



Milwaukee, Wisconsin

# Scholarship Update

2019 Q1

Monthly Progress			
Month Three	Testing of impulse generator	Analog Design and Simulation using OrCAD Capture and PSpice	Customer Requirement Documents (CRD)
Month Four	Euro TechCon - Paper and Presentation		
Month Five	OSHA Training (the Occupational Safety and Health Administration)	Attended the 2019 DISTRIBUTECH Conference	
Month Six		TechCon NA – Paper, Panel and Presentation	

TARA-LEE'S EXPERIENCE FROM DECEMBER 2018 – FEBRUARY 2019.

### HIGHVOLT

- Analysis and interpretation of fault location measurements on a 131 km long DC-cable (250 kV)
- Simulation of cable faults with the software tool OrCAD Capture / PSPICE
- Hands-on testing during factory tests of an impulse generator



In my first month at HIGHVOLT, I completed several acceptance tests for an impulse generator (up to 2400 kV cumulative charging voltage). Impulse testing systems are designed to generate impulse voltages that simulate lightning strikes and switching surges on cables, surge arresters and power transformers. I normally witness transformer factory acceptance tests, so it was fascinating to see how the test equipment itself is designed, manufactured and tested before it gets to an equipment factory.

The test system generally consists of an impulse voltage generator and three components (voltage divider, chopping sphere gap and overvoltage correction). For one customer we were testing a connection point (Items 4,5,6) which is an innovative patented solution combining all three in one device.

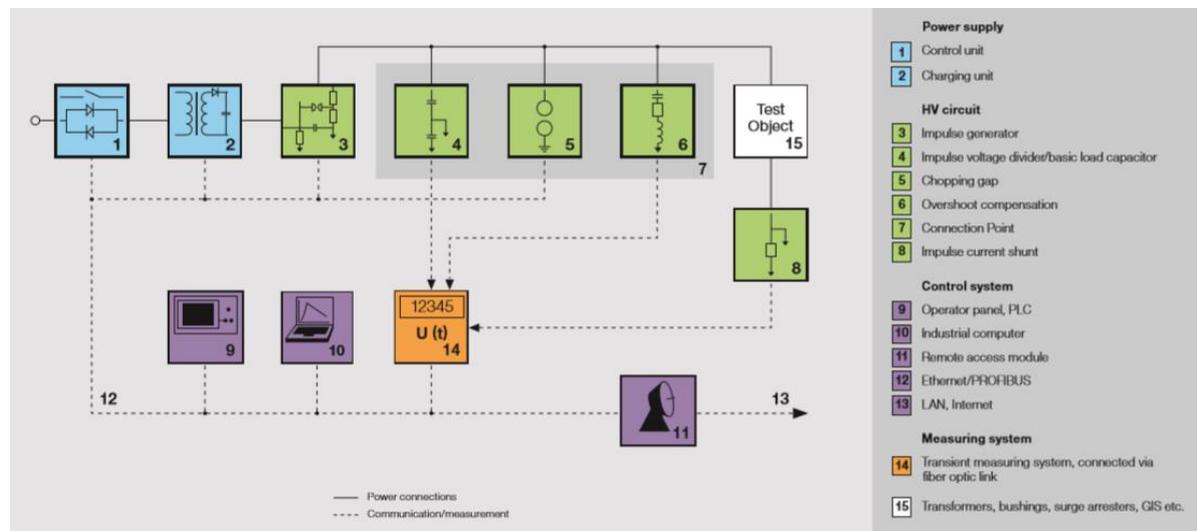


Fig.3 Block diagram of impulse voltage test system

Safety was a priority in this test facility to ensure the health and safety of the testing engineers. The control of each test system had safety functions which included emergency off and a safety loop that fulfilled the requirements of the standard IEC 62061. Additionally, during the tests we had:

- Guard fence with door and signal lamps
- An audible alarm which indicated 3 seconds to impulse
- Loud “Achtung” verbal warnings prior to each test
- Testing was completed during employee breaks or after hours when the test bay wasn’t as populated
- Appropriate PPE was worn, including hearing protection

It was an amazing experience to set up and operate the equipment especially at voltage levels around 1900 kV. Under instruction and supervision, I followed the test plans and adjusted the chopping gap distances to the required amount for each test and reported the results.

During my second month at HIGHVOLT, I learnt how to use the software tool OrCAD Capture / PSPICE. I also learnt how to analyse fault location measurements on HVAC and HVDC cables and online and offline fault location monitoring techniques. I think the case below and my visual notes page is a great summary of my experience in Dresden.

Case 1 - High voltage direct current (HVDC) link built to transmit offshore wind power to the power grid on mainland Germany. Power rating 576 MW, AC voltage 155 kV (offshore side), DC voltage  $\pm 250$  kV. The project was completed and handed over to its owner in 2015. Three years later, during maintenance, reference measurements were carried out on the  $\sim 100$  km DC cable. This cable was an underwater section which connects the offshore platform with the HVDC station.

Testing the cable: To perform these measurements, a special spark gap was made in advance and brought to the offshore platform. This spark gap was installed by a local employee. The recording of the travelling waves took place with a small universal divider directly connected to the cable termination.

