



Couple of takeaways

- Sulphur hexafluoride (SF₆) is used as an insulating material for a wide range of high voltage electrical and electronic equipment.
- When pure and unused, SF₆ is nontoxic and poses no direct risks to people or animals. However, escaped SF₆ can settle in low-lying areas and displace oxygen.
- If subjected to electrical stress or fire, SF₆ can decompose into toxic by-products that present a health risk. Used (reclaimed) SF₆ is to be considered toxic and corrosive when testing results show a purity of less than 98%.
- SF₆ is a significant environmental hazard and is regarded as one of the most potent greenhouse gases.
- Only people that have received formal training in the safe handling of SF₆ may complete SF₆ re-filling and topping-up of SF₆ containing equipment.
- All SF₆ containing equipment is registered and tracked through the SF₆ inventory register available on the WHS and EMS intranet.

? What is this procedure for?

This procedure outlines the processes and standards to be used across the Hydro Group to manage the risks associated with Sulphur Hexafluoride (SF₆).

Hydro Tasmania uses SF₆ in generation assets at the high voltage interface between the generation and transmission systems for insulation, arc quenching, and current interruption in gas-insulated switchgear and circuit breakers.

Note: It is important to distinguish between two terms which are used in relation to SF₆ :

Topping up – refers to filling of a pre-filled compartment with SF₆ up to the rated filling pressure. This would ordinarily relate to commissioning of new equipment where an item is supplied with SF₆ at a lower pressure.

Re-filling – refers to filling a compartment with SF₆ to the rated filling pressure to assure continuity of service. This would ordinarily relate to equipment where there has been a loss of pressure or gas.

? What is Sulphur Hexafluoride (SF₆)?

- Under ambient conditions, SF₆ is an unreactive, stable, and dense gas, and is not flammable.
- It is a non-toxic gas, but by displacing oxygen in the lungs, it also carries the risk of asphyxiation if too much is inhaled. As it is denser than air, when a substantial quantity of gas is released, it will settle in low-lying areas and present a significant risk of asphyxiation if the area is accessed.
- If subjected to electrical stress (a normal condition during its working cycle) or fire, SF₆ can decompose into toxic by-products that can present a potentially fatal health threat in the event of exposure. The most serious of these decomposition products is Hydrogen Fluoride (HF). Potential HF exposures should be managed as an emergency.
- Used or reclaimed SF₆ gas, with a purity of less than 98%, is to be treated as toxic and corrosive due to the potential of the gas decompose into these by-products under normal working conditions.

- The gaseous by-products of SF₆ pose a risk to eyes, nose, throat and lungs. Solid by-products, indicated by white, grey or tan powder/residue are irritating to exposed skin.
- SF₆ is a very potent greenhouse gas with an atmospheric warming potential 23,900 times that of carbon dioxide with an atmospheric lifetime of 3,200 years.

How do we manage SF₆?

Due to the greenhouse intensity of SF₆, and its potential risk to health and safety, leaks and spills must be minimised. There are three main sources of SF₆ emissions from the electricity supply industry:

- Escaped gas and deliberate venting during handling, decanting, recycling etc.
- Gradual leakage of SF₆ from storage cylinders, transformers and switchgear through loose nuts, split seams, perished seals, rusted covers etc., and
- Equipment failure.

To ensure the risks associated with these sources of emission are minimized and managed appropriately, controls must be in place for the following activities:

- Transport
- Storage
- Transfer
- Use
- Waste

Any activities involving SF₆ transfer and use needs to be tracked through SAP. Transport, storage and waste of SF₆ needs to be coordinated with Supply and Inventory.

How do we transport SF₆?

Transporting gas cylinders containing SF₆

- New SF₆ gas may be transported as a non-flammable, non-toxic gas.
- Used SF₆ is to be transported as a toxic gas on a flat-bed tray with sides, a tailgate and a cab separately ventilated from the load carrying area.
- Use appropriate manual handling aids such as a cylinder trolley to reduce the risk of injury when moving SF₆ cylinders
- Cylinders must be securely restrained with the valve outlet cap and protective cap securely fitted.
- Cylinders are to be correctly labelled.
- Cylinders should ideally be transported in the upright position. However, may be transported laying down provided they are secured effectively, valves are facing rearwards and the base is up against the headboard or another strong part of the load and protected from damage.
- SF₆ Transport and Tracking form is provided to track SF₆ gas usage and as a checklist for safe transport of SF₆ cylinders.
- Where loads exceed 500 L, placards are required on the transport vehicle.

Transporting new equipment containing SF₆

Follow manufacturer's guidelines for transport and installation of new equipment containing SF₆.

