SF$_6$ & ALTERNATIVES
COALITION

Nameplate Adjustments

Recommended Processes to Support Accurate Reporting of SF_6 Emissions

While current data is somewhat limited, empirical information suggests that a large percentage of currently installed gas insulated equipment (GIE) contains a different amount of SF_6 compared to what is indicated on the nameplate. Out of 24 high voltage circuit breakers – ranging from 34.5 kV to 500 kV – tested over a period of 36 months, only (4) contained actual SF_6 weight that was within the 1% accuracy compared to the nameplate. This discrepancy is attributable either to filling error or an inaccurate stated nameplate capacity. The purpose of this document is to provide GIE users with a step-by-step process to determine actual SF_6 weight and to verify nameplate accuracy.

Section 1 – Reporting Requirement

GIE users are required to report SF_6 emissions by the U.S. Environmental Protection Agency's Greenhouse Gas Reporting Rule Subpart DD. Regulatory agencies in California and Massachusetts require reporting as well. The formula for calculating emissions to all three entities is as follows:

> User Emissions = (Decrease in Storage Inventory) + (Acquisitions) - (Disbursements) - (Net increase in Total Nameplate Capacity of Equipment Operated)

To ensure better accuracy when reporting greenhouse gas emissions, and to eliminate the reporting of "Phantom Emissions", users of GIE not only must have a way to accurately determine the actual charge of SF_6 in any given GIE within their inventory, but also must be able to identify whether the stated nameplate capacity is accurate. And in cases where the nameplate is not accurate, users should be able to correct the nameplate value for purposes of reporting (e.g. substitute the correct nameplate capacity for the stated). The Electric Transmission and Distribution SF_6 Coalition hopes that state and federal regulatory agencies will be open to allowing operators the option to use the figures derived from these processes for reporting purposes should they choose to do so.

In order to reduce the likelihood of error we strongly recommend that operators use the following tools:

- Temperature/Pressure curve or chart provided by GIE OEM
- Precision Temperature gauge (accuracy +/- 1.0 F)
- Precision pressure gauge (accuracy +/- 0.5% of complete scale) – requires at least 2 digits past decimal point – should read in absolute values
- Mass flow scale (Accuracy +/- 0.1 lbs.) – requires at least 2 digits past decimal point[1]
- SF6 Recovery System capable of achieving a blank-off pressure of 3.5 Torr or less

For each of the following processes, it is highly recommended that the GIE be de-energized. After the process is complete the user should follow the manufacturer's instructions to re-energize or de-commission the GIE, as appropriate.

[1] Using a mass flow scale is preferred for determining the weight of gas removed from a vessel since it eliminates the confusion concerning incorrect cylinder tare weights and the risk of not properly accounting for gas which may remain in the tubing and components of gas recovery equipment.

Section 2 – How to Identify Exact Weight of SF_6 in GIE

There are two (2) possible processes to determine the exact amount of SF_6 in any vessel:

1. *Pressure/Mass Calculation*

   This process entails removing a small amount of SF_6 that is then weighed, while monitoring the initial and final pressure.

   Procedure:

   1. Record the initial system pressure (a) using a precision pressure gauge
   2. Connect evacuated hose (no longer than 3' with ¼" diameter) to primary side of mass flow scale / use inline T-piece with precision gauge
   3. Connect secondary side to evacuated cylinder
   4. Open GIE valve (or connect to GIE quick connect) and remove a minimum of 2 lbs. as well as a minimum of 2 PSIG (c) (Note: Record all readings with a minimum of two (2) digits past decimal point).
   5. Record final system pressure (b) using precision pressure gauge
   6. Calculate total mass of SF_6 in the vessel per the following formula:

   Total mass of SF_6 in vessel = c x a/ (a-b)

   Where:
   a = Initial system pressure (psi absolute)
   b = Final system pressure (psi absolute)
   c = Amount of SF_6 removed

2. *Complete SF_6 Recovery*

   This process entails removal of all the SF_6 either during GIE maintenance or decommissioning and then precise weighing of the gas during the process. Based on feedback from some members of the utilities industry, this option seems to be preferred.

   Procedure:

   1. Record the initial system pressure using precision pressure gauge
   2. Connect evacuated hose to primary side of mass flow scale, and another hose from the secondary to the inlet of the SF_6 Recovery System
   3. Recover the SF_6 to a blank-off pressure of < 3.5 Torr
   4. Verify that GIE pressure is < 3.5 Torr after a 5 minute hold
   5. Record the final system pressure using precision pressure gauge
   6. Mass shown on mass flow scale is the total amount of SF_6 in the vessel

Note: Amount of SF_6 (mass) weight is to be measured at the GIE's fill valve and on the primary side of any recovery system. As cylinder tare weights are known to be inaccurate, using conventional gas/cylinder weighing scales is not recommended.

Section 3 – How to Verify Nameplate Accuracy of GIE

This process is similar to "Complete SF6 Recovery" discussed in the previous section, but adds a new step (B) and follows a formula as indicated below.

Procedure:

1. Record the initial system pressure (a) using precision pressure gauge
2. Convert the initial system pressure to temperature compensated initial system pressure (d) by accurately measuring the vessel temperature and using the OEM temperature/pressure curve or filling data to compensate the initial system pressure to rated fill temperature (usually 68° F (20° C))
3. Connect evacuated hose to primary side of mass flow scale, and another hose from the secondary to the inlet of the SF_6 Recovery System
4. Recover the SF_6 to a blank-off pressure of < 3.5 Torr (c)
5. Verify that GIE pressure is < 3.5 Torr after a 5 minute hold
6. Record final system pressure (b) using precision pressure gauge
7. Determine the corrected nameplate value using the following formula:

Corrected nameplate mass value = c x a/(a-b) x (e/d)

Where:
a = Initial system pressure (psi absolute)
b = Final system pressure (psi absolute)
c = Mass of SF_6 recovered
d = Temperature compensated initial system pressure (psi absolute)
e = Rated fill pressure at rated temperature (psi absolute) – taken from nameplate

Note: Amount of SF_6 (mass) weight is to be measured at the GIE's fill valve and on the primary side of any recovery system. As cylinder tare weights are known to be inaccurate, using conventional gas/cylinder weighing scales is not recommended

About the Coalition

The SF_6 Coalition & Alternatives Coalition is an industry organization for discussion of SF_6 and alternative insulation technologies as used in electric transmission and distribution equipment, as well as a forum for industry interaction with public officials surrounding emissions reporting and reduction regulations.

The ongoing dialogue on climate change gives the Coalition new opportunities to help producers and users to better prepare for the changes that are underway related to public policy as it impacts this market segment. The Coalition's mission is:

- To provide a forum for equipment manufacturers using SF_6, SF_6 producers and distributors, and transmission and distribution equipment owners for discussion of environmental concerns of SF_6 as a greenhouse gas
- To increase awareness of lower climate impact substitute gases for SF_6 and/or alternative technologies that minimize impact on public health and the environment;
- To develop best practices and recommendations related to sustainable SF_6 usage in electric power transmission and distribution
- To advocate the Coalition positions to federal, state, and local policymakers
- To maintain liaisons with government and industry groups such as U.S. EPA, IEEE, EEI, IEC, CIGRE, and EPRI