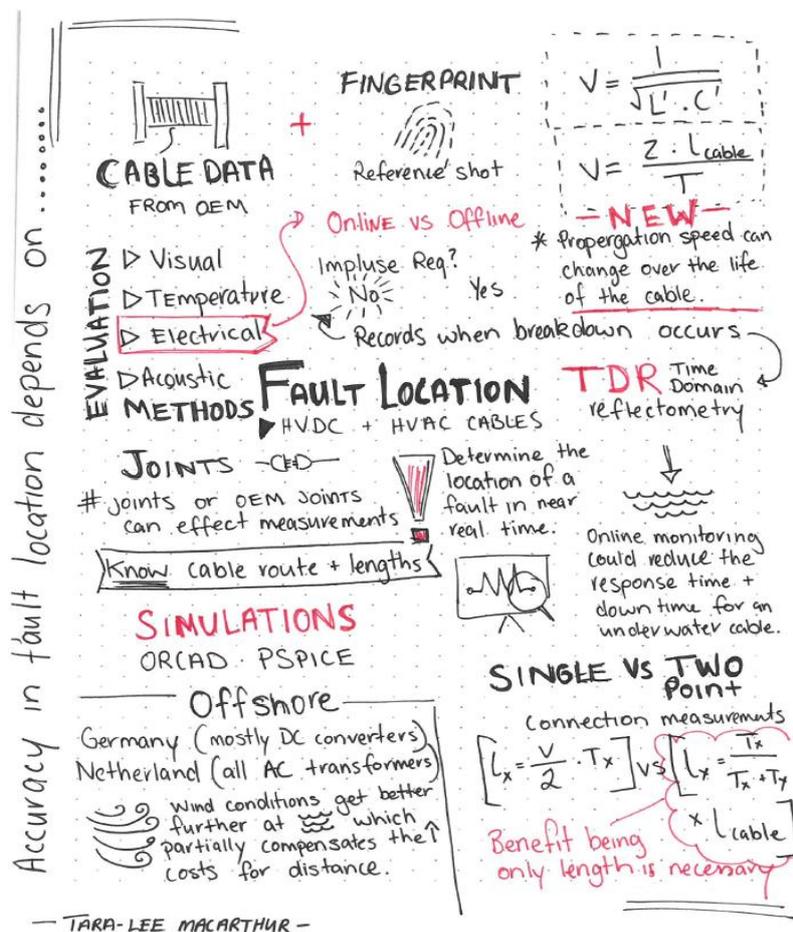
After reading the initial project reports, I noticed a mentioned of an 'unbekannte muffe' (meaning unknown joint as the reports were written in Deutsch). Finding the 'unbekannte muffe' had not been done before or investigated. I looked further into this unknown joint by translating the existing reports, studying the calculations and reviewing existing knowledge on this topic. I used the OrCAD Capture / PSPICE measurement file and analysed the reflection from this point. I recalculated the location of all of the known joints and then the distance into the cable where the unknown joint would be located. I had the cable lengths and joint data from the customer and there was nothing to indicate why we would see a reflection at this point.

After completing my calculations, I believed that there could be an anomaly at {e.g. beginning of a fault, cable stress or undocumented joint} ~23km into the underwater cable worth looking at.

To my supervisor I suggested,

- To see if the customer has had any indication of trouble with the cable so far
- If there is a joint not provided in the information supplied to us or a joint unspecified by the OEM during manufacture.

A retest during the next maintenance could confirm whether there is an anomaly showing at that location on the cable.



After 4 months working in Germany it was time for me to say goodbye.

I am truthfully thankful for my mentors who taught me more than I could have ever imagined and having managers who let me learn and grow. I will miss my colleagues and the customers who went with me on this journey. I am looking forward now to new experiences, new perspectives and a new culture! My journey continues!

#### DYNAMIC RATINGS (DR)

In the last three months, I moved to Wisconsin to start work with DR as a Principle Engineer. My role is to work with different utility customers to learn about their individual asset management strategies and requirements. Some of the companies have well established condition monitoring programs for their transformer fleet while others are just developing a monitoring strategy. My task is to document the customer's technical requirements for the projects and look at how improvements can be made from both sides. I will be able to see a range of projects from concept to design and commissioning. I will be working on this project for the duration of my time at DR and looking forward to helping customers solve some of their biggest transformer issues.

