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High-Voltage Direct Current Interference

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Foreword

The purpose of this technical committee report is to present information and review data on the operation of high-voltage direct current (HVDC) transmission systems and their effect on underground/underwater or surface metallic structures, such as pipelines, telephone, electric power, and cable television signal transmission (CATV) cables, railways, reinforced concrete structures, etc. It is intended for individuals associated with the pipeline, water, cable, railway, and electrical transmission and distribution industries. Stray direct current (DC) associated with HVDC transmission systems can result from normal operation of monopolar transmission systems or unbalanced currents in bipolar transmission systems. Bipolar transmission systems can also generate significant levels of stray DC when operating in monopolar operation using the earth as a return circuit as a result of equipment faults or during planned maintenance of the system or converters.

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Introduction

HVDC transmission is used to carry electrical energy over long distances or to interface two alternating current (AC) power systems that might not be synchronized. HVDC transmission can be performed using monopolar systems, which are typically earth-return systems, or bipolar wire-return systems.

In monopolar systems, power is transmitted through a metallic conductor in one direction; see Figure 1. (IG refers to current flow in the Earth). Monopolar earth return systems use the earth as a conductor, and they typically use the sea as the earth return because of its low resistance and its ability to conduct large currents for a sustained period of time. Continuous operation of monopolar HVDC transmission systems is prohibited in some countries.

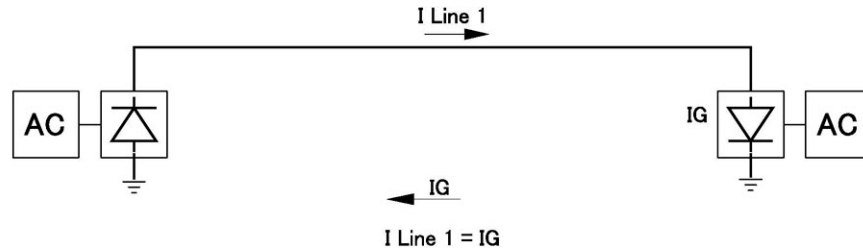


Figure 1: Monopolar Earth-Return HVDC Transmission

Back-to-back HVDC systems are generally used to solve synchronization problems or where different operating frequencies exist. These stations generally use a metallic return conductor rather than earth return. Monopolar *metallic* return systems do not use the earth as a conductor or earth return circuit.

Bipolar HVDC systems generally transmit power over a two-wire system where one wire is positive and the other wire is negative to ground (see Figure 2). Current through the earth is the unbalanced current between the two wires. In the case of a fault or equipment failure, bipolar systems generally revert to monopolar operation.

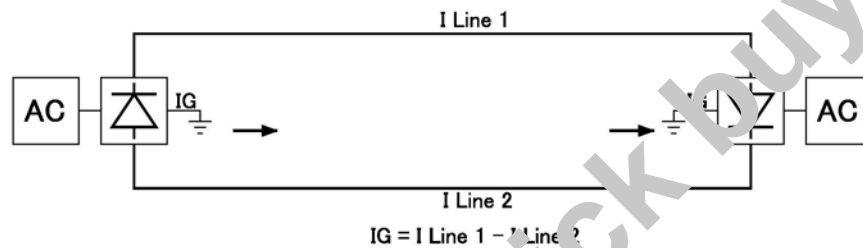


Figure 2: Bipolar HVDC Transmission

Both the operation of bipolar HVDC transmission systems that use the earth as a conductor of transmission currents and monopolar systems that use earth return currents can have serious repercussions on underground metallic structures. Whenever stray DC interference current discharges directly into the ground, corrosion occurs.

The following is a list of underground or underwater metallic structures that may be affected by HVDC stray currents. This list is not exhaustive.

- Oil pipelines,
- Gas pipelines,
- Slurry pipelines,
- Chemical products pipelines
- Water transmission pipeline
- Water distribution pipelines,
- Telephone cables,
- Pipe type cables,
- Cables,
- Railways,
- Electrical transmission and distribution systems, and
- Any other underground/underwater metallic plant.