



The SF₆-ReUse-Process

A contribution on the sustainability of SF₆

PROCESS FOR REUSING USED SF₆ GAS

- A Contribution towards SF₆ Sustainability -

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1 INTRODUCTION

Thanks to its outstanding insulation and arc-extinguishing properties, SF₆ is mainly used in the field of electrical engineering. For more than 40 years the gas has been used for high and medium voltage applications, such as gas-insulated switchgears (GIS), high-voltage cable-in-conduit conductors and transformers.

Due to the ecological and economical aspects, any SF_6 which escapes during maintenance work or when electrical systems are decommissioned should be contained and returned to the economic cycle. This limits emissions of SF_6 into the atmosphere to the extremely low leakage rate of the systems.[1]

Solvay, as a globally leading producer of SF_6 , developed the SF_6 – ReUse – Process at the beginning of the 1990s in order to provide SF_6 users with virtually unlimited reuse possibilities for SF_6 and, consequently, to eliminate emissions as much as possible.

The known name "ReUse" represents within this concept an efficient process which is integrated in the production of SF₆. During this process the used SF₆ - as long as it meets certain quality requirements – is converted into new virgin SF₆ meeting all established specifications for new SF₆ incl. the non-toxic requirement according to IEC 60376. In case the used gas does not meet the established quality requirements and, thus, cannot be transformed again into virgin new gas the used gas is treated as waste and environmentally friendly destroyed at accredited waste incineration plants.

The SF_6 – ReUse – Process has been successfully implemented by SF_6 system manufacturers and operators and also by accredited electrical and disposal companies for more than 15 years.

The SF_6 – ReUse – Brochure describes the SF_6 – ReUse – Process and various applications connected with reuse.

The brochure also contains descriptions of SF₆ measuring and service equipment, SF₆ treatment units and packaging and also lists the costs for returning used SF₆.

A prerequisite for the successful implementation of the SF_6 – Reuse – Process is the observation and the compliance with all information and guidelines contained in this brochure.

The effective implementation of a closed-cycle SF₆ – ReUse – Process requires companyinternal regulations and stipulations.

Solvay operates SF₆ production plants at Bad Wimpfen, Germany and at Onsan, South Korea. At both SF₆ plants Solvay is able to accept used SF₆ gas and to convert the used SF₆ into new virgin SF₆ according to the SF₆ – ReUse – Process described in this brochure.

The information and guidelines in this brochure apply in particular for return of used SF₆ gas to Solvay's plant at Bad Wimpfen, Germany, only.

For the return of used SF₆ to Solvay's plant in South-Korea please contact us for a separate information brochure as regulations and terms differ according to the plant locations.

In case of any further questions, our SF₆ experts will be glad to assist you and help you to develop an optimum solution for reusing your used SF₆.

2 The SF₆ – ReUse – Process

The SF₆ – ReUse – Process from Solvay is illustrated in the following diagram in Figure 1, where a distinction is made among Inspection, ReUse and Disposal Cases.



Figure 1 : Diagram for implementing the SF₆ – ReUse – Process

Before SF₆ is removed from electrical equipment, the gas state must be analyzed with the portable measuring instruments described in Table 3.

Generally, when used SF₆ is returned to Solvay for ReUse and Disposal Cases, its gas analysis is conducted at the Solvay plant laboratory.

The following case distinctions are made on the basis of the results from the gas analysis.

2.1 Inspection Case

All contaminants such as dust, moisture, air, oil and SO_2 / SO_2F_2 compounds result from the operating process and are a normal ageing process of the gas. Operating-related contaminants may be eliminated by the operator on-site during maintenance work using service equipment fitted with the corresponding gas treatment systems, as described in Section 3.2. The treated gas is then analyzed with portable measuring instruments as described in Section 3.1.

If the treated SF₆ fulfills the requirements of the plant operator and IEC 60480 [2] for used SF₆ during this maintenance work, the SF₆ may be filled directly via an SF₆ service systems.

In case the used gas does not meet at least the requirements of the plant operator and the IEC 60480 standard, the SF₆ ReUse Case must be applied.