My key findings are found in the table below:

Technical Customer Requirement Document	Date
Looking particularly at success cases, transformer failures and utilities biggest challenges	Jan 19
<p>Background: DR creates a requirements document for each utility's monitoring strategy.</p> <p>My task is to;</p> <ul style="list-style-type: none"> <li>• Review the current customer requirement document process and documentation</li> <li>• Share my own experiences from Ergon and the power industry</li> </ul> <p>Specific goals and objectives for this phase: To gain insight and experience from multiple asset management experts in the industry and witness the strengths, weaknesses and challenges of the various different approaches.</p> <p>I will be learning a lot through in-depth discussions and reviewing of assets management plans from different utility customers. I anticipate that I will find significant differences in the strategies and tactics used amongst all the utilities. So far I have found some utilities have a strategy of "run to failure" and they utilise equipment redundancy to maintain grid reliability. On the other hand, others heavily leverage technology to detect equipment problems and utilise corrective and preventative actions to maintain reliability.</p>	
Did it relate to my scholarship proposal?	Yes. So far my activities have involved preparing for and conducting interviews with Senior Strategic Asset Managers at major utilities and documenting how they utilise monitoring technology to achieve their business objectives. Notes from these meeting and interviews have been noted in a technical customer requirement document for each utility.
Was the project mission completed?	Still ongoing.
Lessons learnt	I have found that due to my utility background, that customers are open in sharing their practices and thoughts with me.
Were the stakeholders satisfied?	So far, all stakeholders have been happy with my progress and improvements to the CRD process.

## OTHER ACTIVITIES

### CIGRE

#### GREEN BOOK

Next meeting is at the DOBLE conference. This progress will be documented in future reports.

#### TECHNICAL BROCHURE WG A2.49

While the document is going to be published March 2019, I will continue to work on this body of work. I am putting together some extra case studies using data from three different utilities. I will have the opportunity to present the new material at two upcoming events, CIRED Madrid and CIGRE A2 Colloquium in India. I specifically asked to give the tutorial to gain more experience writing technical papers and giving presentations.

## CONFERENCES

### DISTRIBUTECH

I recently attended the DistribuTECH conference and exhibition in New Orleans. Overall it was a great conference and one of the largest events I have ever attended. I highly recommend those working in transmission and distribution space to attend.

The 2019 theme was the collection, integration and analysis of grid data and its applications for grid performance improvement or commonly known as “grid edge”. Each year approximately 12,000 utility professionals gather for the week to learn and discuss products and trends in the industry.

It was the latest industry event that I have attended to demonstrate the importance of data and how to make informed decisions out of it. Data collection through various sensors and monitoring devices has been growing over the past few years. In my opinion, we need to continue to collect data but should also prioritise investments in data analytics. I am interested in the concept of transforming data from numbers on a screen into informed decisions especially in the power transformer space. This “Digital Twin” concept was displayed by the some of the larger manufacturers in the exhibition. Digital Twin refers to a digital replica of physical assets. Early days yet but I think this is something we will see take off over the next couple of years and an area I would like to explore more.

Another one of the challenges that took centre stage at the conference was being able to effectively manage Distributed Energy Resources (DER). We discussed creating a smart grid that can handle conventional power sources while integrating utility scale renewable energy sources.

Fun fact: For anyone organising a conference, ‘When the Saints Go Marching In’ and ‘Ready to Go’ by Republica are excellent songs to get people seated and prepared for the keynote.

## TECHCON NORTH AMERICA

I had a great time presenting and hosting the panel at NA TechCon earlier this year. The TechCon event held in San Diego showcased the journey towards new technologies and asset life extensions. Brian Sparling and I presented on situational and operational awareness, calling on our own experiences to share case studies on reducing risks on substation power transformers. During both the presentation and panel discussion, we had great engagement and questions from the audience.



I was fortunate to catch up with some familiar faces and fellow Aussie engineers, Chris Shaw, Stuart Nell and Kevin Chong who also presented at TechCon in San Diego. It's great to see Australians contributing in this field.



Future ideas to explore: This idea comes from a paper authored by a US utility where they started using a Tesla Battery for effectively managing life support customers. I think there is an opportunity for EQL to do something similar to this and they would have an interest in learning more about this project. I am looking forward to connecting the two organisations to have a conversation about it.

## DYNAMIC RATINGS

<https://www.dynamicratings.com/>

Dynamic Ratings (DR) is an Asset Management Solutions provider. Using end-to-end comprehensive products and services to improve customers' business performance. Helping utilities address the various challenges associated with successfully deploying and managing their Condition Based Monitoring programs. They offer transformer and other asset monitoring solutions, support and customer service in the global marketplace.

Dynamic Ratings is a wholly owned subsidiary of Wilson Transformer Company (WTC). WTC was founded in 1933 and has multiple transformer manufacturing plants. In the early 1980's, WTC started a joint development with one of the largest utilities in Australia to provide a transformer monitoring system. This evolved into the Dynamic Ratings division of WTC. In 2002, the US office was opened and is now the headquarters.

DR's US office is in Milwaukee which is the largest city in the state of Wisconsin.

### **Americas Headquarters**

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## MY POSITION IN THE COMPANY

Job title: Principle Engineer

- Tasks: To understand the needs of the market in great technical detail and to then utilize this detailed knowledge to guide experimentation and research into new analytics, sensors, product formulations and approaches.
- Manage key customer projects to ensure technical accuracy in supply and on time delivery of products and services.
- Act as the liaison between the end user (customer) and the various departments within DR and/or 3<sup>rd</sup> party (transformer manufactures, strategic partners, consultants, contractors, etc.)
- Provide input to the Application Engineering team as needed to ensure system designs meet customer requirements.