

September 21, 2020

Subject: 3M Company's comments regarding the *Proposed Amendments to the Regulation for Reducing Sulfur Hexafluoride Emissions from Gas Insulated Switchgear*

To:

Carey Bylin
Manager, California Air Resources Board
1001 I Street, Sacramento, CA 95814

Submitted via electronic portal:

<https://www.arb.ca.gov/lispub/comm/bclist.php>

Dear Ms. Bylin:

3M Company (3M) appreciates the opportunity to present comments in response to the California Air Resources Board's (CARB) Proposed Amendments to the Regulation for Reducing Sulfur Hexafluoride Emissions from Gas Insulated Switchgear.

In regard to the proposed reporting requirements for a "Covered Insulating Gas" in Gas-Insulated Equipment (GIE), specifically insulating gas mixtures using 3M™ Novec™ 4710 Insulating Gas, we urge CARB to base its reporting criteria on CO₂ equivalents (CO₂e) and not Global Warming Potential (GWP).

As background on Novec 4710 gas compared to sulfur hexafluoride (SF₆), please refer to the following table:

Property	3M™ Novec™ 4710 Insulating Gas	SF ₆
Atmospheric lifetime (years)	30	3,200
Global Warming Potential *	2,100	23,500
Dielectric strength (kV, relative to SF ₆)	1.9	1.0
Ozone depletion potential	0	0

*100-yr 1TH, IPCC 2013 method.

Comparing technologies by focusing on any single property does not provide a complete metric reflecting the environmental advantages of a technology to reduce greenhouse gas (GHG) emissions, which is the intention of the CARB project to amend regulations for gas insulated switchgear¹ per AB32, "AB 32 directs CARB to

develop and track GHG emissions and progress toward the 2020 statewide GHG target².”

When considering only the GWP of a single component of the technology (i.e. the pure gas), one does not gain an appreciation that technologies using alternative gases can provide significant environmental advantages. The full environmental advantage can be better observed when considering the emissions reductions as measured in CO₂e. CO₂e reductions more accurately describe the environmental advantages of alternative gas technologies and is a more useful metric for comparison of technologies. Focusing only on GWP could potentially limit a new technology’s adoption rate. CARB is already using the CO₂e metric in other areas (such as in its Annual Emissions Limit and Threshold calculations³).

To demonstrate how different gas mixtures can reduce the GHG emissions, the following table shows the CO₂e reductions for a piece of gas insulated switchgear filled with different gases:

Gas formulation	3.5% 3M™ Novec™ 4710 Insulating Gas in CO ₂	100% SF ₆
Gas pressure (bar)	6	4
Gas density at 25°C (kg/m ³)	11.9	23.6
Composite GWP* of gas mixture	292	23,500
GWP reduction compared to SF ₆	98.8%	-
GHG emissions (MT CO ₂ e/m ³)	3.5	554
GHG emissions reduction (i.e. CO ₂ e reduction)	99.4%**	-

* $GWP_{mixture} = \sum_i x_i GWP_i$

**Since GHG emissions reduction in CO₂e uses the commonly accepted GWP calculated over a 100-year integration time horizon, it discounts the longer-term effects of SF₆, which continue far beyond 100 years. As a result, the CO₂e emissions reductions calculated over longer time frames are > 99.9%.

CARB’s current proposal, which requires reporting of alternative gas mixtures based solely upon GWP, would likely result in a significant disadvantage to alternative gas adoption rates due to the imposed reporting requirements. Such reporting requirements impose a burden on the end customers and may effectively limit the number of options available to them. As such, equipment manufactures may be deterred from developing equipment using alternative gas technologies, thereby further limiting the number of available solutions to end customers.

Based on commercially available systems, solutions using 3M™ Novec™ 4710 Insulating Gas are the only technologies with the demonstrated capability of directly replacing SF₆ in non-switching compartments of existing equipment. This could drastically accelerate an SF₆ phase out. One such project working to retro-

fill existing systems is the UK National Grid’s “Alternatives to SF₆ for retro-filling existing equipment⁴.” Despite these advantages, without changes to the proposed amendments, these systems would be subject to the same reporting requirements and systems using SF₆.

In future updates to these amendments, CARB should consider adopting the Life Cycle Assessment (LCA) approach. The LCA approach allows a complete view of the technology, including the dielectric medium, size and weight of the equipment and so on. The LCA also shows technologies using Novec 4710 gas may be the strongest means to enable the broad transition away from using SF₆. To our knowledge, systems using Novec 4710 gas are the only known systems that can support designs without any increased physical space requirements. A comprehensive LCA demonstrated that technologies using Novec 4710 gas offer the most benefit to the environment compared to competing technologies⁵.

We urge CARB to take this opportunity to demonstrate that CO₂e emissions reductions are a more valuable metric for determining the benefits and environmental impact of each technology. This will allow for the selection of SF₆ alternative technologies to be driven by performance and their ability to reduce GHG emissions.

Recommendations: To meet CARB’s goals for GHG reductions and to support a meaningful transition away from SF₆ filled switchgear, we recommend the following:

- Define reporting requirement thresholds based upon CO₂e.
- Eliminate reporting requirements for all alternative gas mixtures based solely on GWP.
- Establish a reporting threshold for gas mixtures measured in CO₂e and only when the CO₂e emissions reduction is <95%, as compared to SF₆.

Sincerely,



Erik Olson
Global Segment Manager
3M Electronics Materials Solutions Division
erik.olson@mmm.com

References:

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- 2). https://ww2.arb.ca.gov/sites/default/files/classic//cc/scopingplan/scoping_plan_2017.pdf
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- 4). https://www.gegridsolutions.com/products/reference/ge_g3_roadmap_2025-en.pdf
- 5). https://www.smarternetworks.org/project/nia_nget0199