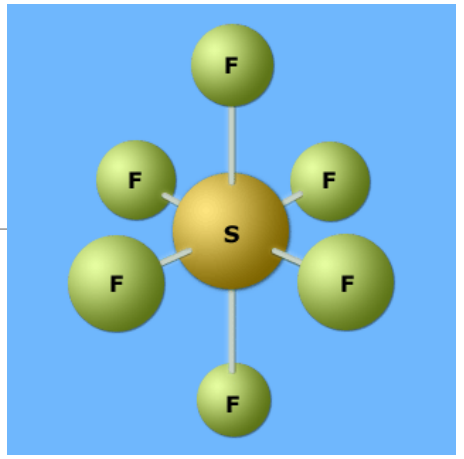
Draft Amendments to the Regulation for Reducing Sulfur Hexafluoride (SF_6) Emissions from Gas Insulated Switchgear

AUGUST 15, 2019

Workshop Materials and Comments

- This presentation and other materials are posted on our webpage: https://ww2.arb.ca.gov/our-work/programs/elect-tandd/meetings-workshops
- Presentation webcast: https://video.calepa.ca.gov/
- During this workshop, e-mail questions to: auditorium@calepa.ca.gov
- Following the workshop, please submit written comments by 5:00 p.m. Pacific time on August 29 via our webpage: https://ww2.arb.ca.gov/our-work/programs/elect-tandd/meetings-workshops

SF_6 and Assembly Bill 32



- SF_6 is the most potent greenhouse gas (GHG)
  - Global warming potential (GWP) of 22,800 over 100 years (IPCC AR4)
  - Atmospheric lifetime of 3,200 years
- Electrical transmission and distribution equipment is the primary source of SF_6 emissions in California
- Assembly Bill 32 (2006) requires that the State reduce GHG emissions to the 1990 level by 2020
  - The Regulation for Reducing SF_6 Emissions from Gas Insulated Switchgear (SF_6 GIS Regulation) was adopted as an early action measure due to the high GWP of SF_6

Current SF_6 GIS Regulation

- Adopted by the Board in 2010 and went into effect in 2011
- Applies to owners of SF_6 GIS
- Sets an annual emission rate limit for SF_6 as a percentage of an owner's cumulative SF_6 nameplate capacity
  - Allowable emission rate started at 10 percent in 2011, decreased 1 percent per year until 2020, after which point it remains constant at 1 percent

Recent Climate Policy and Potential Amendments to the SF_6 GIS Regulation

- In 2016, the State's GHG emissions dropped below the 2020 target four years earlier than mandated
- Senate Bill 32 (2016) requires the State to reduce GHG emissions to 40 percent below the 1990 level by 2030
- Board Resolution 17-46 (2017) directs CARB staff to evaluate and explore opportunities to achieve additional cuts in GHG emissions from all sources
- CARB is evaluating regulatory amendments to the SF_6 GIS Regulation to:
  - Further reduce GHG emissions
  - Include non-SF_6 GHG emissions
  - Streamline regulatory requirements

Nov 2017: Public workshop and release of draft revisions → *May 2018*: Public working group meeting → *Feb 2019*: Public workshop and release of discussion draft → *August 2019*: Public workshop, release of 2nd discussion draft

Potential Revisions to Discussion Draft

- Phase out use of SF_6 in gas-insulated equipment (GIE)
- Add SF_6 Phase Out Exemption
- Change from an emission *rate* limit (%) to an *emissions* limit in metric tons of carbon dioxide equivalent ($MTCO_2e$)
- Alternate emissions limit for GIE owners below capacity threshold
- Modify emissions calculation
- Add process for adjusting nameplate capacity of GIE
- Other revisions

Presentation Format

- This section describes the regulatory requirement included in the Discussion Draft released at our February workshop

- *This section describes key comments received from stakeholders during the comment period*

- This section summarizes changes CARB staff has made to the Discussion Draft or additional questions CARB staff has as a result of comments received

Phase Out of SF_6 GIE: Transmission-level

- Phase out GIE owners' ability to acquire new SF_6 GIE without an approved SF_6 Phase Out Exemption

- *The phase out schedule in the February Discussion Draft is geared toward transmission-level GIE, add a separate schedule for distribution-level GIE*
- *In addition to voltage class, interrupting current and above/below-ground placement determine product availability*

