framework, backed by legislation, to ensure that electrical engineers carrying out power system protection are suitably educated, experienced, and qualified in this specialised and expert field. At the present time this does not exist at all. In some other fields of engineering, such as structural engineering, this is much more formalized.

Yet there is a danger in regulation. It too easily becomes bureaucratic. It too easily inhibits developments, new technologies, new concepts, and new applications. It too easily leads to applying a set of rules of thumb instead of proper analysis and design to think out a protection scheme which is appropriate for the power system it is protecting.

Therefore a regulatory framework needs to ensure the appropriate education, experience and formal qualification mechanisms are in place, whilst not constraining the actual engineering, but leaving sufficient freedom to encourage and facilitate new developments, technologies, concepts, and applications. It will not be easy to get the right balance in such a framework.

It is worthwhile drawing comparisons with the medical profession to get ideas. We all know the respective roles of the GP and the Specialist and the medical system in Australia is second to none. We know that doctors cannot practice here if their qualifications are not up to scratch. We know that they can be struck off if not carrying out their duties correctly. Who decides? What is the regulatory framework?

I know that this issue is wider than the mining industry, and wider than just WHS issues, but it has to start somewhere, and it seems that the present Independent Review is not an inappropriate place to start.

I would suggest that it has to be approached one step at a time, and that an appropriate first step would be for the Independent Review to call for a statement of necessary qualifications for a competent electrical protection engineer to be developed and included in legislation.

6. My position.

I am recently retired from a long career in the electricity supply industry with Ausgrid (previously called EnergyAustralia, Sydney Electricity, and Sydney County Council at various stages, but the same utility throughout). I was an electrical power system engineer throughout, and spent the bulk of the time in the specialist group of Protection Engineers, and at a later stage was responsible for all electrical protection on Ausgrid's system.

As part of this scene I have lectured on and off over the last 35 years at several universities at post graduate level in power system protection. I also conduct the course I mentioned earlier in " Advanced Power System Protection " around Australia, which I have continued in retirement.

As part of this scene I have been active for 40 years on Standards Australia committees developing and updating Australian Standards and IEC Standards, including those involving power system protection. Because of my recognized experience I was co-opted to assist in preparing a "Mines and Quarries Electrical Protection" handbook, published recently by Standards Australia as HB 119-2019. This is a significant step forward in the education of mining engineers in the protection field. I am continuing some of this standards work in retirement.

Also I have been extensively involved in two CIGRE international committees, one in particular on Power system protection.

An important part of all this work at Ausgrid and external committees has been the analysis of faults and failures on the power systems which lead to blackouts and severe damage and safety issues. It is very educational to have to find out what went wrong, and this is another essential part of producing an experienced and competent protection engineer.

Because of all these involvements I am acutely aware of the need for suitably trained, experienced, and formally qualified protection engineers. Also acutely aware of how poorly the electrical power industry is currently set up in this regard. This goes to my motivation for making this submission to the Independent Review.

For your consideration.

Regards,

John Ainsworth.