



**SF<sub>6</sub> HANDLING PROCEDURE**

**A. PURPOSE AND SCOPE**

This procedure establishes safe working practices for handling sulfur hexafluoride (SF<sub>6</sub>) gas and release minimization practices. This document also specifies methods for handling of SF<sub>6</sub> gas and removal, handling, and disposal of hazardous by-products.

**B. REFERENCES**

1. National Grid USA Safety rules and procedures
2. National Grid USA Environmental Policy
3. Confined Space Entry
4. EPRI Guidelines for Safe Handling of SF<sub>6</sub>
5. DOT CFR 49 Chapter 1 Subchapter C

**C. PREREQUISITES / CAUTIONS**

1. Sulfur Hexafluoride Gas

- a. Clean SF<sub>6</sub> gas is an inert, stable, colorless, odorless, nontoxic, nonflammable gas. It is approximately five times heavier than air and will displace air in confined areas. SF<sub>6</sub> gas contains no oxygen and will not support life. Confined areas must be force-ventilated when working with SF<sub>6</sub> gas.
- b. The Occupational Safety and Health Administration (OSHA) regulation on air contaminants, 29 CFR 1910.1000, establishes that SF<sub>6</sub> gas has no adverse effects when inhaled in the air at a Threshold Limit Value (TLV) of 1000 ppm.
- c. DOT regulations require equipment containing SF<sub>6</sub> gas at pressures greater than 25 psig at 68° F. to be certified to transport compressed gas.
- d. DOT regulations require cylinders of SF<sub>6</sub> gas with a gross weight greater than 220 lbs. to include a shipping paper. See Environmental Guidance 1110 document for additional information.
- e. The Environmental Protection Agency has identified Sulfur Hexafluoride as a greenhouse gas, with a global warming potential 23,900 times the effect of an equal mass of Carbon Dioxide, and an atmospheric lifetime of 3200 years. National Grid USA has entered into a Memorandum of Understanding (MOU) with the USEPA requiring monitoring and reporting of annual usage and leakage (emissions) amounts. This procedure is consistent with the National Grid USA Environmental Policy in that it will help protect the environment for future generations by making our contribution to minimizing climate change.
- f. The venting of SF<sub>6</sub> shall be minimized as much as possible. If discharge of small quantities is necessary for test purposes (i.e., contamination or moisture analysis, etc.), such discharge is to be kept to the minimum required to obtain a reading.

2. Decomposition Gasses and Solid By-Products



**SF<sub>6</sub> HANDLING PROCEDURE**

- a. When exposed to sustained or intense electrical arcs, SF<sub>6</sub> gas decomposes to form sulfur-fluoride gases and metal-fluorides, which are toxic. If moisture is present, the decomposition by-products may also include sulfur-oxyfluorides, hydrofluoric acid and sulfuric acid. The presence of these by-products can be readily detected by a white or gray powdery substance or a very pungent odor similar to rotten eggs.
- b. All in-service SF<sub>6</sub> equipment shall be assumed to contain decomposition by-products, unless the gas has been tested as safe. When handling gas containing SF<sub>6</sub> arc byproducts or solid by-products the following cautions are applicable:
  - i. Personnel are to wear the appropriate protective clothing / equipment.
  - ii. OSHA regulations on respiratory protective equipment, 29 CFR 1910.134, require that personnel wearing respiratory protective equipment be properly trained in the use of this equipment, medically qualified, and mask fit tested.

3. Definitions / Terminology --

- a. **Reclaimer** - A gas-handling unit equipped with a vacuum pump, storage tank(s), and filtration equipment necessary to recycle SF<sub>6</sub> gas.
  - i. The storage tank(s) on these carts is either a large central reservoir or one or more DOT-approved cylinders.
  - ii. Reservoir-equipped carts shall not be transported over public roadways if the gas pressure is above 25 psig, unless the cart is properly certified for transportation of compressed gas.
- b. **Transfer Cart** - A cart used to invert and / or heat gas cylinders when filling equipment to ensure the cylinder is thoroughly emptied.

**D. PROCEDURE**

**Section A -- Handling of Sulfur Hexafluoride Gas:**

- 1. The amount of SF<sub>6</sub> gas voluntarily discharged into the atmosphere shall be minimized.
- 2. The Person in Charge is responsible for recording the instances of equipment being filled with SF<sub>6</sub>.
- 3. These instances of filling shall be recorded and entered into the appropriate substation maintenance priority system program. The number of times a piece of equipment is filled with SF<sub>6</sub> due to a leak will be used to help prioritize repair of the leak or replacement of the equipment.

**Section B -- Filling or Topping with SF<sub>6</sub> from a Cylinder:**

- 1. For small volume SF<sub>6</sub> equipment and for topping off purposes, it may be more practical to fill the





### SF<sub>6</sub> HANDLING PROCEDURE

enclosure directly from certified SF<sub>6</sub> cylinders instead of using a gas handling apparatus. Refer to EOP 430.51.4 "Adding SF<sub>6</sub> to Station Equipment Procedure" for more details.

2. To facilitate the transfer of SF<sub>6</sub> gas store cylinders indoors and preheat cylinders with a blanket heater of appropriate design.
3. Prior to topping off, all filling pipe work, valves, etc. should be clean and dry. Cap off all hoses after use to maintain cleanliness and dryness.
4. Loosely connect hose to gas compartment valve.
5. Partially open the gas cylinder valve.
6. Allow SF<sub>6</sub> to flow through the hose and purge the air.
7. Seal all fittings as soon as the air is purged.
8. Open gas compartment valve and fill to the appropriate pressure.

