Presenter: Kellie Kininmont

Principal Project Engineer

PSD Energy

https://www.psdenergy.com/

Complexities of Brownfield HV Projects

Education And Experience:

- Bachelor of Electrical Engineering with Honours
- Graduate Certificate in Infrastructure Management
- Associate Diploma in Project Management
- Over 25 years in Electrical Engineering, High Voltage Specialist

Highlights

•Wired a floor level control box, (Work Experience During Bachelor).
•Iron Duke Connection Project, Electrical Upgrade Connection to Grid (Project Manager).
•Prominent Hill Connection Project, Electrical Connection to Grid (Senior Electrical Engineer).
•Used SOHCAHTOA in real life application, Prominent Hill
•Inpex Ichthys Gas Plant, Tier 1 Electrical Contractor (Lead Project Engineer Commissioning).
•Developed Bovinophobia, Mt Gambier (Project Officer).
•Cultana Substation IEC 61850 Augmentation Project, Electrical Contractor (Project Engineer).
•Loss of Power Risk Reduction Project (Construction Manager).
•Clements Gap BESS Connection Project, Design and Construction Contractor (Principal Project Engineer).

Figure 2-1: Inpex Gas Plant in Construction

Figure 2-2: Our cats: Kaos, Zod, Shadow

Figure 2-3: Zappy

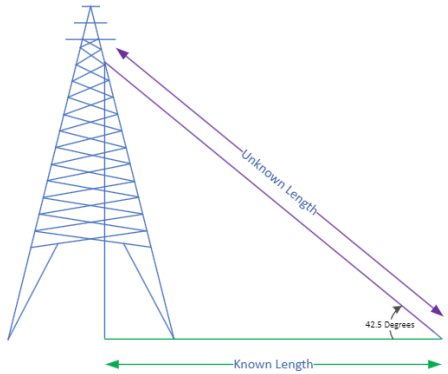


Figure 2-4: SOHCAHTOA (It was COS)

psdenergy

About the Presenter

LV, MV, HV Electrical Infrastructure Solutions from Design to Final Handover

Multi-Design teams of +100 engineers
- Project management
- Design
  - Arc Flash Studies
  - Harmonic Studies
  - HV, MV, LV Design
- Safety Engineering
- Value Engineering
- Civil Engineering

Manufacturing and Fabrication
- Substation transportable buildings
- Power distribution switchboards
- Substation control
- Substation protection panels/enclosures
- Bespoke LV Switch Boards

Construction and Civil
- Fleet of own plant and equipment
- Skilled workforce (electrical, mechanical, civil)
- Substation construction
- Specialised civil works for site preparation/foundations

Figure 3-1: PSD Energy Capabilities

- Greenfield Project – clear area not previously used.
- Brownfield Project – on or adjacent to an existing site.
- Brownfield designs are becoming more common and it is important to understand some of the key items to look for.
- Though perhaps there exists a perfect brownfields project…

Figure 4-1: Brownfield Substation Project in Construction

> In another universe all Brownfield Design requests come with:

- All drawings up to date with current as built (full audit was completed in the last 6 months), both site and adjacent areas.
- All protection settings available, for all group settings, for all devices upstream and downstream, they were downloaded in the last week, and all grade.
- Full Lidar of the entire site, including 3D model.
- The lead design and construction manager from the original build
- Full ground penetration radar completed of the area, with accurate cable routes, depths and types.
- Enough space for the new equipment.
- Enough space for the Temporary Construction Area, including carparking, laydown areas, offices.
- Good roads to the site, with easy access.
- ***Extra space for the unicorn stable.***
- ***And a tame beholder as security***.

Figure 5-1: One of the unicorns for the Stable

Figure 5-2: The tame beholder security guard

- Sadly we are not in that universe.
- Today we are considering the following types of challenges:
  - Finding Accurate As Built Drawings.
  - Age Effect on Equipment.
  - Underground and Hidden Assets.
  - Adjacent areas and the effect on design and construction.
  - Existing issues with Infrastructure.
  - Continuation of Supply.
  - Upgrade of Systems – Temporary Set Ups.

Figure 6-1: Brownfield Substation Project in Construction

- First task is to find the as built drawings.
  - Owner's database.
  - On Site Mark ups.
  - Office storage sites.
  - Hidden in a drawer that the original engineer has maintained but not shared since the last update
- Identify if there are any concerns.
  - Date on the drawing (Figure 7-1)
    - Personal best was an as-built from 1986 (presented as current in 2023).
  - Different revisions available.
  - On site review shows marks up not evident on current as built drawings.
  - On site review shows new installations,
    - New Primary equipment.
    - New panels.
    - Entire new control buildings.
    - relays newer than the as built date.
    - Signs of temporary wiring.

