Draft Amendments to the Regulation for Reducing Sulfur Hexafluoride (SF₆) 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-tannd/meetings-workshops):
- Presentation [webcast](https://video.calepa.ca.gov/)
- During this workshop, e-mail questions to: [auditorium@calepa.ca.gov](mailto: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-tannd/meetings-workshops):
SF₆ and Assembly Bill 32

- SF₆ 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 SF₆ emissions in California
- Assembly Bill 32 (2006) requires that the State reduce GHG emissions to the 1990 level by 2020
  - The Regulation for Reducing SF₆ Emissions from Gas Insulated Switchgear (SF₆ GIS Regulation) was adopted as an early action measure due to the high GWP of SF₆
Current \( \text{SF}_6 \) GIS Regulation

- Adopted by the Board in 2010 and went into effect in 2011
- Applies to owners of \( \text{SF}_6 \) GIS
- Sets an annual emission rate limit for \( \text{SF}_6 \) as a percentage of an owner’s cumulative \( \text{SF}_6 \) 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 SF₆ 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 SF₆ GIS Regulation to:
  - Further reduce GHG emissions
  - Include non-SF₆ GHG emissions
  - Streamline regulatory requirements

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov 2017</td>
<td>Public workshop and release of draft revisions</td>
</tr>
<tr>
<td>May 2018</td>
<td>Public working group meeting</td>
</tr>
<tr>
<td>Feb 2019</td>
<td>Public workshop and release of discussion draft</td>
</tr>
<tr>
<td>August 2019</td>
<td>Public workshop, release of 2nd discussion draft</td>
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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$_2$e)
- 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.

<table>
<thead>
<tr>
<th>Voltage (kV)</th>
<th>Short-circuit Current (kA)</th>
<th>CARB Phase out Date</th>
<th>Commenter Suggested Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 145</td>
<td>&lt; 63</td>
<td>1/1/2025</td>
<td>1/1/2025 – 1/1/2029</td>
</tr>
<tr>
<td></td>
<td>≥ 63</td>
<td>1/1/2025</td>
<td>1/1/2027 – 1/1/2029</td>
</tr>
<tr>
<td>≤ 245</td>
<td>All</td>
<td>1/1/2029</td>
<td>1/1/2029 – 1/1/2033</td>
</tr>
<tr>
<td>&gt; 245</td>
<td>All</td>
<td>1/1/2031</td>
<td>1/1/2031 – 1/1/2036</td>
</tr>
</tbody>
</table>
## Phase Out of SF$_6$ GIE: Distribution-level

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Voltage (kV)</th>
<th>Short-circuit Current (kA)</th>
<th>CARB Phase out Date</th>
<th>Commenter Suggested Dates</th>
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<tbody>
<tr>
<td><strong>Aboveground</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 38</td>
<td>&lt; 25</td>
<td></td>
<td>1/1/2025</td>
<td>≤ 17.5 kV: 1/1/2025</td>
</tr>
<tr>
<td></td>
<td>≥ 25</td>
<td></td>
<td>1/1/2025</td>
<td></td>
</tr>
<tr>
<td>≥ 38</td>
<td>&lt; 25</td>
<td></td>
<td>1/1/2025</td>
<td>Otherwise: 1/1/2031</td>
</tr>
<tr>
<td></td>
<td>≥ 25</td>
<td></td>
<td>1/1/2025</td>
<td></td>
</tr>
<tr>
<td><strong>Belowground</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 38</td>
<td>&lt; 25</td>
<td></td>
<td>1/1/2025</td>
<td>1/1/2031</td>
</tr>
<tr>
<td></td>
<td>≥ 25</td>
<td></td>
<td>1/1/2025</td>
<td></td>
</tr>
<tr>
<td>≥ 38</td>
<td>&lt; 25</td>
<td></td>
<td>1/1/2025</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥ 25</td>
<td></td>
<td>1/1/2025</td>
<td></td>
</tr>
</tbody>
</table>
SF₆ Phase Out Exemption

- Process for GIE owners to request permission from CARB to acquire SF₆ GIE, after the phase out, under specified conditions (e.g. non-SF₆ GIE unavailable, cannot meet size requirements)
  
  - Add exemption category for cost or non-SF₆ 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-SF₆ GIE
  - Staff requests feedback on Non-SF₆ Electrical Power Equipment Clearinghouse
  - Single request may cover multiple locations with same or similar justification
  - SF₆ GIE acquired with an SF₆ 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$_2$e)
- GIE owners with average CO$_2$e capacity < 5,500 MTCO$_2$e not subject to limit

\[
\text{Emissions limit} = \frac{AEF_i}{100} \times \text{Average CO}_2\text{e Capacity}
\]

