IEEE PES Transformers Committee
Fall 2021 Meeting
Online/Virtual

HVDC Tutorial 2: HVDC Equipment Aspects (LCC and VSC)

— Technical Presentation —

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1. Abstract

High Voltage Direct Current (HVDC) transmission links have been in the market for more than 60 years. This is the selected application to transmit electricity over long distances (via overhead lines or DC cables) or connection of asynchronous AC systems. An HVDC link is controlled via semiconductor devices and the control features are often used to stabilize the connected AC networks, e.g. by power oscillation damping controllers, frequency controllers and AC voltage controllers.

Today, two main technical alternatives exist for HVDC:

- Line commutated converters (LCC), which use thyristors as semiconductors
- Voltage source converters (VSC), which use IGBTs as semiconductors

This tutorial has five parts. In the first part, Mr. Pierre Riffon will provide an overview of special stresses and testing of converter transformers (LCC and asymmetric VSC). Mr. Klaus Pointner will continue into part two to provide an overview of special stresses and testing of smoothing reactors. In the third part, Mr. Klaus Pointner will provide an overview of special stresses and testing of converter reactors (only VSC). Mr. Waldemar Ziomek will present part four, providing an overview of special stresses and testing of DC bushings. In the fifth part, Mr. Alexander Gaun will provide an overview of special stresses and testing of AC and DC filter equipment for LCC with a focus on filter reactors.

This tutorial follows an HVDC tutorial conducted at the Spring 2021 meeting that covered HVDC System Aspects for LCC and VSC.

2. Learning Objectives

This tutorial provides the following learning opportunities:

- Explain the special stresses on equipment in HVDC converter stations
- Explain the tests needed for equipment in HVDC converter stations
- Demonstrate the differences in stresses and tests for equipment in LCC and VSC converter stations

3. Learning Outcomes

By attending this tutorial, attendees will gain an understanding of the following:

- Further general knowledge of the HVDC technologies LCC and VSC (in addition to what was learned in the previous tutorial on system aspects)
- Special stresses and special tests on equipment in HVDC converter stations

4. Presenters' Biographies

Alexander Gaun has worked for Coil Innovation GmbH in Austria since 2013, where he started as an R&D engineer for air-core dry-type reactors and presently holds the position of manager of the design and sales department. He received his doctoral degree in electrical engineering at Graz University of Technology in Austria in 2010, where he also worked as a scientific assistant at the Institute of Electrical Power Systems before joining an Austrian transmission system utility as a project manager for high and medium voltage transmission cables in 2010.

Alexander is a regular Austrian B4 subcommittee member for CIGRE and is involved in several working groups dealing with HVDC and FACTS topics. Alexander is a member of IEEE's Power Engineering Society and is also actively involved in several IEEE Transformers Committee working groups.

Klaus Pointner started his career at the Higher Institute of Technical Education for Electrical Engineering in 1988 as a design engineer for air-core dry-type reactors at Spezielektra, the predecessor of Trench Austria. After leading the engineering group, he became head of R&D from 2006 through 2013, which included leading the development of 800kV UHVDC dry-type smoothing reactors. From 2014 to 2017, Klaus became the head of marketing and sales for Trench Austria and is currently the head of R&D for Trench coil products in a global function.

Klaus is a member of the IEEE Power Engineering Society and a member of the Transformers Committee. Within the Transformers Committee, he was acting chair of the IEEE 1277-2020, is currently secretary of the HVDC subcommittee and participates in several other working groups. He is also a member of the MT IEC60076-6 on reactors, a member of CIGRE with a focus on B4 (HVDC) and A3 (high voltage equipment) topics and a participant in the Austrian OEVE in the GMT TC14 working group. He received his Dipl.Ing (similar to Master of Science) degree in mechatronics from the University of Applied Science in Wels, Austria in 2001.

Pierre Riffon joined Hydro-Québec's Research Institute (IREQ) as a test engineer for the High Power Laboratory in 1980. From 1988 to 2013, he worked as a test specialist for Hydro-Québec's Quality Control Department and was responsible for type tests on high voltage substation equipment and special project apparatus, including static and series compensation and HVDC converters. Pierre retired from Hydro-Québec in 2013 and now works as an independent consultant for high voltage equipment testing. He is also currently associated with Englobe Corporation as a high voltage equipment principal engineer.

Pierre is a member of the IEEE Transformers Committee, on which he is participating in several subcommittees and working groups. In particular, he is chair of the working group on Test Requirements for Instrument Transformers for Nominal Voltage 115 kV and above and chair of the task force on Revision to Impulse Test Sections of IEEE C57.12.00 and IEEE C57.12.90. Pierre is also vice chair of the Canadian IEC Technical Committee TC17 and Subcommittees SC17A and SC17C, Switchgear and Control Gear. He is the convener of a WG on high voltage alternating current by-pass switches and the Canadian representative on SC17A/MT36 for the revision of IEC 62271-100 High Voltage Circuit Breakers. He joined the Canadian IEC Technical Committee TC14 on Transformers and is a member of MT 60076-5 on transformer short-circuit withstand testing. Pierre is a member of the IEEE Power Engineering Society, CIGRE and registered as a Professional Engineer in the Province of Québec. He received his B.Sc.A. in Electrical Engineering from École Polytechnique de Montréal in 1980.

Waldemar Ziomek works as a director of R&D for PTI Transformers LP, a Canadian manufacturer of large power transformers, since 2015. From 2013 to 2015, he worked for CG Power Systems, an international T&D equipment company, as a global senior expert specializing in large power transformers and high voltage insulation. Prior to 2013, Waldemar was employed by CG Power Systems Canada Inc. (formerly Pauwels Canada Inc.). He started with Pauwels Canada in 1997 as a transformer electrical designer, moved to the position of electrical engineering manager in 1999 and finally into the manager of engineering role in 2003.

Since 2001, Waldemar has been an Adjunct Professor at The University of Manitoba, Winnipeg, Canada, where previously he worked from 1995 to 1997 as a Post-Doctoral Fellow. In 1995, he was with Stuttgart University, Germany, as a visiting researcher. From 1993 to 1994, he was a visiting researcher at University of Strathclyde, Glasgow, UK. He also worked previously at Poznan University of Technology, Institute of Electrical Power Engineering as an assistant professor from 1992 to 1997 and a teaching assistant and researcher from 1987 to 1992. Waldemar received his Master of Science Degree in Electrical Engineering in 1987 and a PhD in Electric Power & High Voltage Engineering in 1992, both from Poznan University of Technology, Poland.

Waldemar is an author and co-author of more than 80 scientific and technical papers. He is a member of IEEE, CSA, IEC and CIGRE as well as an active member in the IEEE PES Transformers Committee and in IEEE DEIS, where he is an associate editor for IEEE Transactions on Dielectrics and Electrical Insulation.