Grid Solutions

California Air Resources Board
Attn: Carey Bylin
Manager, Energy Section. Project Assessment Branch
1001 I Street
Sacramento, CA 95814

September 10, 2020

Dear Ms. Bylin:

Please find herein GE's comments to the California Air Resources Board Proposed Amendments to the Regulation for Reducing Sulfur Hexafluoride Emissions from Gas Insulated Switchgear, Release Date July 21, 2020. We respectfully request your consideration of our comments and feel these changes will enhance the proposed regulation as the global regulatory environment has facilitated GIE with GWP up to 500 to be widely accepted by multiple European utilities as well as the EU's Life program (https://think-grid.org/eu-contributes-development-sf6-free-420-kv-switchgear). Many OEMs including GE already have developed a range of SF_6-free products for international 50 Hz markets. Our recommended improvements to the proposed regulation will further encourage open-market technological advancement in the 60 Hz SF_6-free high voltage switchgear domain with benefit for all stakeholders within and outside the State of California.

We believe the proposed regulation does not fully acknowledge the significant GHG reductions realized with the use of gas blends, through the definition of "Covered Insulating Gas" as well as the impact when such gases are used in "gas blends". As stated on page 129 of the Initial Statement of Reasons, "*….under the proposed Regulation, equipment that uses an insulating medium with a GWP less than or equal to one are exempt from reporting, which further lowers GIE owners' staff time and cost.*". The current proposed regulation places existing proven SF_6-Free technology at a competitive disadvantage and could further discourage California stakeholders to broadly adopt viable SF_6-Free solutions.

The reporting exemption threshold of GWP ≤ 1 presents an additional reporting burden on users who use gas blends, providing a competitive advantage to other technologies even though gas blends present a 99% or better improvement compared to SF_6. Defining this threshold for gas blends at GWP ≤500 will encourage development and adoption of SF_6-free solutions for a broad range of applications which will still represent substantial GHG reduction compared to SF_6, as much as 99% or more. A reasonable threshold will also provide further incentive to drive OEM development meeting the proposed phase-out schedule, particularly for higher short-circuit and voltage ratings.

For example, a typical 145kV/63kA SF_6 dead tank circuit breaker contains approximately 96 lbs of SF_6 gas, which has a CO_2e of 993 metric tons. A gas blend dead tank circuit breaker with $CO_2/O_2/C_4F_7N$ (Novec4710) will use a gas blend total of only 37.5 lbs to achieve equivalent performance. The gas blend dead tank in this example will have a partial pressure mixture ratio of 83.5/13/3.5% ($CO_2/O_2/C_4F_7N$) meaning that allowing for molar weight (195g/mol) there is only 5.4 lbs of NOVEC 4710 contained within the mixture. Using GWP defined in § 95351 (a) for Novec 4710, the net GWP of the blend is 287, thus CO_2e for the example gas blend is 5.05metric tons.

The use of Novec 4710 in this example is only 5.4 lbs while an equivalent SF_6 circuit breaker could use 96 lbs or more of SF_6. Following the example presented in the Initial Statement of Reasons (page 22), if all the SF_6 in non-hermetically sealed GIE were replaced with this gas blend and assuming 1% leak rate, annual CO_2e emissions would be roughly equivalent to driving less than 600 passenger vehicles for one year. Annual CO_2e emissions for SF_6 GIE are comparable to driving over 45,000 passenger vehicles per year. Furthermore, modern GIE has a demonstrably lower emission rate compared to the installed base over the past several decades, meaning to actual emission rate will be less than 0.5%.

The following actions and revisions are requested to further incentivize users and OEMs of alternative gas blend GIE to pursue new product with higher ratings performance for the 60 Hz market (vs 50Hz in Europe) and without the reporting burden associated with SF_6 and other very high GWP GHGs:

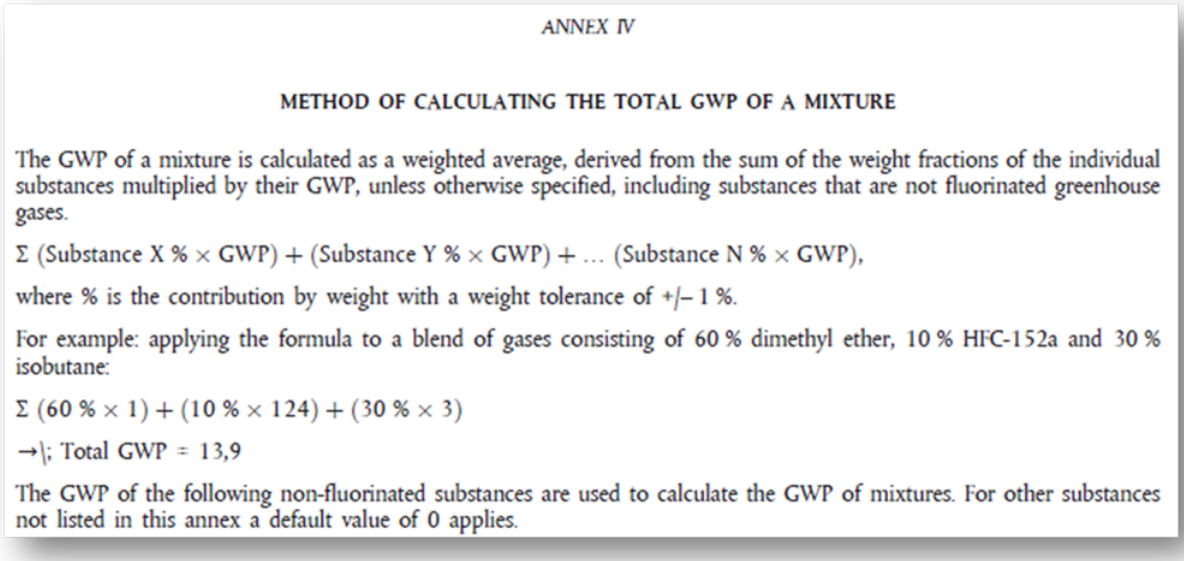
1. Change the definition of "Covered Insulating Gas" to include gas blends and Raise GWP exclusion for gas blends to 500.
2. Consider GWP of the gas blend, rather than the individual components.