1	AS BUILT	SC	DD	09.04.09
REV	DETAIL OF REVISION	RVD	CHKD	DATE

Figure 7-1: Example of As Built Time Area of Concern

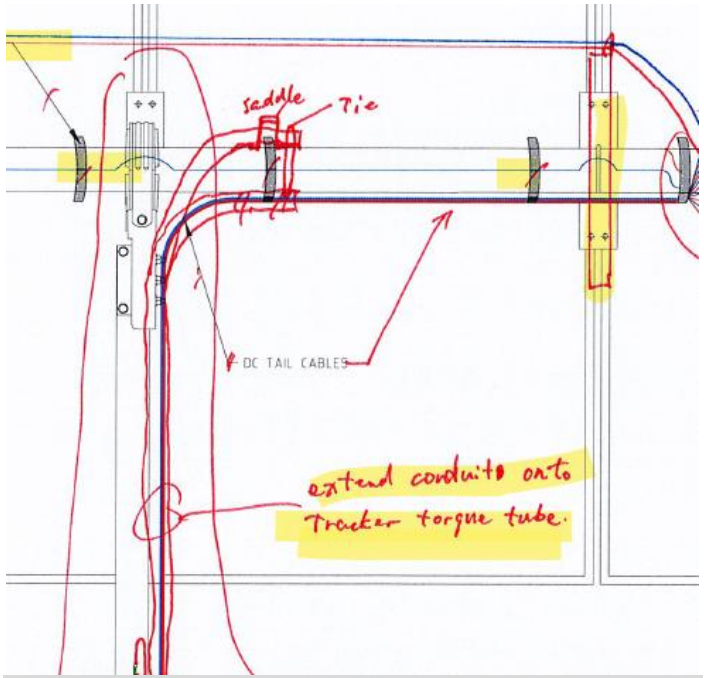


Figure 7-2: Example - Site Found Redline Mark Up

- What to do?
  - Highlight areas of concern.
  - Ask if there are any designers from the time of construction.
  - Complete a site review.
    - Time consuming and labour intensive.
  - Understand that your design may have to have some flexibility.

Figure 8-1: Testing Existing Electrical Systems

- Age Effect on Equipment:
  - Earth Grid:
    - Broken connections.
    - Earth grid not as designed.
    - Copper Theft.
  - Switchboards:
    - Reduced ratings.
    - Higher Risk of fault (including Arc Flash).
  - Structural Calculations.
  - Conductor ratings.
  - Underground Cable Ratings.
  - Equipment Key parameters:
    - Transformer Impedance.
    - Closing times for Circuit breakers.
    - Arc quenching for circuit breakers (breakdown of SF6).

Figure 9-1: Damaged Conductor

Figure 9-2: Damage Cable

Figure 9-3: Structural Damage

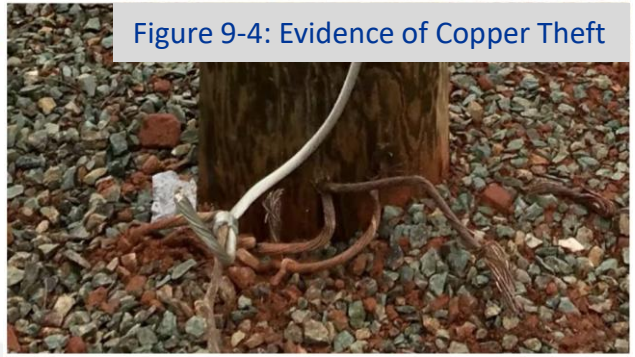


Figure 9-4: Evidence of Copper Theft

Thieves have been cutting and stealing copper used for grounding at Maritime Electric substations. (Gary O'Rielly/Maritime Electric)

Figure 9-5: Insulator Damage

Defective manufacture has made this 500 kV insulator housing crack (photo INMR).

psdenergy

Age Affect on Equipment

> Methods of locating:

- » Magnetic Locator .
- » Radial Direction Locator.
- » Ground Penetrating Radar.
- » Hydro-excavation
- » Hand digging.

> Issues:

- » Different types of assets require different techniques.
- » Most effective requires excavation.
- » The locators and radar have specific limitations.
- » Focus on Power Cables and not Control and Fibre.
- » Areas of multiple cables are difficult for all types of locating.
- » Specific Challenge - Switchroom exits and layered cables.