Transport of used equipment containing SF₆ to be maintained for future use

The pressure of SF₆ in the equipment should be reduced to 1.5 bar or 10% of operating pressure for transport and storage.

How do I work safely around SF₆?

A risk assessment, such as a Take 5, should be completed for tasks involving work with and around SF₆ gas. The following general requirements should be followed when working with cylinders:

- Protect cylinders from damage.
- Use a suitable hand trolley to move cylinders; do not drag, roll, slide, or drop.
- Never attempt to lift a cylinder by its cap; the cap is intended solely to protect the valve.

Storage of SF₆ Cylinders

While the SF₆ Safety Data Sheet has specific storage requirements, the following can be considered general precautions to be followed during storage:

- Firmly secure cylinders upright to keep them from falling or being knocked over in an area of adequate ventilation.
- Screw valve protection cap firmly in place by hand.

- Store only where temperature will not exceed 65°C.
- Use a first-in, first-out inventory system to prevent storing full cylinders for long periods.
- Ensure cylinders and equipment are appropriately labelled.
- Ensure empty cylinders are clearly identified.
- Store cylinders clear of wet ground.
- Reclaimed SF₆ gas is to be treated as a toxic and corrosive gas when testing results show a purity of less than 98% and stored separately from other gases, including new SF₆.

Storage of equipment containing SF₆

Before storing equipment containing SF₆, remove SF₆ to 1.5 bar or 10% of operating pressure and decontaminate the equipment. During the storage of equipment, the following requirements must be met:

- Decision to store with SF₆ must be supported by a risk assessment.
- Pressure in equipment should be reduced.
- Operators of storage facilities must be made aware.
- The equipment must be documented and monitored through the SF₆ Inventory Register.
- The equipment must be appropriately labelled.

SF₆ Monitoring and Registers

Due to environmental reporting requirements, it is important to monitor and track SF₆ containing equipment and the transport and usage of gas through the two following registers:

SF₆ Inventory Register

Routine monitoring and tracking of all SF₆ and associated equipment is maintained through the SF₆ inventory register to ensure environmental, safety and operational obligations are adhered to.

The SF₆ inventory register, maintained by **Assets and Infrastructure**, is to be used to track the following:

- Register of SF₆ containing equipment (in service and out of service)
- Monitoring and sampling results.

SF₆ Re-fill Register

The SF₆ re-fill register outlines where an SF₆ gas bottle came from, the weight of the bottle before being taken and the weight of the bottle upon return for the purposes of supply and inventory tracking. The register is saved and accessed through SAP and is maintained by **Supply and Inventory**. The SF₆ Transport and Tracking form can be used to record gas cylinders weights and submit to stores for data entry into the register.

For further information on environmental reporting requirements, see National Greenhouse and Energy Report (NGER) procedure.

Handling and Transfer of SF₆

Handling and transfer of SF₆ gas to and from equipment is to be conducted in accordance with the standard AS IEC 62271.4 High-voltage Switchgear and Control gear Part 4: Handling Procedures for Sulphur Hexafluoride (SF₆) and Its Mixtures, with attention to the following:

Pre-requisites:

- Received formal training in the safe handling of SF₆ (see Appendix A: SF₆ Training).
- Equipment to be worked on must be isolated.
- Read and understand Safety Data Sheet (SDS) for SF₆.
- Coordinate SF₆ transfer with **Supply and Inventory**.

Before transfer:

- Ensure exit way is marked and clear of obstructions.
- Ensure all of work crew are aware of gas pressure to be achieved.
- Ensure all equipment is in good condition.

During transfer:

- Closely observe gas fittings and driving pressure.
- SF₆ must not be intentionally vented to atmosphere. Venting to atmosphere during transfer will be recorded as an incident.
- If indoors, ensure room is well ventilated.

After transfer:

- Tools and equipment which have been in contact with by-products must be washed and neutralised with a water/soda solution as detailed in AS IEC 62271.4.
- Properly dispose of any contaminated material with a licenced waste contractor.
- Ensure **Supply and Inventory** update the SF₆ refill register when returning cylinders to storage.

Receiving SF₆ gas and equipment

All SF₆ received from suppliers (including SF₆ containing equipment) shall be inspected upon receipt by the accountable person.

SF₆ gas cylinders are to be weighed upon arrival and checked against the supplied invoice to ensure no loss of SF₆ has occurred.

Note: Certificates of compliance are kept at Gowrie Park store. Check the scales for calibration before weighing the gas bottles by checking with designated calibration weights. If a problem is encountered, the supplier shall be contacted, and remedial action requested.



How do we manage and dispose of used SF₆ and SF₆ containing equipment?

