Watertight Cable Designs in Hydropower Generation Plants

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ABSTRACT

This paper considers the problems with induced currents in copper screens and aluminium laminate, consequences and improvements for a 24 kV watertight XLPE cable system. Repeated faults on a heavily loaded new cable system installed for the generators of a Norwegian hydropower generation station resulted in serious doubts about the performance and life expectancy of the installed system. At times during the project, a full replacement with new cables was seriously discussed. The costs involved would; however, be substantial. Hence a team consisting of parties involved was set up with the aim to try to come up with a reliable solution to avoid replacement of the cable system.

KEYWORDS

Laminate, screen current, XLPE watertight cables, contact issues, electrical induction

INTRODUCTION

During the period from 2006 to 2008 new 24 kV XLPE 1x1200mm^2 Al cables were installed at a hydro-power generation plant in Norway [1]. A total of 17 trefoil cable groups connecting 7 generators to the grid were put in. They were installed on horizontal cable ladders between the generators and transformers over a distance of several hundred meters, clamped in snaked formation. The power-plant is located inside mountain halls and tunnels. Cables had 50 mm^2 copper wire screens connected and grounded at each cable termination. The cables also had 0.2 mm aluminum laminated with PE for radial water protection. The outer sheath had a semi conducting outer layer. See Figure 2.

Faults occurred after just a short period of operation. A full short circuit to ground appeared directly under a cable termination close to where the aluminum laminate was cut, and the copper screen grounding from the cable is performed. This first incident was (incorrectly) ascribed to poor workmanship (knife cut), and was quickly replaced with spare cable and a joint.

As more attention was given to the new cable system, more emerging faults were detected. Mainly heating and burns beneath the terminations at the screen grounding, and bubbling/melting of outer sheath under cable cleats was detected. All findings were within 0-25 m from the cable terminations. Damaged cables were cut out and replaced by spare cables and joints as new emerging faults were detected.

Fig. 1: Example of bubbling/melting of outer sheath under cable cleat caused by heat from laminate and screen wires [1].

As time went on new emerging faults were detected at the replacement joints. As by the terminations, the area where the laminate was cut by the joint tended to heat rapidly. At this point heavy loading of the cable system and high ambient temperatures was suspected to be the cause of failure. With a full load conductor current of approximately 900 A, a total of 195 A current would be induced, divided between the laminate (65 A) and copper screen (130 A).

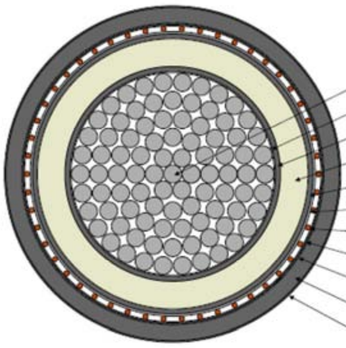

Fig. 2: Cross section of watertight 24 kV XLPE cable design [1].