Fault Location, Failure Analysis and Repair of 115kV SCFF Cable System Highlighting Important Asset Management Strategies

Jake **GELHARD**, EHV Power (Canada), jake.gelhard@ehvpower.com

ABSTRACT

An electric utility in North America experienced a cable failure on one of their SCFF cable circuits. There was a build-up of gases at the point of highest elevation along the circuit. This reduced the dielectric strength of the insulation, eventually resulting in a cable fault.

The utility had a strong asset management program in place which allowed the repair to be completed promptly upon locating the failure. The failed section of cable was removed and replaced with a SCFF-XLPE transition joint and XLPE cable. During the installation of the transition joint, the circuit lost pressure unexpectedly. A contractor working in the area had drilled into the same cable circuit at multiple locations. The circuit continued to be repaired utilizing the spare cable accessories in inventory.

KEYWORDS

SCFF (Self Contained Fluid Filled) Cable, LPOF (Low Pressure Oil Filled) Cable, Oil Reservoirs, Dissolved Gas Analysis (DGA), Joint, Termination, Transition Joint, Asset Management, Cross-Linked Polyethylene (XLPE), Cable Thumping, Time Domain Reflectometer (TDR)

INTRODUCTION

In 2021, a major electric utility in North America experienced a cable failure on one of their direct buried, 115kV self-contained fluid filled (SCFF) cable circuits.

The SCFF circuit was installed in 1970 and has been in operation for over 50 years. The cable system consists of approximately 5800 meters of cable, including a short section of submarine cable at a river crossing. It also contains one stop joint, one oil feed joint, nine straight joints and sixteen oil reservoirs. Two oil reservoirs were installed at each termination location. All the oil reservoirs were tied together using a manifold to allow interconnections during emergencies. The land cable, on which the failure occurred, is a single core 1600 kcmil aluminum conductor with oil impregnated paper insulation, aluminum sheath, and a high-density polyethylene jacket (see Fig. 1).

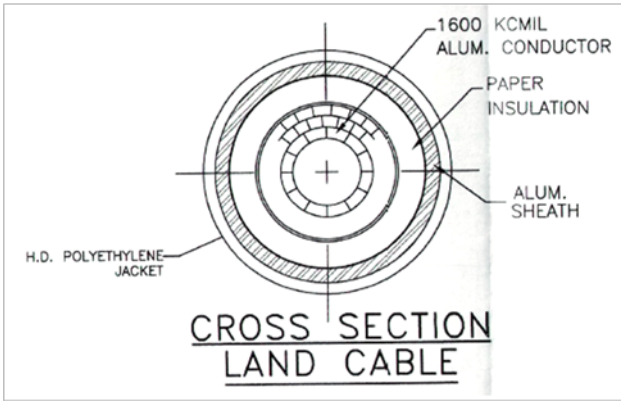

Fig. 1: SCFF Land Cable Cross Section

The B phase cable had a cable fault occur at the top of a hill near the point of highest elevation along the circuit (see Fig. 2). This is also the point along the circuit under the lowest fluid pressure.

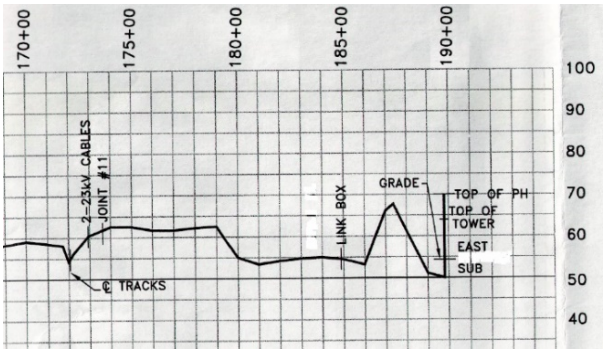

Fig. 2: SCFF Circuit Profile

Positive fluid pressure must be continuously applied to paper cables to maintain a homogenous insulation in order to suppress partial discharges. Paper insulation is particularly vulnerable to small gaps developing during thermal cycling when a cable heats up and cools down.

FAILURE ANALYSIS

An assessment of the cable system was performed to determine the location and cause of the failure, as well as the extent of the damage to the cable system.

An initial visual inspection was conducted and a small leak on the B phase termination at the substation was discovered. The leak occurred at the top assembly of the termination. The termination was an older design and had a sealing washer made of oil-resistant rubber (see Fig. 3). Over time, the rubber had degraded and ultimately resulted in an oil leak. After locating the issue, the leak was contained and the contaminated gravel in the surrounding area was disposed of in accordance with environmental regulations.

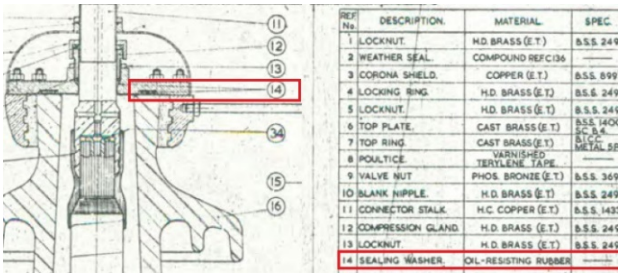

Fig. 3: Termination Top Assembly Seal

While the leak may have contributed to the failure, this was not the ultimate cause of the fault since the pressure never dropped low enough to trigger the low-pressure alarms. At this point, it was not clear what caused the cable to fail.