- CARB staff requests feedback on the revised phase out categories

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

Phase Out of SF_6 GIE: Distribution-level

Configuration	Voltage (kV)	Short-circuit Current (kA)	CARB Phase out Date	Commenter Suggested Dates
Aboveground	< 38	< 25	1/1/2025	≤ 17.5 kV: 1/1/2025 Otherwise: 1/1/2031
		≥ 25	1/1/2025	
	≥ 38	< 25	1/1/2025	
		≥ 25	1/1/2025	
Belowground	< 38	< 25	1/1/2025	1/1/2031
		≥ 25	1/1/2025	
	≥ 38	< 25	1/1/2025	
		≥ 25	1/1/2025	

SF_6 Phase Out Exemption

- Process for GIE owners to request permission from CARB to acquire SF_6 GIE, after the phase out, under specified conditions (e.g. non-SF_6 GIE unavailable, cannot meet size requirements)

- *Add exemption category for cost or non-SF_6 GIE available from only one vendor*
- *Allow for a single exemption request to cover multiple sites and/or standby replacement devices*

- Staff considering exemption if < 2 manufacturers produce specific non-SF_6 GIE
  - Staff requests feedback on Non-SF_6 Electrical Power Equipment Clearinghouse
- Single request may cover multiple locations with same or similar justification
- SF_6 GIE acquired with an SF_6 Phase Out Exemption must be acquired within 1 year

SF_6 Phase Out Exemption Application Process

- Application must include: Project description, amount/type of SF_6 GIE needed, justification for exemption, and summary of bid solicitations/vendor responses
- CARB review time: 75 calendar days

- *Eliminate reliance on bid solicitations and responses from vendors*
- *Shorten CARB's review time (some bids only good for 90 days)*
- *Streamline CARB review process when SF_6 GIE are needed quickly for emergency replacements*

- Provided additional detail on data required for each exemption type
  - Submittal of bid solicitations/vendor responses no longer required
- CARB staff requests feedback on defining equipment eligibility and process for potential "catastrophic failure" provision

Annual Emissions Limit and Threshold (1 of 2)

- Change emission *rate* limit (%) to *emissions* limit ($MTCO_2e$)
- GIE owners with *average CO_2e capacity* < 5,500 $MTCO_2e$ not subject to limit

$$Emissions\ limit = \frac{AEF_i}{100} * Average\ CO_2e\ Capacity$$

- AEF_i = annual emission factor for each year *(i)*
  - AEF_i initially equal to 1.0 for GIE owners with *average CO_2e capacity* ≥ 5,500 $MTCO_2e$
- *Average CO_2e capacity* based on average system nameplate capacity for 2019
- *Commenters support emissions limit*
- *Raise threshold value (most requested 10,000 $MTCO_2e$)*
- Retained threshold value of 5,500 $MTCO_2e$
  - 1% emissions rate limit is feasible above this capacity

Annual Emissions Limit and Threshold (2 of 2)

- New emissions limit for GIE owners with *average CO_2e capacity* < 5,500 $MTCO_2e$ to ensure emissions stay limited over time

$$Emissions\ limit = \frac{AEF_i}{100} * Average\ CO_2e\ Capacity$$

- AEF_i = annual emission factor for each year *(i)*
  - AEF_i equal to 5.0 for GIE owners with *average CO_2e capacity* < 5,500 $MTCO_2e$ in all years
- *Average CO_2e capacity* based on average system nameplate capacity for 2019

Annual Emissions Limit Baseline

- *Average CO_2e capacity* equals capacity of active GIE in 2019, "baseline" value remains fixed for purposes of calculating emissions limit in all subsequent years
- *Baseline year should be 2025, or later*
  - *Installed SF_6 capacity will grow until phase out goes into effect, some GIE owners' capacity will increase at much greater rate than state-wide historical average (3%)*
  - *Firm orders have been placed for SF_6 GIE that will be installed in the near future*
- *Include in Average CO_2e capacity: Inactive GIE and SF_6 GIE acquired after phase out*
- Including inactive capacity could raise individual GIE owners' baseline significantly
  - GIE owners reported inactive capacity up to 300% of active capacity
  - Actual SF_6 contained in inactive GIE is not reported

Emissions Calculation

- Incorporate non-SF_6 insulating gases/other clarifications
- *Emissions should be calculated from all of a GIE owner's GIE (not just active GIE)*
- Revised equation:

Emissions = (Decrease in insulating gas inventory) + (Acquisitions of insulating gas) – (Disbursements of insulating gas) – (Net increase in total nameplate capacity of ~~active~~ non-hermetically sealed GIE owned).

