

The SF₆ ReUse Program

A Case Study

Daniel Lauzon	Solvay Fluorides, Inc.
Todd Morris	AGA Gas, Inc.
David McCreary	American Electric Power
Michael Pittroff	Solvay Fluor und Derivate GmbH

November 21-22, 2002

San Diego, CA

Contents

- 1. Introduction**
- 2. Used SF₆ – A New Product**
- 3. Recruitment**
- 4. The Case Study**
 - 1. Background**
 - 2. Analysis**
 - 3. Transportation**
- 5. Inventory Management**
- 6. Production Plant - Germany**
- 7. Discussion/Conclusion**

Introduction

- /// SF₆ ReUse Program first offered in Europe
 - /// Analytical services, packaging, transport and reclaiming of used SF₆
 - /// Most cases, used SF₆ can be purified on site with gas purification carts
 - /// When corrupt, gas is returned to Solvay Fluor and introduced into production stream
 - /// Fulfills all requirements of virgin SF₆
- /// > 100 tons returned to Solvay Fluor for reclaiming



Introduction

- /// SF₆ ReUse Program introduced in November 2000
 - ▶ Logistical hurdles to overcome
- /// Now fully operational and demonstrated through this Case Study
- /// First quantities reclaimed from American Electric Power – our Case Study
- /// Assistance from AGA Gas, Inc.

Used SF₆ – A New Product

Reclaiming Specifications

H ₂ O	0.1%
Oil	0.1%
SOF ₂	2.0%
HF	3.0%
CF ₄	5.0%
Air	30%

Used SF₆ – A New Product

MSDS Product Name:

USED SULFUR HEXAFLUORIDE
From Electrical Installations

Classification:

Liquefied Gas, Toxic, Corrosive
N.O.S. (Sulfur Hexafluoride, Hydrogen Fluoride)
Class: 2.3 + 8, UN3308, Hazard Zone D

Used SF₆ – A New Product

Used Sulfur Hexafluoride from electrical installations Danger!

MAY CONTAIN DECOMPOSITION GASES INCLUDING HYDROFLUORIC ACID, CAUSES BURNS TO SKIN, EYES, AND RESPIRATORY TRACT, TOXIC IF INHALED OR ABSORBED THROUGH THE INTACT SKIN, RISK OF CARDIAC, NERVOUS DISORDERS.

DELAYED EFFECTS APPEAR HOURS AFTER EXPOSURE TO SKIN, EYES, AND RESPIRATORY TRACT, MAY CAUSE SEVERE FROSTBITE. CONTENTS UNDER PRESSURE.

Do not get in eyes, on skin, or on clothing. Read the material safety data sheet before handling.

First Aid:

IN ALL CASES OF CONTACT, contact a physician as soon as possible. All cases of eye and skin contact are considered severe.

Eye Contact:

- Immediately flush with water for at least five minutes.
- Apply calcium gluconate solution or equivalent as soon as possible.

Skin Contact:

- Remove contaminated clothing as soon as possible. Remove goggles last.
- Wash skin and immediately apply calcium gluconate or equivalent

Inhalation:

- Remove to fresh air. If not breathing, give artificial respiration or oxygen.
- Apply calcium gluconate solution by nebulizer if available



UN3308

Storage and Handling:

- Use adequate ventilation.
- Avoid moisture
- Do not drink, eat, and smoke when handling
- Wash contaminated clothing.
- Prevent discharge to the environment.

Reference: See MSDS.

