

### Monitoring and asset management for C4-FN mixtures solutions

#### Question:

What are the management challenges to maintaining existing substations in both the short term and long term? What new ideas and concepts will provide insight on asset life extension and reduced cost while improving reliability?

#### New challenges

Over the last decades, most of the DSOs and TSOs have implemented SF<sub>6</sub> solutions for MV and HV switchgears. The necessary replacement of SF<sub>6</sub> by alternative media is ramping up and C4-FN mixtures are one of the options.

The manufacturers and users learnt over decades how to maximize the equipment lifetime, by design, maintenance, and monitoring. While the design of SF<sub>6</sub>-free switchgear is done by the OEM and validated by standardized type-tests, users may be more directly affected by the maintenance and monitoring.

#### A similar technology, with similar requirements

Commercially available C4-FN mixture switchgear show their similarity with the SF<sub>6</sub> ones. The GIS and CB are almost identical from the outside, although it is known that interrupting units had to be adapted.

#### Remote monitoring

For the end user, the switchgear is operated by known mechanism, often spring-spring, and actuated by electromagnet coils and generic motors, exactly like for SF<sub>6</sub>. The LV part is identical to SF<sub>6</sub>.

The gas medium is filled in through differentiated gas ports that can be equipped with densimeters capable to trigger alarms or lock the switchgear.

Also like in SF<sub>6</sub>, the switchgear can be equipped with pressure and temperature sensors, arc detectors, LPIT, etc.

It makes therefore possible to monitor the isolating and interrupting medium and control and auxiliary system, ensuring sufficient condition for operation. Additionally, the lifetime of the alternative gas is, like SF<sub>6</sub>, linked to the number of operations and interrupted currents. SF<sub>6</sub> systems can be easily transposed to C4-FN mixtures.

For vacuum circuit-breaker (with either SF<sub>6</sub> or SF<sub>6</sub>-free insulation), the interrupting medium (vacuum) cannot be monitored. Although the performance of vacuum interrupters (VI) has been proven for MV, long-term performance for HV without monitoring is difficult.

#### On-site maintenance

During required maintenances, as SF<sub>6</sub> and C4-FN mixtures share the same principles, the operations are the same. Resistance measurement, timing and travel curve measurements, counter reading, visual inspection, and gas analysis are similar when not identical. The main difference is the gas handling where other material should be used. All other tools are either the same or very similar.

Differences between SF<sub>6</sub> and C4-FN equipment is certainly lower than the difference between equipment of two EOMs.

For VI, the operations and maintenance on the insulating gas medium are transposable, but the VI use causes changes regarding the maintenance. The VI condition cannot be assessed, it cannot serve as disconnecter, could emit some radiations, and represent an important change in the use in HV substations.

#### Conclusions

As C4-FN mixtures equipment use the same technology and principle as SF<sub>6</sub>, most of the knowledge capitalized over the last years for SF<sub>6</sub> can be transposed to the new equipment.

Operators and supervisors will quickly adapt to the few minor changes when switching to C4-FN mixtures. The existing rules for asset management and lifetime extension in SF<sub>6</sub> only need to be adapted to C4-FN without new concepts to be created.