CIGRE WG B1.34: Mechanical forces with large conductor cross section XLPE cables

J. **KAUMANNS** (1), M. **BACCHINI** (2), G. **GEHLIN** (3), B. **GREGORY** (4), D. **JOHNSON** (5), T. **KURATA** (6), H.-P. **MAY** (7), C. **PYE** (8), R. **REINOSO** (9), J. **SAMUEL** (10), J. **TARNOWSKI** (11), R. V. D. **THILLART** (12), M. A. **VILHELMSEN** (13), D. **WALD** (14)

1 LS Cable&System Ltd., Gumi, South Korea, jkaumanns@lscns.com
2 Prysmian, Italy
3 Svenska Kraftnaet, Sweden
4 Cable Consulting International Ltd., United Kingdom
5 Powereng, Unites States of America
6 J-Power System Corporation, Japan
7 nkt cables, Germany
8 MottMcDonald, Ireland
9 Red Electrica, Spain
10 Nexans, France
11 IREQ, Canada
12 Tennet, The Netherlands
13 Energienet.dk, Denmark
14 Eifelkabel, Switzerland

This paper summarizes the work of CIGRE working group B1.34 dealing with the topic of the thermo-mechanical forces involved with large conductor XLPE cable systems. Such forces can reach several tons of axial thrust and/or significant cycling movements in the cable system installed.

The complexity of the physical nature of the problem disallows an easy calculation of the related effects (non linear effects, hysteresis effects, etc.): Therefore, measurements on full size cable samples and best practice experiences are needed to design a safe cable system.

The paper gives an overview about the different design approaches in four sections:

- Rigid cable systems
- Flexible cable systems
- Transition sections between rigid and flexible installations and
- Duct installation.

Each section describes the individual complexity, explains the background and gives a guidance on how to handle the individual topics: The state of art design rules are given and examples for installation with good experiences related to thermo-mechanical issues are shown.

A special section deals with the topic of installations clamps (or cleats), which are an important installation tool to handle the thermo-mechancal forces in a cable system, but not always consid.

In order to get input data for the design formulas, different measurement methods are described which are needed to get the specific mechanical cable values for:

- Linear expansion coefficient α
- Axial stiffness EA
- Bending stiffness EI.

The general basics of the design principles and the thermo-mechanical model, which are described in the CIGRE brochure 194 are followed, but a deeper background is given. Wherever needed, deviation to the CIGRE brochure 194 is explained as most of the experiences were formerly based on paper insulated cable systems, which can behave differently from XLPE insulated cable systems.

Overall, the new brochure is a guide on how to handle this topic and gives a broad overview of the best practices around the world.