Figure 10-1: Switchroom Cable Exit Example

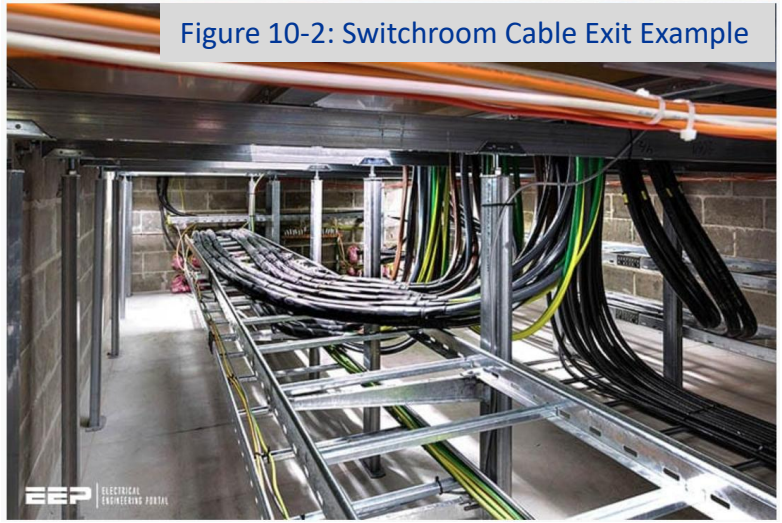


Figure 10-2: Switchroom Cable Exit Example

- Whilst initial surveys will pick up key points, they often do not include general area information:
  - This can include what is adjacent to the site, for example when the new High Voltage Line is through an operational dairy.
  - Insert Story of How I developed a fear of cows here.
  - Though it is important to advise of the general area:
    - How busy are nearby roads (is there one that is busier than the other that may be preferrable for the main entry).
    - How close are nearby residents? Is noise an issue?
    - Is the nearby area industrial, rural, urban, residential?
    - Are there nearby businesses of significance? Or nearby community areas? (Schools, Libraries, Sport Centres).
    - Is there space to locate temporary offices, lay down areas, car parking, ablution blocks?
    - Is there potable water, sewerage connection, construction water?
    - Where is the nearest place to get a proper coffee or lunch?

Figure 11-1: A Cow pretending to be sweet

Figure 11-2: Dairy Cow Plotting Something

psdenergy

Adjacent Areas and Effect on Construction
How I developed a Fear of Cows

Figure 12-1: Example of Existing Trenching Issue

Figure 12-2: Example of Existing Trenching Issue

- Going into an existing substation you may have a project with clauses such as:
  - Completion of minor rectification works.
  - Completion of outstanding maintenance notifications.
  - Updating existing supporting infrastructure to standard.
- These can lead to extensive additional works.
- One common example is existing trenches in a poor state through out site:
  - Lids requiring replacement.
  - Not to standard depths.
  - Already full.
  - Full of detritus.
  - Side walls collapsing.

- The cost of rectifying can be high, and add in a large amount of civil works for a project.

- All Brownfield project will have a focus on the continuation of supply during the project works.
- Some projects this is easy due to N-1 contingency, or the works being limited to non-essential equipment.
- Others will require careful planning to optimise outages.
  - Key is to ensure that the customer has realistic expectations of the duration of the outages .
    - Particularly if the customer is not a power supply utility.
  - Consider the case of a Single Transformer supply,
    - The customer may not understand that is it not a direct switch to the new transformer, due to soaking time on top of commissioning.

Figure 13-1: Brownfield Substation Project in Construction

> Upgrades in Brownfield sites can include updates of protection and SCADA Systems

> In some projects this may be completed in stages.

> For a project that included an upgrade of a substation to IEC61850 included a time where half the substation was running on IEC61850 and the remainder of the substation was on the existing system

> To compensate racks of SEL2506 were required to convert signal types, which took up a large amount of space

> On this project we were lucky to have the room available, but it was not considered as a requirement for the project initialisation.

