Appendix E

Contingency event definition

Contingency event definition

The HumeLink RFP stated that an HVDC bipole is considered as an N-1 contingency event and loss of one pole of a bipole system is considered as an N-0.5 contingency event. This is not consistent with typical transmission system reliability criteria in other jurisdictions. A bipole outage is generally considered to be equivalent to the outage of a double circuit AC line and is categorized as an N-2 contingency event.

As an example, the North American Electric Reliability Corporation (NERC) sets standards by which all system operators in the United States and Canada must comply. NERC Standard TPL-001-4 establishes the transmission system planning performance requirements. Under this standard, a single contingency (N-1) is defined as the loss of a generator, transmission circuit, transformer, shunt device, or single pole of a DC line. For an N-1 event, the interruption of firm transmission service or the non-consequential load loss is not allowed. A multiple contingency (N-2) is defined as the loss of any two adjacent (vertically or horizontally) circuits on a common structure, or the loss of a bipolar DC line. For an N-2 event, the interruption of firm transmission service and the non-consequential load loss are allowed. However, it is noted that NERC moved away from N-1, N-1-1, and N-2 definitions and now uses P1, P2, P3, P4, P5, P6, and P7 to define contingency events.

The European Network of Transmission System Operators for Electricity (ENTSO-E) also considers N-1 to be the loss of a single pole (1).

In the Australian Energy Market Commission (AEMC) National Electricity Rules, HVDC systems are not specifically addressed, however, the outage of a double circuit transmission line is classified as a non-credible contingency event (clause 4.2.3). Therefore, a bipole outage should also be considered as a non-credible contingency event. Per clause 3.9.3C, non-credible contingency events are excluded from unserved energy (USE).

Bipole outages are rare for HVDC systems, especially modern ones. Bipolar systems are designed to maintain independence between the poles to ensure that a forced outage on one pole conductor or a converter does not affect the other healthy pole.

The expected forced outage rates for a modern point-to-point HVDC scheme are given in the table below:

Parameter	Value
Pole forced outage rate – per pole per year	4
Bipole forced outage rate – per year	0.1

The values in Table 7 have been specified in HVDC Technical Specifications and guaranteed by the converter station supplier for recent HVDC projects. The values are also reflective of reliability calculations performed by HVDC suppliers based on the statistical failure rates of converter station components and systems that would cause a forced outage.

The key design aspects of a bipolar HVDC system are separation of poles, redundancy, and the use of high-quality components. The design promotes the independence of the poles as far as technically feasible such that there are very few components and systems that are common points of failure and therefore may cause a bipole forced outage. The result of this design effort is demonstrated by the very low bipole forced outage rate relative to the pole forced outage rate.

Reference: ENTSO-E, HVDC links in system operations, December 3, 2019.