The Hydro Tasmania group engineering standard *GP-AM-603 – Management of Sulphur Hexafluoride in Use* shall be referred to for gas sampling and testing standards.

Used gas needs to meet the following requirements to be suitable for reuse:

- Gas samples have met the acceptance criterion as detailed in *GP-AM-603 Section 2-2 SF₆ Gas Testing Acceptance Criteria, Table 4*, and
- Has been used for insulation only (instrument transformers and Gas Insulated Switchgear), and
- Not experienced an electrical fault.

For SF₆ from circuit breakers, testing for key gases SO₂ and SOF₂ is required prior to decommissioning. The acceptance criterion is detailed in

GP-AM-603 Section 2-4 Handling of Contaminated SF₆ and its Arc Products.

Waste SF₆ and SF₆ containing equipment must be sent to a certified agency for disposal/recycling and a disposal certificate must be obtained and kept on record.

Redundant equipment must be decommissioned with SF₆ removed for re-cycling or disposal and the equipment decontaminated by a licensed contractor and made safe prior to disposal. For further assistance, contact environment@hydro.com.au

Should the equipment be sold or given to a fellow authority such as TasNetworks, then a record of this transaction is required from that company. This record needs to include:

- The identity of the authority taking over the equipment
- The quantity of SF₆ gas that was in the redundant circuit breaker
- The date on which this transaction occurred.

In all instances, the SF₆ inventory register must be updated to reflect the status of the equipment.



What training is required?

Workers who work with or in the vicinity of SF₆ containing equipment will be made aware of the safety aspects, environmental aspects, regulatory requirements and properties of the gas.

Persons performing work involving SF₆ handling must be trained by a training provider in accordance with AS IEC 62271.4 High-voltage

Switchgear and Control gear Part 4: Handling Procedures for Sulphur Hexafluoride (SF₆) and Its Mixtures: Annex C (See Appendix A: SF₆ Training).



What personal protective equipment is required?

No additional PPE is required for normal re-filling, topping up, recovery and evacuation activities.

However, when opening or accessing gas compartments, in case of abnormal release or where other work is performed that may create exposure to SF₆ by-products, additional PPE may be required, with particular attention given to protecting the eyes and respiratory tract. This may include acid proof gloves, protective mask or respirator, disposable overalls, and protective goggles or full-face mask. Refer to AS IEC 62271.4 for additional PPE requirements.

Workers must observe high levels of personal hygiene and protective clothing must be washed as soon as possible. PPE, tools and components which have been in contact with by-products must be packed in sealed bags and treated with a water/soda solution as per AS IEC 62271.4 to neutralise residues.



How do we manage emergencies or incidents?

In the event of a significant failure within SF₆ containing equipment, both hazardous gases and solid by products may be present.

Only personnel trained and competent in the handling of SF₆ and its by-products may handle equipment and products involved in an SF₆ emergency or incident.

If a worker has been exposed to a decomposition product of SF₆, seek medical attention immediately.

Once the site has been made safe and well-ventilated, workers should avoid contact with any residual solids. If skin contact occurs, wash the area with large amounts of water or use a neutralizing agent such as bicarbonate soda or calcium gluconate.

Refer to Incident Management procedure, Emergency Preparedness Standard and procedure and the Site Incident Response Plans for specific guidance on spill management and reporting and investigation requirements.

Each operational area should have an SF₆ by-product response kit readily available, containing personal protective equipment (PPE), sodium carbonate, a pH test kit and clean up equipment to ensure a prompt and effective response to any contamination incident.

All spills or releases to atmosphere including quantities of SF₆ must be recorded as an incident in SAP.

Appendix A: SF₆ Training

Hydro Tasmania Training level	Alignment to AS IEC 62271.4	Activity	Training format / provider
Awareness	Module A - Awareness	People working in the vicinity of SF ₆ containing equipment and / or operating equipment or working on plant containing SF ₆ - No handling of SF ₆ gas except for cylinder transport and storage.	Internal awareness via Instructed Person training
Level 1 – Refilling and testing	Module B1 – maintenance not implying gas recovery	Check the SF ₆ quality on site Perform SF ₆ re-filling Density monitor testing Select and use appropriate safety equipment and PPE	Must be delivered by a training provider
Level 2 – Advanced SF ₆ handling	Module B2 – installation and commissioning Module C1 – maintenance or repair implying gas recovery Module C2 – Decommissioning at end of life	Install and commission SF ₆ containing equipment on site. SF ₆ Top-up Perform maintenance or repair of electric power equipment utilising, including gas recovery, reclaim and appropriate handling of by-products Decommissioning SF ₆ containing plant at end of life Select and use appropriate safety equipment and PPE Neutralizing and handling of by-products	Must be delivered by a training provider