Review Comments
February 25, 2019 Staff Presentation
sf6-gis-reg-slides022519_0.pdf

- Slide 2
  - Recommend posting draft documents at least 3 business days before public meeting.
- Slide 3
  - Should reference IPCC AR5 which has SF6 GWP = 23,500 (100 years) – or explain reference choice as there are multiple sources.
- Slide 4
  - Should reference GIE, not GIS. GIS refers to "Gas Insulated Substation" which could be misinterpreted to exclude free-standing circuit breakers, switchgear and other gas insulated equipment.
- Slide 7
  - We believe the technical infeasibility exemptions could be dramatically lowered if adding ratings granularity to Table 1 as proposed herein
  - We think it is unlikely that non-SF6 GIE manufacturers will be able to deliver these special ratings such as X/R >17, <3 cycle interrupting, >63kA short circuit interrupting in the time originally allotted
  - Under safety requirements, the user should be provided with guidelines for evaluating X-Ray radiation exposure. This is a known issue with high voltage vacuum circuit breaker interrupters.
- Slide 8
  - The exemption application process as written with add at least 2-3 months to the procurement process for commercially available equipment that is commonly available within 16-20 weeks.
- Slide 9
  - We recommend that CA-ARB should strongly consider adding additional ratings requirements to the phase-out table. It is our understanding that is unlikely that manufacturers can deliver the special ratings requirements frequently found in California within the prescribed phase-out schedule. This includes
    - Short circuit current >63kA
    - Continuous current > 3000A or 4000A
    - Interrupting time <3cycles
    - System X/R >17
  - The frequency of such requirements are likely underestimated and will place an undue burden on the GIE owner as well as CARB staff for exemption review.
- Slide 16
  - Phase-out scheduled should be revisited as suggested
  - Nameplate capacity accuracy at greater of 1lb or 1% is only possible with filling from vacuum at site. The manufacturer will need to transport with an inert gas such as Nitrogen and the owner will be responsible to weight the gas at filling on site.
- Slide 17
  - Cost difference need to be closely reconsidered and should be evaluated based on more granular ratings than simply kV. For example, NEMA could provide an independent confidential survey. This is particularly important for CARB and GIE owners to understand any technical (ratings) limitations that may exist for SF6-free solutions.
- Slide 18
  - We believe these cost differences are not realistic and do not reflect an accurate view of the marketplace today.
  - For example, it is public knowledge through open records bidding that the cost for a 72.5kV/3000A/40kA dead tank circuit breaker is at $15,000 to $20,000 more for a vacuum breaker (zero GWP) than for SF6

- Short circuit, continuous current, interrupting time and X/R should be strongly considered in this analysis.
- Also to be considered in cost analysis:
  - Extra land required for larger SF6-free equipment
  - Larger foundations required for larger SF6-free equipment
  - Reconfiguration and/or demolition of existing substations to accommodate larger SF6-free equipment
  - Cost to implement safety restrictions and procedures, for example for radiation exposure.
  - Cost of extra TRV capacitors required to achieve the circuit breaker rating
  - Cost of extra surge arrestors required to manage dielectric withstand limitations of some SF6-free solutions.
  - Cost to add vacuum interrupter monitoring to "zero-GWP' solution
- Slide 19
  - There is no such thing as maintenance-free technology.
  - The discussion of so-called lower maintenance cost for zero-GWP solutions is inaccurate
    - For most applications the expected service life is a function of the electrical endurance capabilities which should be similar for most technologies. In fact IEEE standards define an electrical life classification.
    - Largest maintenance cost will be maintaining gaskets, which is a 20-30 year maintenance procedure. This requirement will exist for ALL technologies including zero-GWP. Zero-GWP still has an insulating gas which must be contained to maintain the dielectric integrity of the device. Therefore, the costs should be similar.
    - The only maintenance cost benefit to zero-GWP is that special gas handling equipment is not needed. However, owner will still need to test insulating gas for moisture content.
    - Zero-GWP GIE use vacuum interrupters which have unproven lifecycle cost and reliability at high voltage >72kV.
      - There is risk of loss-of-vacuum which is very difficult and expensive to monitor.
      - Monitoring devices are unreliable
      - Failure mode for loss-of-vacuum can be catastrophic.
    - Replacement parts will be more expensive that SF6 or alternative gases because the materials are more expensive, costly to produce and physically larger than gas interrupters.
  - CARB should also consider market for
    - Different short circuit current: 40kA, 63kA, 80kA
    - Different continuous current: 2000A, 3000A, 4000A, 5000A
    - Faster interrupting times <3 cycles
    - Higher system X/R, >17
  - Tracking: Although reporting is not required for zero-GWP technologies, the owner will still need to track the equipment in an overall report to be able to demonstrate that it's zero-GWP within it's fleet of circuit breakers, GIS, etc.

