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29 August, 2019

California Air Resources Board  
 Ms. Carey Bylin  
 Mr. Brian Cook

SUBJECT: Comments Regarding Draft Amendments to the Regulation for Reducing Sulfur Hexafluoride (SF<sub>6</sub>) Emissions from Gas Insulated Switchgear (GIE) as Presented 15 August, 2019

Dear Ms. Bylin and Mr. Cook:

Thank you very much for the 15 August, 2019 public workshop in which the subject draft amendments to the regulation regarding SF<sub>6</sub> gas emissions from GIE were reviewed.

ABB is a global engineering company which provides live tank circuit breakers (LTB), dead tank circuit breakers (DTB), gas-insulated switchgear (GIS) and generator circuit breakers (GCB) around the world.

ABB's primary concern regarding the latest draft amendments to the regulation is the SF<sub>6</sub> phase out categories for the transmission level as shown below.

Voltage (kV)	Short-circuit Current (kA)	CARB Phase out Date	Commenter Suggested Dates
≤ 145	< 63	1/1/2025	1/1/2025 – 1/1/2029
	≥ 63	1/1/2025	1/1/2027 – 1/1/2029
≤ 245	All	1/1/2029	1/1/2029 – 1/1/2033
> 245	All	1/1/2031	1/1/2031 – 1/1/2036

Though operated at voltages of 36 kV and below, GCB's have historically been categorized as high-voltage (HV) circuit breakers. However, generator circuit breakers are quite different from general purpose HV circuit-breakers especially due to their installation location, i.e. between the generator and the associated step-up transformer.

The application of GCB's imposes very demanding duties and severe stress on the equipment. In contrast to general purpose HV circuit breakers, in case of fault, the current delivered by the nearby generator normally exhibits delayed zero crossing. This interrupting condition is specifically addressed in the standard for generator circuit-breakers IEC/IEEE 62271-37-013 and in its predecessor IEEE C37.013. An alternating current generator circuit breaker can

only be considered as suitable for such applications if it can force current down to zero by means of its arc voltage. To accomplish forcing a current zero, the higher the arc voltage magnitude, the better.

Vacuum interrupter based generator circuit breakers are well-known to have a very small magnitude of arc voltage compared to SF<sub>6</sub> based interrupter technologies (approximately a factor of 10) and for this reason they are often not suitable for generator applications. At the moment there is no SF<sub>6</sub>-free solution on the market able to cope with the requirements of generator circuit breakers for most power plant applications. Moreover, above 75 kA there is only one supplier of vacuum GCB's and these solutions are currently only available up to 100 kA.

Based on current technologies, a ban of SF<sub>6</sub> for GCB's, on the dates earlier presented, would leave generator applications up to 100 kA with a single GCB supplier with high risk to fail during fault current interruption. Additionally, all applications above 100 kA are potentially left without any solution meeting the proposed timelines. ABB therefore suggests that CARB regulations should treat GCB's differently than general purpose high voltage circuit breakers as is done in industry standards. A specific category for GCB's is recommended.

Thank you for the opportunity to review the draft regulation and submit the above comments. Should you have any questions, please feel free to contact me.

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