Secured power supply in rough environmental conditions

To secure global power supply over the long term, reliable equipment is essential. This naturally also applies to applications in rough environmental conditions. In particular, low temperatures affect the performance of high-voltage circuit-breakers.

The most common medium used for arc-extinguishing and high-voltage insulation is sulphur hexafluoride (SF₆). One major technical limitation of SF₆, however, is the condensation temperature, especially when this gas is used with significant overpressure. At rated lockout pressure and temperatures lower than approx. −30 °C liquefaction occurs and the remaining SF₆ gas density would not be sufficient to ensure the full switching performance of the circuit-breaker.

An appropriate solution is the use of a mixture of SF₆ and tetrafluoromethane (CF₄). The mixture of these two gases represents an optimum solution for covering the low-temperature applications without affecting switching performance. The mixture ensures a liquefaction-free insulation and arc-extinguishing medium as the SF₆ partial pressure is sufficiently reduced.

Based on the existing circuit-breaker design, the pure SF₆ filling will be replaced by a composition of

- 43 percent SF₆ and 57 percent CF₄ for applications down to −50 °C, and
- 25 percent SF₆ and 75 percent CF₄ for conditions down to −60 °C.

Additionally, the rated filling pressure is increased by 1.5 bar to 7.5 bar.

Consequently, the new low-temperature circuit-breaker with mixed gases offers mainly the same technical key ratings as the standard circuit-breaker that is used for low temperature conditions down to −30 °C.

The new mixed gas solution is an alternative option to the proven devices with tank heaters for operation in harsh weather conditions with temperatures down to −60°C.
In terms of overall global warming potential (GWP), the mixed gas solution also offers advantages for a 100-year time horizon, because the GWP of CF₄ (7,400) is three times lower than that of SF₆ (22,800).

Additionally, the new dead tank offers a leakage rate of less than 0.1 percent per annum of gas losses for the complete circuit-breaker.

In comparison to other low-temperature applications with tank heaters, the mixed gas solution shows a markedly reduced CO₂ footprint.

Even within the same voltage range, a reduction of the GWP by 56 percent can be achieved by the enhanced design from 2015 and the use of mixed gases as shown in the diagrams.

During the manufacturing phase, optimized utilization of materials (e.g., a smaller base frame), as well as the use of mixed gases instead of permanent heating during operation in low-temperature areas, all aspects contribute to the improved GWP.