- Replaced other instances of "active" with "non-hermetically sealed"
- Acquisitions/disbursements of insulating gas in GIE accounted for when device is filled to operating pressure for the first time/permanently decommissioned
- Insulating gas in permanently decommissioned GIE must be accounted for annually
- GIE considered "permanently decommissioned" if out of active service for 3 years

Nameplate Capacity Adjustments

- GIE owners requested that CARB add a nameplate capacity adjustment process because SF_6 capacity provided on a GIE's nameplate may be inaccurate
- CARB staff requested specific feedback on how to structure the process
- *The process should be optional. Few specific proposals provided.*
- Process is optional
- Process can only be performed when SF_6 is scheduled to be removed from the device (e.g. end of life, acquisition, maintenance)
- CARB staff requests feedback on
  - Potential systematic approaches for selecting SF_6 GIE that will go through the process (e.g. all SF_6 GIE of a certain voltage, model number, SF_6 capacity)
  - Methodologies that can be used to recalculate capacity

Other Changes from February Draft

- Reporting not required for GIE that use an insulating gas with GWP ≤ 1
- Specified that, after the phase out, GIE owner may ship SF_6 GIE to the original manufacturer for repairs, and the SF_6 GIE may be returned to the GIE owner
- Defective SF_6 GIE may be exchanged for new SF_6 GIE after the phase out if under the manufacturer's warranty period
- The nameplate capacity for new SF_6 GIE must be accurate to within 5%
- GIE owners need not label GIE and insulating gas containers to indicate the type of gas designed to be used
- Container tracking procedures need not be submitted to CARB, unless requested

Economic Analysis: SF_6 GIE Phase Out

- Analysis based on incremental cost of purchasing and using non-SF_6 equipment that must be acquired due to SF_6 phase out
- Costs include capital purchase, operation and maintenance, reporting, and submission of an exemption request

- Key Assumptions include:
  - Equipment Inventory Baseline: 2017 reported data provides number, type, voltage, and age of equipment
  - Equipment Replacement: 40 years from GIE manufacture date
  - 3% annual growth rate

Economic Analysis: Non-SF_6 GIE Purchase Cost

- SF_6/non-SF_6 equipment cost difference varies by voltage class but not by technology type
  - Conservatively assumed to remain constant for all analysis years
- Stakeholder feedback yielded large cost range
  - CARB staff requests cost data for new phase out categories of equipment

kV Class	Feb Workshop	Stakeholder Comments
	Cost Diff	Cost Diff Range
kV ≤ 17.5	$3,000	$2,000-$25,000
17.5 < kV ≤ 38	$3,000	$6,000-$31,000
38 < kV ≤ 72.5	$6,000	$3,000-15,000
72.5 < kV ≤ 145	$10,000	$8,000-$19,000
145 < kV ≤ 245	$10,000	$20,000-$34,000
kV > 245	$50,000	$61,000

Economic Analysis: Non-SF_6 GIE Maintenance Cost

- Maintenance includes but not limited to gas purchase, inspection, and repair
- Cost difference varies by non-SF_6 technology type:
  - Alternative gas technologies are expected to require similar level of maintenance as SF_6, hence zero cost difference
  - Vacuum technologies require less maintenance and are expected to produce an estimated cost benefit of $600 - $1000 per piece of equipment per year
- Anticipated technology market share based on initial assessment of technology development and constraints

Category	Vacuum	Alt. Gases
Distribution	100%	0%
kV ≤ 145	80%	20%
145 < kV ≤ 245	50%	50%
kV > 245	20%	80%

Economic Analysis: Non-SF_6 GIE Reporting and Other Costs

- Reporting cost difference varies by non-SF_6 technology type:
  - Alternative gas technologies with GWP > 1: similar reporting requirements as SF_6, hence zero cost difference
  - Technologies with GWP ≤ 1: exempt from reporting requirements and are expected to produce a cost benefit

- Submitting an SF_6 Phase Out Exemption application

Next Steps and Additional Information

- August 29, 5:00 p.m. Pacific time: Written comments due via our webpage: https://ww2.arb.ca.gov/our-work/programs/elect-tandd/meetings-workshops
- Early 2020: Present regulatory amendments to the Board
- Late 2020: Regulatory amendments become effective
- For additional information on the SF_6 Regulation, visit our webpage or email energy@arb.ca.gov

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