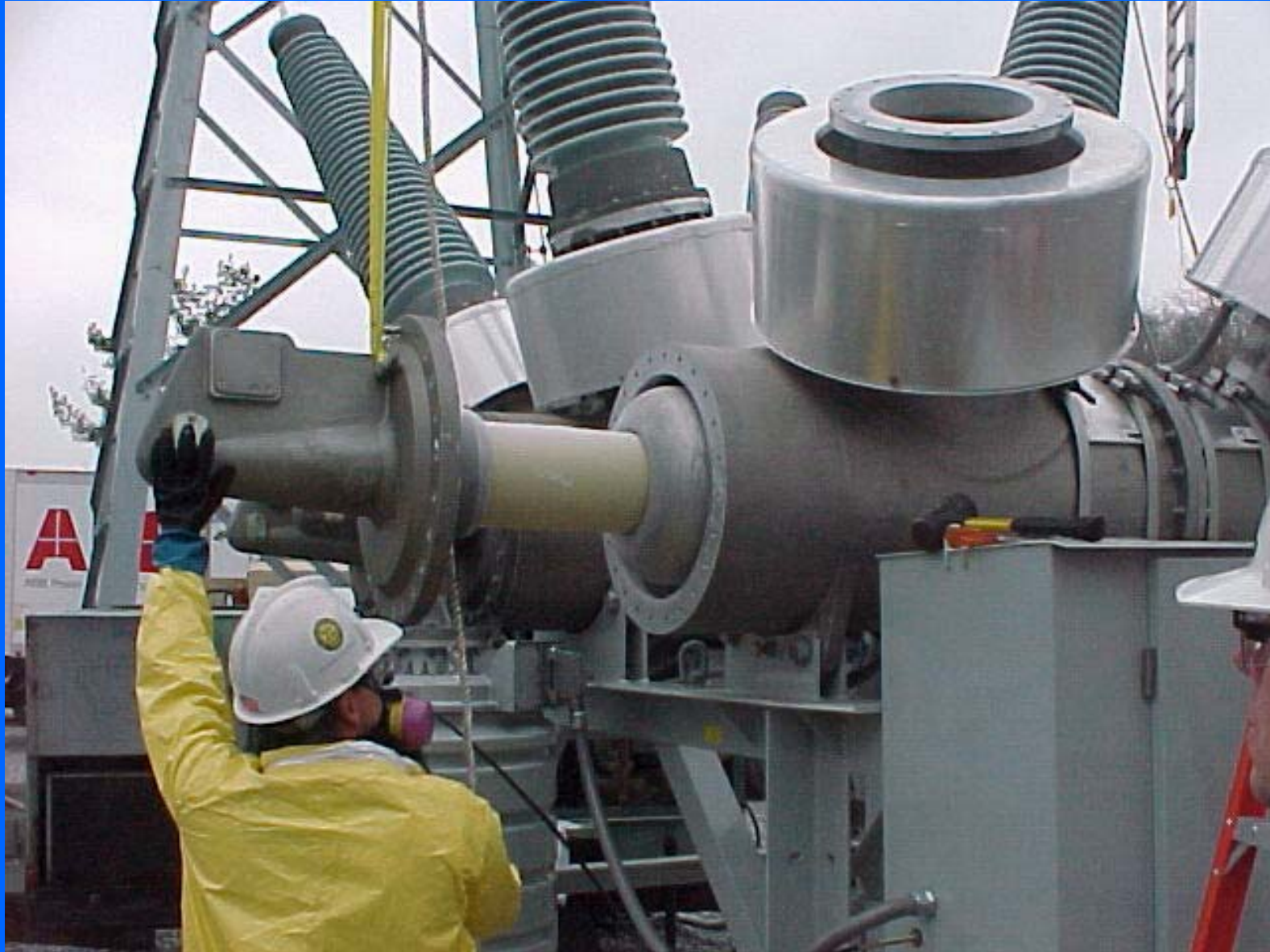
Case Study - Background

- /// 138 kV circuit breaker failed when initially energized
- /// Arc over open contacts – 44,000 amps measured
 - /// Believed to be sustained for 20 minutes
 - /// Rupture disk burst – immediately covered
- /// SF₆ pulled from breaker into gas cart
 - /// SO₂ concentration remained too high
 - /// Gas deemed corrupt
- /// Gas filled into empty N₂ cylinders
 - /// No other cylinders on site
- /// AGA Gas contacted for assistance

Case Study – 138 kV Breaker



Case Study – Removing Interrupter



Case Study – Failure at Interrupter



Analysis

- /// Must fall within Solvay's specifications for reclaiming
- /// Challenges:
 - /// Used SF₆ contained in N₂ cylinder
 - /// Cylinder cannot be transported until contents analyzed
 - /// Gas pressure in N₂ cylinder < 100 psi
 - /// Liquid phase??
- /// Sample kit dispatched

Analysis

- /// Weigh scale did not record a weight gain on sample cylinder
 - /// Accurate only to plus/minus 1 lb
- /// Counted on ΔP sufficient to obtain reasonable quantity
- /// Lecture bottle sent to Solvay Fluor, Germany
 - /// Software glitch with analysis equipment in Catoosa OK.
 - /// Sent by cargo vessel under IMDG regulations

Analysis – Sampling at AEP



Analysis – Hannover, Germany



Analysis Results

Hydrogen	< 1 ppmw
Air	233 ppmw
carbon tetrafluoride	1031 ppmw
carbon dioxide	152 ppmw
trifluoromethane	<1 ppmw
thionyl fluoride	4881 ppmw
sulfuryl fluoride	< 1 ppmw
nitrogen trifluoride	< 1 ppmw
sulfur dioxide	6545 ppmw

