

## Lightning Impulse test requirement for HVDC transmission systems

Markus **SALTZER**, Henrik **JANSSON**, Thomas **WORZYK**, ABB AB, High Voltage Cables, Karlskrona, Sweden  
[markus.saltzer@se.abb.com](mailto:markus.saltzer@se.abb.com), [henrik.l.jansson@se.abb.com](mailto:henrik.l.jansson@se.abb.com), [thomas.worzyk@se.abb.com](mailto:thomas.worzyk@se.abb.com)

### ABSTRACT

Transmission systems comprising overhead lines are exposed to lightning strikes. When cables are a part of the system, the cable system will also be exposed to lightning strikes. For AC transmission systems, relevant standards specify test voltage levels for lightning impulse, but for DC systems the relevant standards specify that the cable system should be tested at voltage levels corresponding to the conditions of the specific project.

In order to establish such test voltage levels a study has been conducted. The study concludes that general statements on test voltages, related to the rated voltage, cannot be given. The study shows that the overvoltages may be significantly different both in terms of voltage level and polarity from what is commonly seen in specifications of HVDC cable projects. The lightning impulse overvoltages of a HVDC system are dependent on project specific parameters such as region specific ground flash density, overhead line tower configuration and tower grounding conditions. In order to get relevant lightning impulse test requirement of a HVDC transmission system, a project specific study is required. The study also concludes that it may be relevant with different lightning impulse test requirements in different parts of the system due to attenuation of the surge along the cable.

### KEYWORDS

HVDC, extruded cables, lightning impulse withstand levels

### INTRODUCTION

To enable the planned production of renewable energy according to EU's energy policy objectives development of the national grids is necessary. Due to challenges of getting permissions for overhead lines, the need of more environmental friendly ways of transmitting electrical power on land has increased which has resulted in transmission systems where overhead lines are combined with underground cable. Such systems are inevitably subjected to lightning impulses. Overvoltage waves emanating from lightning strikes to the overhead lines can propagate into the cables.

HVDC cable system relevant test requirements do not specify impulse testing voltages, c.f. [1]; instead, it is required that the test voltage levels shall reflect the actual conditions in a given system, which are often not very well known. In order to get relevant lightning impulse test requirement of a HVDC transmission system simulation studies have been conducted and are summarized in this contribution.

The outline is in four parts. First the electromagnetic simulation model is summarized on a general basis. In a

second step the statistical modeling approach is highlighted, which serves as input to the electromagnetic model and the simulation procedure. As a third step case study results are presented before, fourth, the study is concluded.

### SIMULATION MODEL

The phenomena of lightning striking a combined overhead line-cable system is performed using the electromagnetic transients program software tool EMTP-ATP as a backbone. EMTP-ATP has been widely used for the time domain transient solution and was first developed at Bonneville Power Administration (BPA). Nearly all system components can be represented by built-in elements in the EMTP-ATP tool, like overhead lines with conductors, ground wires and towers as well as underground cables, c.f. [2]. The key elements for the current study are presented in the following.

### Lightning strike parameters

The lightning strike current and its wave shape have been based on the Cigré guidelines [3] and more recent measurement of lightning strike currents to transmission lines in Japan [4]. An example of the lightning current wave