2.2 ReUse Case

If the analysis of the used SF₆ shows that the gas is contaminated above prescribed tolerance limits (e.g. IEC 60480 standard), the contaminated SF6 should be liquefied by using SF₆ service devices at 50 bar and filled into SF₆ – ReUse – Packaging. These contaminants may result from exceptional incidents or could be caused if the gas is not handled properly.

The filled SF_6 – ReUse – Packaging are sent back to Solvay's plant in Germany where the used SF6 is regenerated into new virgin gas. SF6 which has been regenerated by Solvay fulfills even a higher specification than that required by IEC 60376, as illustrated in Table 1.

In order to be able to transform the used SF_6 gas back into new virgin SF_6 the used gas must fulfill the so-called SF_6 – ReUse – Specification in Table 2.

In addition the material must be of one sort only and shall not be radioactive. Also, information regarding the area of application in which the used SF₆ has been utilized must also be provided.

In case of other contaminants (e.g. SOF_2 , SO_2F_2 etc), please contact Solvay to check if the material can be converted back into new SF_6 .

The **Disposal Case** exists when the used SF_6 does not fulfill the SF_6 – ReUse – Specification.

Table 1: Solvay product specification, IEC 60376 specification and ASTM specification for new SF6 analysis of liquid phase[3]

	Solvay specification	IEC 60376 specification	ASTM D2472-00 specification
Assay	99.993 % wt	> 99.7 % wt	99.8 % wt
Air	50 ppm wt	2000 ppm wt 0.20 % wt	500 ppm wt 0.05 % wt
CF ₄	10 ppm wt	2400 ppm wt	500 ppm wt 0.05 % wt
Water	0.65 ppm wt (Dew point – 65 °C)	25 ppm wt (Dew point –36 °C)	1.0 ppm wt (Dew point –62 °C)
Oil Content	1 ppm wt	10 ppm wt	not specified
Acidity (as HF)	0.3 ppm wt	1.0 ppm wt	0.3 ppm wt*
Hydrolyzable Fluoride (as HF)	1 ppm wt	not specified	not specified
Toxicity	Non-toxic, acc.to IEC 60376	Not listed as a specification but required to be determinded non-toxic by the supplier	not specified

Table 2 : SF₆ – ReUse – Specification

Contamination	SF ₆ – ReUse - Specification
Air (N ₂ , O ₂)	< 30 % by volume
CF ₄	< 5 % by volume
H ₂ O	< 1000ppm by weight
HF	< 1000ppm by weight
Oil	< 0.1% by weight
Companion substances	< 5 % by weight

2.3 Disposal Case

When a Disposal Case arises, the used SF_6 must be incinerated in accredited incineration plants. The used SF_6 is listed with waste key numbers 160504* and

160215*. Solvay has the possibility to dispose contaminated SF₆ in the special waste incineration plant of Infraserv GmbH & Co. KG at Industriepark Frankfurt-Höchst.

3. APPLICATION INFORMATION

The following equipment and its proper use are important prerequisites for implementation of the SF_6 – ReUse – Process.

3.1 SF₆ Measuring equipment

The gas state is determined during maintenance work or before any used SF₆ is removed from the system.

Portable and easy-to-operate measuring devices are used to analyze the used SF₆ gas for moisture and oil content, the SO₂ and HF concentration as well as the SF₆ content. The SF₆ measuring devices are able to determine the state of the gas within a short time and with very little loss of sample gas.

Dew point or frost point measuring devices are used to determine the moisture concentration. The devices automatically display the dew point or frost point in ppm H_2O or in degree centigrade.

If the gas contains contaminants caused by decomposition, SO₂ is formed as a stable end product. For this reason, portable decomposition product measuring instruments using Dräger[®] Tubes may be used for detection. Because of the cross-sensitivity of these instruments, they also show the presence of other acidic constituents such as SO₂F₂.

Electro-chemical sensors for measuring SO₂ concentrations in SF₆ are available and were more and more inserted to used SF₆ gas determination.

Decomposition product measuring instruments using Dräger Tubes are also used to determine the HF and oil content. Other, more precise analytical instruments for field operations are available and are described in the reviewed IEC 62271-4.

The purity of SF_6 in regard to other gases, such as air, is determined with measuring instruments that determine the percentage of SF_6 by volume.

On top of this SF₆ combination measuring instruments are developed, which integrate the above measuring methods in one instrument shown in figure 2.