Review Comments
DISCUSSION DRAFT of Potential Changes to the Regulation for Reducing Sulfur Hexafluoride Emissions from Gas Insulated Switchgear
sf6-gis-discussion-draft022219.pdf

- 95351 (a)
  - Non-hermetically sealed – Definitions for hermetically and non-hermitically sealed should be included.
  - GWP and GHG – recommend including a link: https://www.govinfo.gov/content/pkg/CFR-2018-title40-vol23/pdf/CFR-2018-title40-vol23-part98-subpartA-appA.pdf. Note that this reference indicated SF6 GWP = 22,800 but the more commonly referenced source is 23,500 from *"Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)"* IPCC Fifth Assessment Report, 2014 (AR5) www.ipcc.ch
  - Insulating gas. The gas in GIE may be used for both interrupting and electrical insulation. Propose the following definition: "…means the gas used in GIE for electrical insulation and to interrupt electrical currents."
  - Hermetically sealed GIE: The definition here implies that non-hermitically sealed GIE might not be "gas tight". The definition of "gas tight" should be included with defined emission rate parameters.
  - Add definition for "gas tight". "gas-tight means the GIE has a maximum emission rate not exceeding 0.5% of the gas mass per year for the intended service life of the GIE"
  - Non-hermetically sealed GIE: All GIE is designed to be "Gas Tight". The definition should be changed to "…means GIE that is designed to be gas-tight but not sealed for the life of the equipment."
  - SF6 GIE: "… means GIE configured to use SF6 as the insulating or current interrupting gas"
- 95351 (a)
  - ME: "Means metric tons (2204.62 pounds)"
- 95352 (a): phase out dates should be more granular and reflect different ratings required but the diverse transmission systems in California. Proposed structure:

Voltage (kV)	Continuous Current (Amps)	Interrupting Time (cycles)	Short Circuit Current (kA)	X/R	Phase-out Date
≤ 145	3000	3	≤ 40	17	January 1, 2025
≤ 145	3000	3	40 <kA ≤ 63	17	January 1, 2027
145 < kV ≤ 245	3000	3	≤ 40	17	January 1, 2029
145 < kV ≤ 245	3000	3	40 <kA ≤ 63	17	January 1, 2031
> 245	4000	2	≤ 40	17	January 1, 2033
> 245	4000	2	40 <kA ≤ 63	17	January 1, 2035

  - Generator circuit breakers (unit low side) should be excluded.
- 95352 (a) (1) (A): Add #3 as below

  3. This provision does not apply to any application requiring ratings performance exceeding those identified in Table 1. GIE owners may continue to purchase SF6 gas insulated equipment until such time as products with those ratings are commercially available from at least two independent manufacturers.
- 95352 (1) (2) – Recommend considering standardization for labeling. Color coded tag and location.
- 95352.1 (c) metric ton = 2204.62 pounds
- 95352.3 (a) add point (3)

  (3) The application requires GIE with ratings exceeding those identified in Table 1Phase-out Dates
- 95352.3 – The most accurate method for defining the nameplate capacity of the GIE is for the equipment to ship from the manufacturer with an inert gas such as Nitrogen for transportation. The GIE user would then measure the precise amount of SF6 used to fill the equipment at site and that measured value would be added to the nameplate.

The reason for this issue is that the tolerances of the equipment including the measuring devices (pressure, temperature, mass at both the user and manufacturer), the handling equipment and the GIE itself will introduce tolerance stacking that could easily exceed the desired level.

- 95353 – Reporting Requirements. Reporting for all GWP > 0 influences the market and restricts competition. Disincentive for accelerating R&D, disproportionately influences the market towards vacuum circuit breakers. OEMs should be encouraged to innovate solutions to drive the best solution, technically and commercially. Threshold should be set higher to allow for market forces to evolve. >500 GWP recommended.
- 95353 (f) (8) (A) – Gas mixtures are delivered as a pre-mixed solution. The mixture should be considered one gas for the purpose of reporting.
- 95353 (g) (3) (A) – Gas mixtures are delivered as a pre-mixed solution. The mixture should be considered one gas for the purpose of reporting.
- 95355.3 – The technical infeasibility exemption process is expected to result in an overwhelming number of exemption submittals. This issue is easily mitigated by adding additional granularity to the ratings in Table 1, the Phase-out Dates schedule. As a result, this will reduce the number of ratings-related exemptions and leave more manageable requests for incompatibility, safety, reliability and size requirements.

  GIE users should also have the opportunity to claim an exemption if there are not two or more commercially available products on the market. Many RFP processes require at least 2-3 competitive bidders to ensure the best cost for the owner.

  Not also that the exemption process will add at least 2-3 months to the procurement process for equipment that is often commercially available within 16-20 weeks.

  Another possible exemption could be use of common LCA (Life Cycle Assessment) analysis for environmental impact. The introduction of certain types of SF6-Free equipment could result in higher than expected environmental impact and CO2 footprint including but not limited to: increase in land usage for larger equipment, additional foundation materials for larger equipment, greater energy usage to produce extra materials in larger equipment, energy losses due to equipment operation, end-of-life energy costs to dispose of equipment and safety risks such as exposure to x-ray radiation from some SF6-free equipment.