SEL-2506

Rack-Mount Remote I/O Module

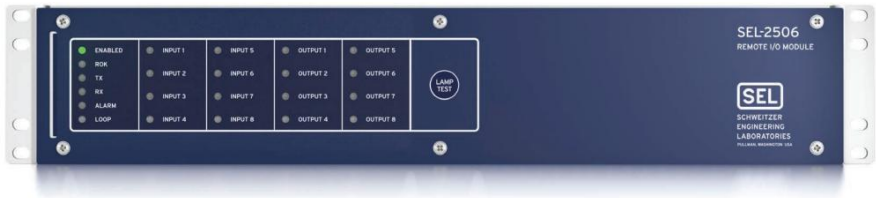


Figure 14-1: SEL-2506 I/O Module

> With Special Thanks:

- Ignatius Muller, PSD Energy
- Chris Moore, PSD Energy
- Grant Kininmont, Editor
- Michael Lee, Marcus Evans

- PSD Energy Support Team:
  - Swannie Swanepoel
  - Jon Coils
  - Xinyu Dai
  - Thilak Perera
  - Brad Bown
  - Shaun Hards
  - Matthew Pepe
  - Sherie Francis
  - Bhavan Nelakanti
  - Henrique Dutra

Slide 2:

- Figure 2-1: https://thewest.com.au/news/wa/ichthys-on-track-says-inpex-ng-ya-197566
- Figure 2-2: Presenter's Photo, Presenter happy to share pictures of the cats.
- Figure 2-3: Presenter's creation, based on multiple images.
- Figure 2-4: Presenter's Visio Sketch of SOHCAHTOA in real life

Slide 3

- Figure 3-1: PSD Energy Photos, https://www.psdenergy.com/

Slide 4

- Figure 4-1: PSD Energy Photos, Previous Brownfield Project Photos

Slide 5

- Figure 5-1: https://magicalunicornlife.com/cute-unicorn-pictures/
- Figure 5-2: Briar Fox Designs, Sticker Set

Slide 6

- Figure 6-1: PSD Energy Photos, Previous Brownfield Project Photos

Slide 7

- Figure 7-1 and 7-2: PSD Energy Information, From a real drawing, source hidden for privacy

Slide 8

- Figure 8-1: https://www.swartzengineering.com/What-Is-A-Mobile-Substation%3F

Slide 9

- Figure 9-1: https://classicconnectors.com/extending-the-life-of-overhead-aging-assets-with-focus-on-the-energized-portion-of-transmission-line/
- Figure 9-2: https://diy.stackexchange.com/questions/168364/damaged-steel-wire-armoured-cable
- Figure 9-3: https://pilemedic.com/repair-of-corrosion-damaged-substation-structures/
- Figure 9-4: https://www.cbc.ca/news/canada/prince-edward-island/pei-copper-theft-dingwells-mills-1.4871664
- Figure 9-5: https://www.inmr.com/bad-things-can-happen-to-insulators/

Slide 10

- Figure 10-1 and 10-2: https://electrical-engineering-portal.com/good-practice-in-the-design-of-concrete-and-steel-structures-in-power-substations

Slide 11

- Figure 11-1: https://www.freepik.com/premium-vector/cute-cow-vector-cartoon-illustration_145380422.htm
- Figure 11-2: https://www.thedairyjohnsriver.com/about-us?lightbox=dataItem-kqx9zset1

Slide 12

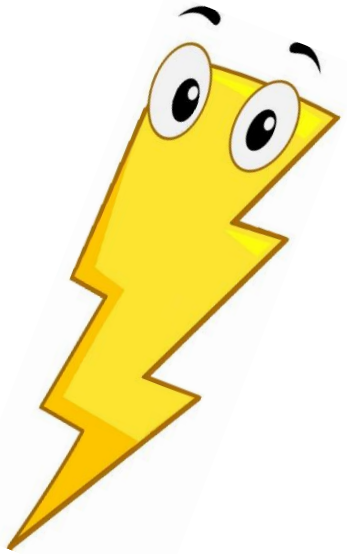
- Figure 12-1 and 11-2: PSD Energy Information, From a site, source hidden for privacy

Slide 13

- Figure 13-1: PSD Energy Photos, Previous Brownfield Project Photos

Slide 14

- Figure 14-1: https://selinc.com/api/download/1197/ (SEL-2506 – Rack mount Remote I/O Module Flyer, from the SEL site)



psdenergy

References and Sources

> https://www.trinitysubsurface.com/utility-locating-limitations

> https://geoscopelocating.com.au/locating-underground-services-the-expert-guide-to-utility-locating-equipment-and-procedures/

> https://geoscopelocating.com.au/the-best-utility-locating-method/

> https://en.wikipedia.org/wiki/Ground-penetrating_radar

> https://classicconnectors.com/extending-the-life-of-overhead-aging-assets-with-focus-on-the-energized-portion-of-transmission-line/

Reading List