Table 3 contains an overview of analytical SF₆ instruments for determining the state of the gas. It is important that the different measuring ranges are considered when the results of the measurements are being assessed.







Figure 2 : Measuring Device for SF6 (DILO Multi Analyser [4], WIKA [5])

Measuring instrument	Measuring medium	Measuring range	Measuring accuracy
Percentage by volume measuring instrument	SF _e /N ₂ ,SF _e /air	0-100% by volume	+/- 1% by volume
Electronic moisture measuring instrument	H ₂ O/dew point	from -50°C to 0°C	+/- 3°C
Frost point measuring instrument	H ₂ O/frost point	from -60°C to 5°C	+/- 0.2°C
ecomposition product SO ₂ neasuring instrument HF vith Dräger® Tubes Oil mist		1500ppm by vol. 1.515ppm by vol. 0.161.6ppm by weight	N/A
Electrochemical sensor	SO ₂	typical 0-20ppm by vol.	+/- 1ppm by vol.

3.2 SF₆ Service Equipment

When users are maintaining or decommissioning gas-insulated systems, they may use service equipment, which can extract, clean, store and refill the gaseous SF₆ back into the

system. Service devices also exist which can evacuate the system and liquefy the gaseous SF₆ before it is filled into suitable pressurized gas containers (cf. section 3.3). The SF₆ service devices are portable, simple to use, gas-proof and oil-free (Figure 3).



Figure 3 : Portable SF₆ – Service Devices[4]

All materials used in the devices are compatible with SF_6 and its decomposition products. SF_6 service devices are equipped with filters and adsorption units from table 4.

Gas can be stored in a liquid or gaseous state. In all cases it should be possible to extract the gas from the SF₆ system until a residual pressure of max. 2 mbar is reached.

To prevent emissions during the evacuation, systems filled with SF₆ should be fitted with secure gas tight connections, such as DILO couplings with 8 and 20mm nominal width.

The gas connection should be constructed in such a way that mistakes during filling, maintenance and emptying are prevented. Table 5 shows a survey on different service devices.

New gas quality according to IEC 60376 cannot be achieved with the SF₆ Service devices!

Contamination	Filter type	Task	Properties
General contamination: Oil, moisture, particles, reactive products, etc.	Prefilter	Reduce the concentration of solid and gaseous contamination before heavily contaminated gas enters the treatment unit	Pore size 10 μm Residual moisture < 200 ppm by vol. Residual reactive products < 200 ppm by vol. Also retains oil
Dust/particles, carbon switching dust: CuF ₂ , WO _x F _y ,	Particle filter / solids filter	Remove solid contaminants and other particles before the gas enters the treatment unit	Pore size 1 μm
Moisture	Moisture filter	Remove moisture	Alumina (Al ₂ O ₃ , aluminium oxide) Molecular sieve (pore size 4- 5Å) Residual moisture < 100 ppm by vol.
Gaseous decomposition products: SF ₄ , WF ₆ , SOF ₄ , SO ₂ F ₂ , SOF ₂ , SO ₂ , HF	Gas filter	Remove gaseous decomposition products	Activated carbon and zeolites Also retains small particles SO ₂ +SOF ₂ < 12 ppm by vol.
Oil	Oil filter	Remove oil	Activated carbon, special filter with sight glass at the inlet and outlet sides
SO ₂ , SOF ₂ , SO ₂ F ₂ , HF	Detoxification filter	Reduce reactive decomposition products to 200 ppm by vol., to enable transport as a non-toxic gas	Like prefilters

Table 4 : Various types of filters and adsorption agents used in gas treatment units

Figure 4 : DILO Portable Pre-Filter Unit (Dry Filter & Particle Filter)



Table 5 : Different DILO SF₆ Service Devices(Extract)[4]

