June 13, 2018
LEG 2018-0323

Dave Mehl, SF_6 Program Manager
California Air Resources Board
1001 I Street
Sacramento, CA 95814

Re: Justification for Exemption of Hermetically-Sealed SF_6 GIE Switchgear (voltage 38kV and below) From Proposed SF_6 Phase-Out

Dear Mr. Mehl:

We support the tiered phase-out of Sulfur Hexafluoride (SF_6) in non-hermetically sealed gas-insulated equipment (GIE), coupled with a reasonable process for allowing continued SF_6 purchases and installations where safety, reliability, space, or cost issues make alternatives infeasible (technical exemptions). We have concerns about including hermetically-sealed GIE switchgear in the proposed phase-out requirement, particularly in underground distribution vaults and confined-space installations (e.g., inside wind turbine generators), and suggest that this type of GIE be explicitly excluded from the phase-out. Alternatively, SMUD suggests that this use of hermetically-sealed switchgear be provided a “deemed” technical exemption, with minimal, if any, application requirements. The amount of SF_6 involved is a low percentage of a typical utility’s capacity, and hermetically-sealed equipment has significantly lower leak potential.

SF_6 Hermetically-Sealed Switchgear in Underground Applications

Hermetically-sealed switchgear insulated with SF_6 (voltage level 38kV and below) is commonly employed in distribution applications in busy urban settings where concerns with respect to public safety are paramount. Typical applications involve GIE in underground vaults, where pedestrian and vehicle traffic on the sidewalks and roads above is dense, and inside wind turbine generators, where space constraints are especially tight. In these applications, inert SF_6 is the insulating medium of choice for switchgear because of its non-combustibility, safety, reliability and resistance to degradation, relatively compact size, and affordability. Alternatives to SF_6 switchgear in underground and confined-space applications either present safety and reliability concerns or are simply not available in the market today.

Safety

The non-combustibility of SF_6 is extremely important in these dense urban settings. Explosions and fires under or on heavily used public sidewalks and roads should be avoided at all costs, and SF_6 alternatives (e.g., solid dielectric) that involve combustible hydrocarbons or hydrocarbon byproducts upon failure raise concerns for public safety, as well as the safety of utility workers that must inspect and service this equipment.

Reliability, Inspections, and Testing
In addition to public safety, reliability is a major concern for utilities because environmental conditions within underground vaults are unique. Underground switchgear must be able to withstand flooding, stagnant water, hydro carbon infiltration (gas and oil), exposure to salts, decomposing organic material, and other contaminants. These conditions can lead to increased risk of catastrophic failure, which presents safety concerns. For this reason, switchgear in underground applications is subject to routine inspections. Frequent monitoring and/or testing for reliability to remove equipment from service prior to failures is vital, as is a high baseline reliability. SF_6 GIE has proven to be the safest and most reliable equipment available for installation in underground vaults.

Visual Inspections & Accessibility
The integrity of hermetically-sealed SF_6 switchgear is easily determined by visual inspection of a pressure gauge, along with visual examination of the exterior of the equipment. Other forms of electrical insulation (e.g., solid dielectric, oil) require significantly greater economic costs and human effort to determine integrity.

For instance, solid dielectric switchgear cannot be evaluated visually and must be tested to determine the integrity of the insulation system. To perform testing, solid dielectric switchgear must be removed from service and isolated. Specialized testing equipment must be utilized, requiring street and sidewalk closures and the associated permits to perform such work. Oil insulated switchgear is problematic because routine testing by sample analysis cannot be performed onsite. Samples must be sent to a laboratory, so testing is more time consuming, challenging, and costly to execute. Furthermore, oil testing provides only a snapshot analysis of the insulation integrity.

For SMUD, operation of equipment “to failure” is not an acceptable alternative, especially in underground applications. When selecting switchgear options, the testing requirements necessary to prevent failure is always a key consideration.

Risk of Leakage from Hermetically-Sealed GIE is Minimal
Hermetically-sealed SF_6 switchgear is a very minimal component of an average utility’s SF_6 emissions leakage exposure. For a typical utility like SMUD, the percent of hermetically-sealed equipment relative to the total nameplate is less than 1%. Moreover, the historical leakage rate of hermetically-sealed SF_6 switchgear has been extremely low. For example, since SMUD began mandatory reporting of its SF_6 emissions in 2011, SMUD has not added any SF_6 to its underground distribution switchgear.

There has been only one incident of an underground SF_6 switchgear emission leak in SMUD's history. In that instance, the loss was due to a defect that was immediately addressed by the manufacturer. More importantly, the failure resulted in a mere five pounds of SF_6 being emitted, a catastrophic failure was avoided, and public safety and reliability was not compromised. Because the issue was swiftly identified by SMUD crews during a routine visual inspection, it was promptly rectified. This would not have been the case with oil or solid dielectric technology, since switchgear integrity could not have been easily evaluated. There have been zero catastrophic failures at SMUD due to hermetically-sealed SF_6 switchgear.

Additionally, hermetically-sealed distribution switchgear contains a nominal amount of SF_6. For example, the typical 27kV switch contains approximately 16 pounds of SF_6, while a 38kV switcher in a wind generator may contain just seven pounds of SF_6, as shown in the table below. In contrast, a 69kV non-hermetically sealed circuit breaker may contain between 30 to 60 pounds of SF_6.

Equipment Type	Application	Catalog or Model #	Seal Type	Voltage Capacity (kilovolts)	SF_6 Nameplate Capacity (lbs)
Switch	Submersible Vault/ Underground Applications	422 (CAT 934223-M2R12T2V4-S364)	Hermetically Sealed	27.0	16
Switch	Wind Turbine Generator Switchgear	S&C Vista	Hermetically Sealed	38.0	7

Cost and Availability

At this time, there are no specific plans or schedules available from manufacturers for submersible, distribution, gas-insulated switchgear using alternative insulating gases. The economic feasibility and reliability of alternative gases in distribution switchgear applications is unknown. Also, as a publicly-owned entity, it is customary for utilities like SMUD to request a minimum of three bids to ensure competitive procurement practices.

Solid-dielectric-in-air designs for submersible switchgear do not have an established track record for all the applications performed by hermetically-sealed equipment, unlike hermetically-sealed SF_6 switchgear, which is a proven technology.[1] Air insulation is also subject to ozone creation under high voltage conditions. Other designs utilizing polymer insulation (e.g., solid dielectric) may produce combustible gas during insulation breakdown or overheating.

[1] "Both switch and interrupter applications are based upon patent-pending insulating and safety innovations." http://www.innovative-switchgear.com/ (Accessed May 17, 2018).

Disposal of SF_6 at End of Life

SMUD shares CARB's concerns about the disposal of SF_6 at the end of life of hermetically-sealed equipment. Ensuring that SF_6 is properly managed throughout its lifecycle will allay this issue. Siemens and other suppliers have developed best practices for recovering SF_6 gas in hermetically-sealed switchgear at end of life and either destroying it in a manner acceptable to the U.S. EPA or reconditioning it.[2] New SF_6 recycling centers are being constructed to recycle contaminated SF_6 through cryogenic processes that enable SF_6 to be continually reused.[3]

/s/

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cc: Corporate Files

[2] https://w3.usa.siemens.com/us/internet-dms/btlv/PowerDistributionComm/PowerDistribution/docs_MV/TechTopics/ANSI_MV_TechTopics63_EN.pdf (Accessed May 17, 2018).

[3] https://library.e.abb.com/public/9b26230323b445c6c12579f3004de971/22-25%201m218_EN_72dpi.pdf (Accessed May 17, 2018).