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GROUP REF. : SC A3
PREF. SUBJECT : PS.2
QUESTION N° : Q11

Q 11: Report 10848 states that a double break 420 kV C4-FN based circuit breaker, including grading capacitor has similar bay-width size as a single-break SF6 breaker of that rating. How would a compressed air-insulated 420 kV VCB (envisaged in 11068) compare with that?

Answer: The task force on SF6 alternative technologies of JEMA (Japan Electrical Manufacturers' Association) did a survey on footprint comparison between emerging natural-origin gas (NOG) and existing SF6 gas insulated switchgears. According to the survey by the manufacturers of the TF, the following 2 points were concluded for the considered cases:
(1) As for a GIS, footprints of NOG products are approx. 1.3 times larger than those of SF6 products now, while they are still applicable for near-term replacement needs for existing SF6 products installed more than 30 years ago.
(2) As for a circuit-breaker, footprints of NOG products are relatively comparable to those of SF6 products, because air insulating distance among bushings is the dominant factor in this case.

JEMA's survey on footprint comparison between natural-origin gas and SF6 gas insulated switchgears

JEMA (Japan Electrical Manufacturers' Association) is an industrial association that covers power transmission & distribution fields. The task force on SF6 alternative technologies (hereafter called "TF") was established in August, 2021 in JEMA, composed of the Japanese major seven switchgear manufacturers.

The manufacturers of the TF agreed to develop a joint roadmap of non-SF6 switchgear development in order to show when non-SF6 switchgears would be available in the market, which activates industry-level discussions for relevant stakeholders (manufacturers, users, government and so forth) to build most effective and reasonable plan of how and when to introduce the emerging technologies and products. (See the contribution to SC A3, PS2, Question 13 abut details of this joint roadmap)

In this activity, participating manufacturers did consider the "7 requirements" to the SF6 alternative technologies (shown in Table 1) [1] as a common condition, which had been developed by "SF6 Alternative Gas Study Group" composed of Japanese 11 utilities, 7 manufacturers and 6 academia and CRIEPI, together with TDGC (Japan T&D Grid Council) and JEMA as observers. There is one requirement "replaceable footprint with existing SF6 products" in it, and therefore the TF did a survey on footprint comparison between emerging natural-origin gas (NOG) and existing SF6 gas insulated switchgears. According to the survey by the manufacturers of the TF, the following 2 points were concluded for the considered cases:

(1) As for a GIS, footprints of NOG products are approx. 1.3 times larger than those of SF6 products now, while they are still applicable for near-term replacement needs for existing SF6 products installed more than 30 years ago. Of course, continuous design improvements and technological innovations are necessary to make footprints of NOG products comparable to those of the latest SF6 products.
(2) As for a circuit-breaker, footprints of NOG products are relatively comparable to those of SF6 products, because air insulating distance among bushings is the dominant factor in this case.

Table 1 7 requirements to the SF6 alternative technologies [1]

No	Category	Requirement
1	EHS	Especially, toxicity of decomposition gases and decompositions
2	Service Condition	Normal use conditions specified in the standard
3	Stable Supply	Stable supply of alternative gases is essential Multi gas supplier is desirable
4	Gas Handling	Simple gas handling is essential during / after installation
5	Life Cycle Cost	Life cycle cost is equivalent or reasonable to SF_6 gas equipment
6	Footprint	Confined replacement space indoor / underground
7	Voltage Coverage	Support operating system voltage up to 500kV-63kA

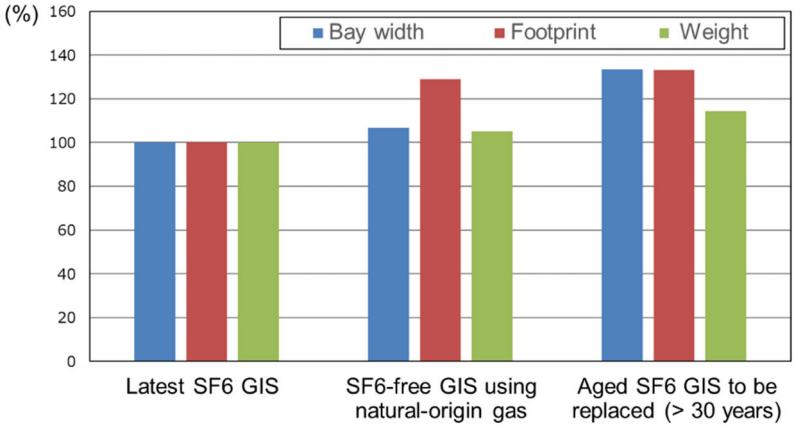

Figure 1 Footprint comparison between natural-origin gas and SF6 gas GISs [2]
(e.g. 72.5kV-class GIS cases)

	Projection drawing	Dimension A	Dimension B	Dimension C	Area S
SF_6-free CB	#1	2600	1630	2130	4.2 m^2 (100%)
SF_6 CB (manufacture A)	#2	2410	1570	1770	3.8 m^2 (89%)
SF_6 CB (manufacture B)	#2	2480	1530	<1530	3.8 m^2 (90%)

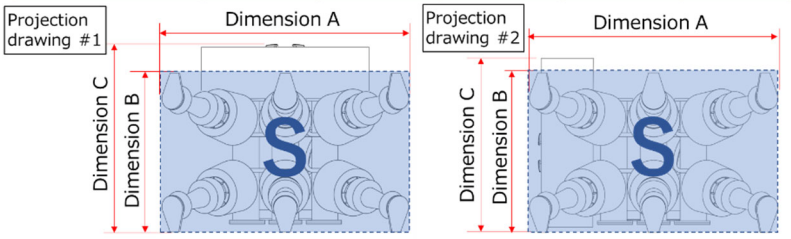

Figure 2 Footprint comparison between natural-origin gas and SF6 gas circuit-breakers [2]
(e.g. 72.5kV-class breakers cases for low pollution area)

Bibliography

[1] K. Nakamura, S. Tsukao, T. Nishioka, K. Taketa, T. Uchii, H. Hama, "Management of SF_6 gas leakage from substation equipment and technical guidelines on application of substation equipment using SF_6 alternative gases in Japan", CIGRE 2022, Paper B3-10736

[2] The Japan Electrical Manufacturers' Association, "Roadmap of Transition toward SF_6 Alternative Technologies",
URL: < https://www.jema-net.or.jp/English/businessfields/equipment/SF6phaseoutroadmap.html >