SF ₆ Service device with performance for:	Name	Order – No.
- <u>gaseous storage</u> with compressore (11,4m ³ /h, 23bar) and vacuum pump (5,2 m ³ /h, < 50 mbar)	Economy Serie / G	B 120 R61
 <u>gaseous storage</u> with compressor (15 m³/h, 23bar) and two vacuum pumps (10,4 m³/h, < 50 mbar) 	Economy Serie / G	B 120 R62
 <u>gaseous storage</u> with compressor (15 m³/h, 23bar) and oil free suction pump (30 m³/h, < 1 mbar) 	Economy Serie / G	B 120 R71
 - <u>liquid storgage</u> with compressor (5,7 m³/h, 50 bar) and vacuum pump (5,2 m³/h, < 50 mbar) 	Economy Serie / L	B 120 R21
- <u>liquid storage</u> with two compressors (11,4 m ³ /h, 50 bar) and two vacuum pumps (10,4 m ³ /h, < 50 mbar)	Economy Serie / L	B 120 R22
 <u>liquid storage</u> with compressor (5,7 m³/h, 50 bar) and oil free suction pump (30 m³/h, < 1 mbar) 	Economy Serie / L	B 120 R01
 <u>liquid storage</u> with two compressors (11,4 m³/h, 50 bar) and oil free suction pump (30m³/h, < 1 mbar) 	Economy Serie / L	B 120 R02

We recommend SF_6 service devices enabling evacuation until 1mbar in order to avoid SF_6 emissions.

3.3 Packaging, Labeling and Transportation

A distinction is always made between packaging for new gas and for used SF₆ gas.

As used SF₆ may contain decomposition products, used SF₆ must be filled only into SF₆ – ReUse – Packaging, as shown in Figure 5. Special service devices are needed to transfer the used gas into the SF₆ – ReUse – Packaging.



Figure 5: 40I and 600I SF₆ – ReUse – Packaging

 SF_6 – ReUse – Packaging approved to minimum 100bar is available.

Minimum 100bar SF_6 – ReUse – Packaging complies with the regulations for hydrogen chloride and is approved for used SF_6 with corrosive substances > 1% by mass [6].

All SF_6 – ReUse – Packaging are equipped with valves (DIN 477 – Part 1 : Type A, 1" No. 8) and screw-in fittings which are different from those used in containers for new gas to prevent inadvertent filling and contamination of new SF_6 . The valves are made of stainless steel to resist corrosive decomposition products.

The Solvay plant in Bad Wimpfen provides this packaging on a rental basis. They contain a small SF_6 residual pressure and are marked with the prescribed hazard labels (UN3308) as shown in Table 6.

The described SF_6 – ReUse – Packaging for used SF6 may be purchased from Solvay plant. Customers may also send their own SF_6 – ReUse – Packaging if they fulfill the described criteria.

In case of contamination of new SF₆ packaging with used gas, packaging has to be cleaned in a costly and time-consuming process. Responsible parties will be invoiced for the cleaning costs.

Transportation of used SF₆ in pressurized gas containers

The party who is the shipper of the goods (e.g. used SF_6 gas in the appropriate containers) is responsible for the transport of the consignment.

When these packaging are being transported, ADR (road), RID (rail), IMDG code (sea) and IATA - DGR (air) regulations must be respected.

The packaging must be labeled and the transportation documents must contain the information as described in Table 6.

It is the sender's responsibility to attach the prescribed hazard label and UN number to the container. The required Accident Instruction Leaflets for road transportation and the prescribed hazard labels with UN numbers are listed in the appendix and can be sent on request.

 Table 6 : Gas Categories, Packaging and Labeling according to ADR, RID, IMDG Code and IATA - DGR

Regulation	SF ₆ complies with IEC 60480	SF ₆ does not comply with IEC 60480 Contains toxic by-products	SF ₆ does not comply with IEC 60480 Contains toxic and corrosive by-products
Packaging	70 bar SF ₆ packaging	Corrosive by-products < 1% by mass [5], 70 bar SF ₆ – ReUse - Packaging	Corrosive by-products > 1% by mass [5] 100 or 250 bar SF ₆ – ReUse - Packaging
Valve Type A acc. to DIN 477	Brass, side connection – external – right-hand thread, W21.8 x 1/14", Connection No. 6	Stainless steel, side connection – external – right-hand thread, 1", Connection No. 8	Stainless steel, side connection – external – right-hand thread, 1", Connection No. 8
UN number	3163 (liquefied gas)	3162 (liquefied and toxic gas)	3308 (liquefied, toxic and corrosive gas)
Classification code (Class 2)	2A	2T	2TC
Hazard category	2.2	2.3	2.3 + 8
Final classification	UN 3163 Liquefied gas, n.o.s. , 2.2	UN 3162 Liquefied gas, toxic, n.o.s. , 2.3	UN 3308 Liquefied gas, toxic, corrosive, n.o.s. , 2.3 (8)
Transport document	UN 3163 Liquefied gas, n.o.s. (sulphur hexafluoride and air or nitrogen or carbon tetrafluoride), 2.2	UN 3162 Liquefied gas, toxic, n.o.s. (sulphur hexafluoride and hydrogen fluoride and thionylfluoride), 2.3	UN3308 Liquefied gas, toxic, corrosive, n.o.s. (sulphur hexafluoride and hydrogen fluoride and thionylfluoride), 2.3 (8)