- $AEF_i$ = annual emission factor for each year $(i)$
  - $AEF_i$ initially equal to 1.0 for GIE owners with average CO$_2$e capacity $\geq$ 5,500 MTCO$_2$e
- Average CO$_2$e capacity based on average system nameplate capacity for 2019

Commenters support emissions limit

- Raise threshold value (most requested 10,000 MTCO$_2$e)
- Retained threshold value of 5,500 MTCO$_2$e
  - 1% emissions rate limit is feasible above this capacity
New emissions limit for GIE owners with *average CO₂e capacity* < 5,500 MTCO₂e to ensure emissions stay limited over time

\[
Emissions \ limit = \frac{AEF_i}{100} \times Average \ CO₂e \ Capacity
\]

- \( AEF_i \) = annual emission factor for each year \((i)\)
  - \( AEF_i \) equal to 5.0 for GIE owners with *average CO₂e capacity* < 5,500 MTCO₂e in all years
- *Average CO₂e capacity* based on average system nameplate capacity for 2019
Annual Emissions Limit Baseline

- **Average CO\textsubscript{2}e 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\textsubscript{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\textsubscript{6} GIE that will be installed in the near future.

- **Include in Average CO\textsubscript{2}e capacity: Inactive GIE and SF\textsubscript{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\textsubscript{6} contained in inactive GIE is not reported.
Emissions Calculation

- Incorporate non-SF₆ insulating gases/other clarifications
- Emissions should be calculated from all of a GIE owner’s GIE (not just active GIE)
- Revised equation:

\[
\text{Emissions} = (\text{Decrease in insulating gas inventory}) + (\text{Acquisitions of insulating gas}) - (\text{Disbursements of insulating gas}) - (\text{Net increase in total nameplate capacity of active non-hermetically sealed GIE owned}).
\]

- 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 SF₆ 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 SF₆ 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 SF₆ GIE that will go through the process (e.g. all SF₆ GIE of a certain voltage, model number, SF₆ 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 SF₆ GIE to the original manufacturer for repairs, and the SF₆ GIE may be returned to the GIE owner
- Defective SF₆ GIE may be exchanged for new SF₆ GIE after the phase out if under the manufacturer’s warranty period
- The nameplate capacity for new SF₆ 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

<table>
<thead>
<tr>
<th>kV Class</th>
<th>Feb Workshop</th>
<th>Stakeholder Comments</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Cost Diff</td>
<td>Cost Diff Range</td>
</tr>
<tr>
<td>kV ≤ 17.5</td>
<td>$3,000</td>
<td>$2,000-$25,000</td>
</tr>
<tr>
<td>17.5 &lt; kV ≤ 38</td>
<td>$3,000</td>
<td>$6,000-$31,000</td>
</tr>
<tr>
<td>38 &lt; kV ≤ 72.5</td>
<td>$6,000</td>
<td>$3,000-$15,000</td>
</tr>
<tr>
<td>72.5 &lt; kV ≤ 145</td>
<td>$10,000</td>
<td>$8,000-$19,000</td>
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<tr>
<td>145 &lt; kV ≤ 245</td>
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<td>$20,000-$34,000</td>
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<tr>
<td>kV &gt; 245</td>
<td>$50,000</td>
<td>$61,000</td>
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</table>
Economic Analysis: Non-SF$_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.

<table>
<thead>
<tr>
<th>Category</th>
<th>Vacuum</th>
<th>Alt. Gases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>kV ≤ 145</td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>145 &lt; kV ≤ 245</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>kV &gt; 245</td>
<td>20%</td>
<td>80%</td>
</tr>
</tbody>
</table>
Economic Analysis:
Non-SF\textsubscript{6} GIE Reporting and Other Costs

- Reporting cost difference varies by non-SF\textsubscript{6} technology type:
  - Alternative gas technologies with GWP > 1: similar reporting requirements as SF\textsubscript{6}, hence zero cost difference
  - Technologies with GWP ≤ 1: exempt from reporting requirements and are expected to produce a cost benefit

- Submitting an SF\textsubscript{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](https://ww2.arb.ca.gov/our-work/programs/elect-tandd/meetings-workshops) or email [energy@arb.ca.gov](mailto:energy@arb.ca.gov)

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