

Address to the COTMA Conference. Christchurch October 2016.

**NS** Good Day everyone. I'm Steve Porter the chooser of the short straw. I have been a member of the WTM for less than two years but have been involved in NZ rail heritage for over forty years. I have been asked to tell you about the happenings around Power Supply at the Wellington Tramway Museum this year. The title of my address to you is "The Trials & Tribulations of a Catastrophic Power Outage at the Wellington Museum and what we can all learn from it." I trust that you will be spell bound. Anyone who wishes to ask a question at any stage should close their eyes and appear to be asleep. I will then ask for their question.

#### **NS 1**

All was under control at our Museum. Fiducia 260 was all but ready to enter service after a twenty year plus overhaul. We had:

- a spare 11kV traction transformer,
- two in service rectifiers and spare bottles,
- ALL SORTS OF SPARES FOR OVERHEAD AND TRACK.

So what could possibly go wrong that we were not prepared for?

Passenger counts and therefore revenue were tracking very well until the night of Tuesday 19<sup>th</sup> January when lightning found a path to earth inside our 11 kV oil circuit breaker. **NS 2** The breaker now had a phase to earth fault. We had no spare 11Kv switch. Should we have known that the in service switch was not adequately protected from lightning? I will address the answer to that question later.

The Reyrolle Breakers (we had two in series) were ex New Zealand Railways in the 70's and we had been using them since with occasional minor issues. These 77 year old switches were now, after the lightning strike, beyond economic repair.

Early indications revealed that RPS Switchgear (formerly Reyrolle) could build a replacement for \$70k. Further discussions reduced the price but increased the delivery time.

To reduce the price RPS offered to build a new switch from a mix of obsolescent and new parts. The expected delivery time was extended further by a Fiji order for many switches following Fiji's very serious weather event earlier in the year. When our switch was within days of delivery a further hiccup in delivery occurred.

**NS 3a** In February Electra, our local lines company, had provisionally accepted our continued use of the pole mounted metering transformer. By July Electra required either refurbishment or replacement of this equipment. We opted to do neither and instead asked RPS to include a new VT and CTs in the 11kV switch. These had to be ordered, built and installed.

**NS 4b** The new switch was delivered and installed on Sept 9<sup>th</sup>. The meter was recalibrated on Sept 11 and the 11 kV cable jointing and testing was carried out on 28<sup>th</sup> and 29<sup>th</sup> of September.

**NS 5b** Commissioning of the switch and recommissioning of the rectifier, high speed breaker, overhead, track and the trams themselves is expected to be completed by the end of this month.

Apart from the massive interruption to our operations the new switch acquisition and installation seemed to be a fairly straight forward process.

Because we were unable to operate trams we recognised that there was a good opportunity to upgrade aspects of our rectifier, high speed DC breaker, and the overhead s. Much of this work was known to be required but had been deferred. *Whoever has the time and resources?*

We were aware that lightning protection that had been on the incoming 11kV line had been disconnected years ago when the line had been re-routed to allow construction of our Rear Storage building.

An installation review to confirm compliance with current ESR requirements including step & touch potential revealed that there was a lot of work to do.

Since January we have:

- Upgraded the 11kV transformer earth field. It was 6 pegs (mostly rusted out) down one side of the transformer compound and is now 14 stainless steel pegs in a much larger L shaped array down two sides of the transformer compound and substation.
- **NS 6a** Replaced the wooden pole mesh transformer fence with a steel pole mesh fence with new bunding for the transformers oil.
- Provided concrete paths to ensure adequate “step and touch” clearance from earthed components and also to protect shallow 11kV cables.
- **NS 7b** Roofed the transformer compound.
- **NS 6b** Repainted the transformer.
- **NS 8** Fabricated and installed a shroud for the transformer low tension terminals.
- **NS 9b** Installed a remote start stop panel in the Palace (Lunch Room)
- Overhauled the High Speed DC breaker including the addition of “Delta I” protection to better detect a remote end of line short circuit.
- Serviced the mercury arc rectifier
- Reduced the depth of the cable pits in the Sub Station building and installed a sump pump. Our site is subject to very high ground water levels especially during winter and the resulting surface water in the cable pits raises the humidity in the substation. We don’t mind the moisture but the equipment does.

In August with the continuing outage of power and the effect of that on our public visitation and revenue we decided to accept the offer of a loan motor generator. **NS 10** Not as simple as one would hope. The generator as received was in need of many modifications. A hazard identification process revealed myriad hazards ranging from exposed high voltage terminals through to accessible rotating parts. We had been making progress with the loan power supply when the replacement switch arrived.

The arrival of the new switch created a dilemma. Should we continue to get the generator going or should we concentrate on reinstating the normal power supply? The same people were going to be involved whichever way we went. We knew that a No Volts or reverse polarity issue would need to

be resolved with the generator and it was possible that the generator may not be powerful enough to get our trams over the hill to the beach and back.

Whichever way we decided to go the track, trams, and overhead all needed to be checked as part of the return to service. We opted to use the generator to verify the overhead and trams were in good order but not to enter revenue service with it. We then concentrated on commissioning the new switch and returning our overhead supply from the mains to working order. A very busy 2016!

So what things might have minimised or prevented our exposure?

The failure of the switch through a lightning strike may have been avoidable. As we understand it there was no effective lightning arrestor on the 11kV supply within 4km either side of our supply lateral. The lightning strike was so severe that even if the old lightning protection was in service our switch may still have been spiked. The basic insulation level of the pitch filled Reyrolle switches is way less than that of modern air break types.

An electrically compliant standby motor generator set could have been a good stop gap.

**NS** We were aware that the transformer compound needed work but such work and many other items were on the list. *We all have lists and some of the items on them have been there forever.*

Most groups have a list of things that need to be done or could be done. Everything on these lists attracts a priority. The trick is to ensure that a high priority is given to those things which if not done at the right time might put you out of business and/or affect safety.

In the end risks to business continuance, and have no doubt we are involved in business, need to be recognised and then eliminated, isolated or minimised. Anything less and you can be out of business. The Wellington Tramway Museum managed to survive a very costly outage through the goodwill of its local lines company, RPS Switchgear, and the support of our insurer. The dedication of our membership ensured that completion of required works resulted in a return to normal tram service albeit with a long period out of service to our public.

So what is the answer to the question “**Should we have known that the in service switch was unprotected from lightning?**”? In my view we could have identified that there were real risks to our business and that the lack of lightning protection was one of them. The age of the switches themselves was a potential clue. We will be ensuring that we do Hazard and Risk Analyses once we get our breath back.

**NS** I invite questions and or comments on our experience.