**CAUTION:** Do not invert the gas cylinders to speed up the transfer of SF<sub>6</sub> gas, unless the filling apparatus is designed for this purpose. The gas cylinders may contain particulate metal oxides, which can result in failures if transferred into the gas enclosure. Also, by inverting the cylinders, liquid SF<sub>6</sub> could be forced into the enclosure which, upon evaporation, will result in over-pressure. The pumps of gas carts are designed for transfer of gas and some can be damaged if liquid is passed through them.

#### **Section C -- Removal of Sulfur Hexafluoride Gas from In-Service Equipment:**

- 1) Prior to removal of gas, check the gas compartment and associated devices for leaks using an approved halogen leak detector. Test the gas for arc byproducts if there is a possibility of an internal failure.
- 2) Identify any components that must be repaired while SF<sub>6</sub> gas is evacuated from equipment.
- 3) Obtain replacement parts as necessary to repair leaks.
- 4) Attach the hose from the SF<sub>6</sub> Processing Cart to the gas compartment valve.
- 5) Draw a vacuum on the hose to remove air and moisture. Check for leaks.
- 6) Open the gas compartment valve.
- 7) Remove SF<sub>6</sub> gas from the gas compartment via the processing cart filtration system as described in the processing cart operating / maintenance instruction booklet.



**SF<sub>6</sub> HANDLING PROCEDURE**

- 8) Draw a vacuum on the gas compartment to complete the SF<sub>6</sub> gas removal process. High level of vacuums should not be drawn if equipment leaks will result contaminating the processing cart with air.
- 9) Break vacuum with nitrogen or dry air as applicable.
- 10) SF<sub>6</sub> Gas that is to be reused on the same equipment may be kept in the processing cart until maintenance is complete.
  - a. If equipment is to be retired from use, SF<sub>6</sub> gas must be transferred to DOT - approved cylinders.
  - b. Reservoir - equipped gas carts must not be transported over public roadways if gas pressure exceeds 25 psig at 68° F unless the cart is properly DOT certified for transportation of compressed gas.
- 11) Clean interior of equipment in accordance with Section D prior to working on any internal parts.
- 12) When equipment is to be returned to service, seal all portholes and fittings.
- 13) Fill the equipment in accordance with Section E.

**Section D -- Removal of Hazardous Solid By-Products:**

1. After the SF<sub>6</sub> gas has been removed from the gas compartment and prior to opening the gas compartment's porthole(s), put on the following approved protective outerwear:
  - a. Clothing, protective, rainwear --  
(In hot weather, a lighter weight poly-coated tyvek suit may be worn)
  - b. Glove, safety, disposable, polyethylene, large, clear
  - c. A supplied air respirator or a half-face or full-face reusable respirator, with two HEPA cartridges for organic vapor / acid gas.
  - d. Goggles, chemical splash resistant, without vent, clear lens (if using half-face respirator) --
  - e. Disposable pullover boot.
2. Open the porthole(s) to gain access to the gas compartment.
3. Before entry, ventilate gas compartment with a 50 - cfm blower for at least one-half hour.
4. Test the compartment with an approved air monitor to verify a minimum of 20.9% oxygen and no presence of combustible gases including carbon monoxide.



**SF<sub>6</sub> HANDLING PROCEDURE**

5. Using an approved halogen leak detector, perform checks at various low points within the gas compartment to determine any presence of SF<sub>6</sub> gas.
6. Continue ventilation in low point areas until the detector indicates that SF<sub>6</sub> gas has been purged.
7. Continue ventilation while work is being performed.
8. Remove contaminated powdery deposits using an approved vacuum cleaner equipped with High-Efficiency Particle Arresting (HEPA) filters. **NOTE:** *These deposits must be removed promptly once the gas compartment is opened, since they readily absorb moisture, becoming corrosive and sticky, and making their removal more difficult.*
9. After using the vacuum, clean up any powdery residue using approved wipes.
10. Place powdery deposits contained in the vacuum cleaner disposal bag along with any wipes and other contaminated materials in a plastic waste bag.
11. Upon completion of repair and/or maintenance work, seal all portholes of the gas compartment.
12. Remove protective outerwear.
13. Place disposable coveralls, gloves, boots, and respirator cartridges, and any other contaminated materials in the plastic waste bag.
14. Secure bag with filament tape.
15. Place plastic waste bag in an appropriately sized container, such as a 55 - gallon drum or a 5 - gallon can. SF<sub>6</sub> by-products are corrosive and should not be placed directly in contact with a metal storage container.
16. Wash face and hands following completion of work and before eating or drinking.
17. In the states of Massachusetts and New York the waste shall be labeled as non-hazardous waste. In Rhode Island, New Hampshire and Vermont the waste shall be labeled as hazardous waste. The label shall be filled out with the date and contents. In all states the same personnel protective equipment shall be worn by employees since the waste is a corrosive solid and is regulated by OSHA in the same manner in each state.

**Section E Filling Equipment with Sulfur Hexafluoride Gas after servicing using a Gas Handling Apparatus:**

1. Obtain an SF<sub>6</sub> gas reclaimer.



**SF<sub>6</sub> HANDLING PROCEDURE**

2. Connect hose to gas compartment valve and tighten all fittings.
3. Evacuate hose using vacuum pump. Check for leaks.
4. Evacuate equipment to the level and for the time specified by the manufacturer.
5. Break vacuum using SF<sub>6</sub> gas.
6. Open gas compartment valve.
7. Fill and pressurize the equipment per manufacturer's instructions.
8. Close gas compartment valve.
9. Using the vacuum pump and gas compressor reclaim the SF<sub>6</sub> from the hose back into the gas cart.
10. Disconnect hose from gas compartment valve and cap hose fitting.