Within Solvay's allowable limits

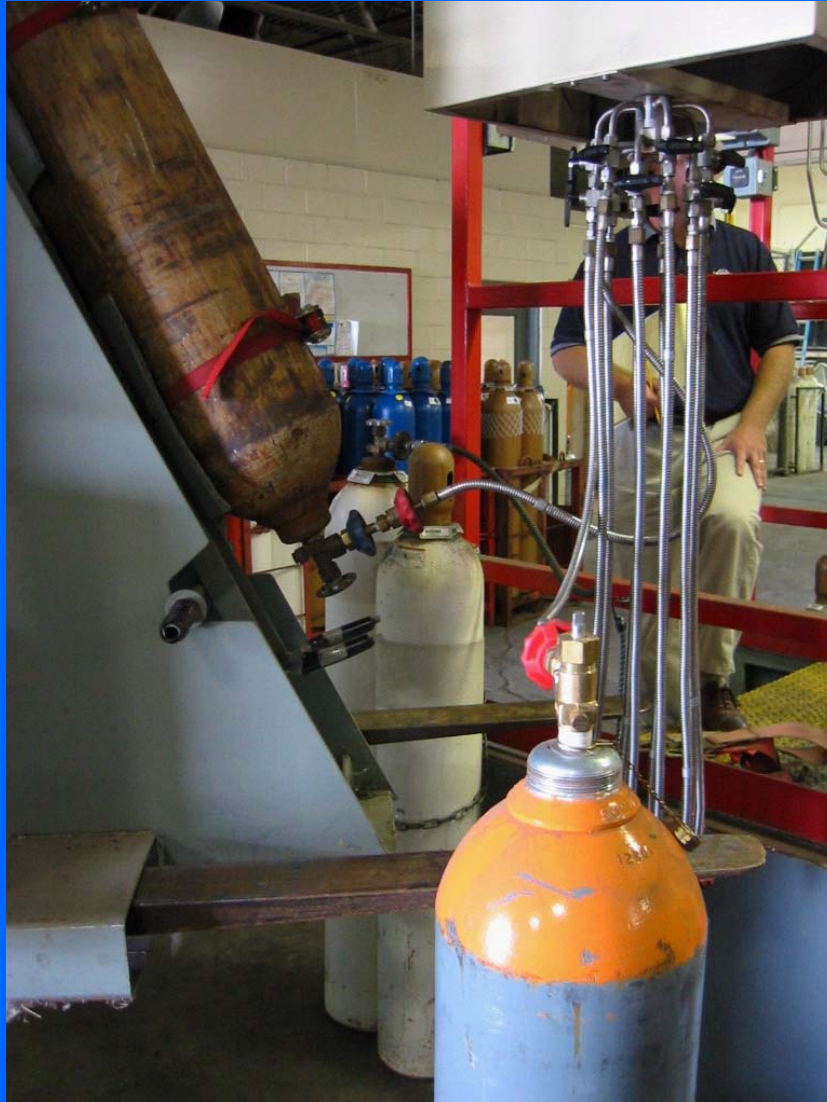
Trans-filling in ReUse Cylinders

- /// SF₆-filled N₂ cylinder transported to AGA Gas, Inc.
- /// Trans-filling in ReUse cylinders conducted by
 - /// trained personnel
 - /// in controlled environment
 - /// appropriate safety measures