- Page 3
  § 95351 (a)
  - "Covered Insulating Gas" means an insulating gas with a GWP greater than one or gas blend with NET GWP greater than five hundred (500). When the ~~amount~~ net GWP of covered insulating gas must be calculated for gas blends, it must be calculated pursuant to section 95354(l).

- Page 5
  § 95351 (a)
  - "Global Warming Potential" or "GWP" means the ratio of the time-integrated radiative forcing from the instantaneous release of one unit of a trace substance relative to that of one unit of a reference gas, in this case, carbon dioxide. The GWP values for this subarticle are as specified in Table A-1 to Subpart A of Title 40 CFR Part 98 as published to the Federal Register on December 11, 2014, which is hereby incorporated by reference. The GWP of Novec-4710 shall be the default GWP for "other fluorinated GHGs" (2,000) as listed in Table A-1 of Subpart A of Title 40 CFR Part 98 as published to the Federal Register on December 11, 2014. Reporting of Novec 5110 is not required because the default GWP in Table A-1 (Subpart A of Title 40 CFR Part 98 as published

to the Federal Register on December 11, 2014) for a compound of its type is 1. Reporting of Novec-4710 is not required when used in a gas blend with net GWP less than 500 calculated pursuant to section 95354(l).

- Page 23
  § 95354 (l)
  - Gas Blends. Whenever GWP of a covered insulating ~~gas that is a constituent of a~~ gas blend must be quantified, use the following equation to calculate the gas blend GWP ~~amount of covered insulating gas to be reported (pounds) and record the values of the inputs used~~: (Reference "*Regulation (EU) No 517/2014 of the European Parliament and of the Council of 16 April 2014 on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006*" https://www.eea.europa.eu/policy-documents/regulation-eu-no-517-2014)



ANNEX IV

METHOD OF CALCULATING THE TOTAL GWP OF A MIXTURE

The GWP of a mixture is calculated as a weighted average, derived from the sum of the weight fractions of the individual substances multiplied by their GWP, unless otherwise specified, including substances that are not fluorinated greenhouse gases.

Σ (Substance X % × GWP) + (Substance Y % × GWP) + … (Substance N % × GWP),

where % is the contribution by weight with a weight tolerance of +/– 1 %.

For example: applying the formula to a blend of gases consisting of 60 % dimethyl ether, 10 % HFC-152a and 30 % isobutane:

Σ (60 % × 1) + (10 % × 124) + (30 % × 3)

→\; Total GWP = 13,9

The GWP of the following non-fluorinated substances are used to calculate the GWP of mixtures. For other substances not listed in this annex a default value of 0 applies.

Please also consider the overall Life Cycle Assessment (LCA) for any SF_6-free solutions. An LCA analysis considers the environmental impact of the equipment beyond insulating gases and can include evaluation of material content, energy usage, emissions, depletion of natural resources and end of life disposal. Reference Hermosillo, Laruelle, Darles, Gregoire, Kieffel, "Environmental Performance of Dead-Tank Circuit Breakers with SF_6 and Alternative Gases" CIGRE Session, paper A3-102, Paris, 2020.

We thank you for your consideration and are happy to support the development of a regulation yielding a reduction in GHG emissions while at the same time ensuring a competitive environment in which high performance GIE will be developed in a timely and cost efficient manner. We are convinced these changes are needed to facilitate the adoption of all SF_6-free technologies and thus a successful timely reduction of installation of SF_6 GIE at all kV and kA ratings in California.

Please feel free to contact us if there should be any questions or clarification requests regarding our recommendations or proposed SF_6-free technology.

Respectfully Submitted,

Heiner Markhoff
President and CEO
GE Grid Solutions

About GE:

Grid Solutions, a GE Renewable Energy business, is focused on bringing together technologies and expertise to help solve the toughest power system challenges, accelerating the global transition to a greener, more resilient and reliable grid. g^3, (pronounced "g" cubed) is GE's environmentally friendly alternative to SF_6 gas, developed for HV electrical transmission equipment. g^3 products feature the same ratings and same dimensional footprint as the state-of-the-art SF_6 ones, with a drastically reduced environmental impact: more than 99% less gas global warming potential (GWP), comparatively. 20 leading utilities have decided to use g^3 products with over 25 sites in service or ordered over the past several years, including over 100 bays of Gas Insulated Switchgear and 2 kilometers of Gas Insulated Lines. https://www.gegridsolutions.com/hvmv_equipment/catalog/g3/