Trans-filling in ReUse Cylinders



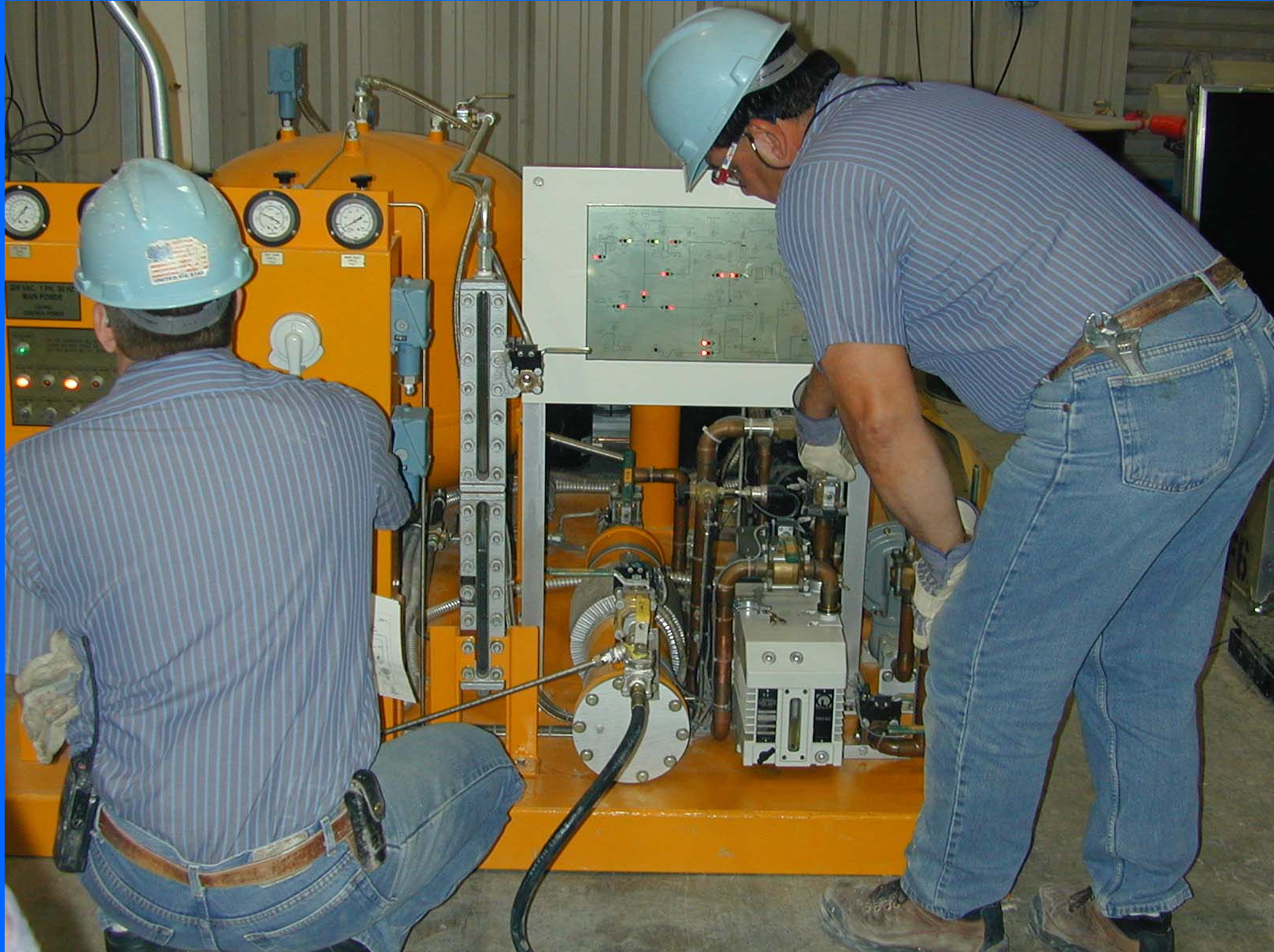
Trans-filling in ReUse Cylinders



Transportation to Germany

- ≡ For the Case Study, only 115 lb cylinder shipped overseas
- ≡ Normally, accumulate sufficient quantity to fill ton cylinder, then ship overseas

Gas Handling – Catoosa OK



Gas Handling – Catoosa OK



Gas Handling – Bad Wimpfen, Germany

- /// At the time the ship was set to sail, SF₆ ReUse cylinder, as classified, was deemed incompatible with other goods on ship
- /// ReUse cylinder was rolled to another cargo vessel, set to sail at later date
- /// Unforeseen delay, no photos available from actual ReUse cylinder in Germany
- /// Archived photos show typical Used SF₆ gas handling procedures

Gas Handling – Bad Wimpfen, Germany



Gas Handling – Bad Wimpfen, Germany



Gas Handling – Bad Wimpfen, Germany



Inventory Management

- Inventory control a must for ReUse Program
 - Control and track every pound of used SF₆
 - Retain ownership until confirmation that gas was introduced in production stream, and
 - Empty cylinders returned to point of origin and final weight recorded

Summary

- /// Viable program for reclaiming used SF₆ gas
- /// Logistics of the program tailored for US
 - /// Working with partners like AGA Gas
 - /// Currently working on other cases with AEP for reclaiming used gas

Conclusion

Every pound of SF₆ taken back for reclaiming and therefore not released in the atmosphere is equivalent to an emissions savings of 22,500 pounds of CO₂

Questions?