3.4 Filling Factor

Filling factors must be considered when pressurized gas containers are being filled in order to guarantee operational safety. The filling factor describes the mass of gas that may be filled into a pressurized gas container with a specific volume.

The filling factor depends on the test pressure of the container and is 1.04kg/l [6] for new SF₆ with a packaging test pressure of 70 bar and less than 0.8kg/l [7] for used SF₆ with IEC 60480 specification. The filling factor for containers with 100 and 250bar test pressure is 1.3kg/l [6] filled with new SF₆ gas and shall not exceed 1kg/l (see Figure 6) for used SF₆ gas.

As the inert gas concentration rises – e.g. the concentration of air – the filling factor falls, as illustrated in Figure 6. This must be considered.



Figure 6 : Relation between inert gas concentration and filling factor for SF₆ [6]

4. Costs

When contaminated SF₆ from switchgear and other application is returned, the following costs can be expected.

4.1 Service Fee

A service fee of \in 500 excluding VAT is charged for each individual Re-Use case / return of used SF6 to cover all administrative and order processing cost.

4.2 Freight

Freight costs are incurred for sending empty packaging to their destination and returning the filled packaging to Solvay's plant. The amount depends on the respective destination and is calculated on a case-by-case basis.

4.3 Rental Packaging (Rental Fees)

Solvay provides 40I and 600I cylinders for SF₆ – ReUse – rental packaging for contaminated SF₆ which is outside the IEC 60376 specification. This special packaging is provided to our SF₆ customers at no cost for 14 days. From the 15th day we charge $\in 0.35$ per day for the 40I cylinder and $\in 5.50$ per day for the 600I container.

4.4 Analysis

When we receive 40l cylinders or 600l containers with reusable SF₆, we invoice €205 per cylinder or container regardless of the filling rate.

4.5 Additional Costs (Disposal Case)

If the analysis shows a composition of SF_6 , which exceeds the SF_6 – ReUse – *S*pecification, and no use for SF_6 production is possible, the disposal is necessary and the following costs will be incurred in addition to the above costs:

- Freight Costs from the Solvay plant in Bad Wimpfen to the disposal plant in Frankfurt and back to Bad Wimpfen.
- Incineration Costs of €2.60 per kilogram product. A minimum charge of €50 per 40l cylinder and €100 per 600l container will be invoiced for each procedure.

5. LITERATURE

[1] Draft voluntary self-regulation of SF₆ procedures, manufacturers and operators of electrical equipment > 1kV for electrical energy transmission and distribution in the Federal Republic of Germany, May 2005, <u>www.zvei.org</u>

[2] IEC 60480, Beuth Verlag GmbH, Berlin, 2003

[3] IEC 60376, Beuth Verlag GmbH, Berlin, April 2005

[4] DILO Product Information, Babenhausen, 2002 and 2013 Version, www.dilo-gmbh.de

[5] WIKA Product Information, Klingenberg, 2010 Version, www.wika.de

[6] Technical Regulations for Pressurized Gases (TRG) : TRG 101 Appendix 2, October 1996

[7] CIGRE : SF₆ Recycling Guide, Document CIGRE 234, 2003

6. Appendix

Appendix 1 : Material Safety Data Sheet for Used SF6 (12 pages)

Appendix 2 : Labels for SF₆ – ReUse – Packaging (1 page)

Appendix 3 : ADR Transport Document (1 page)

SECTION 1. IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE **COMPANY/UNDERTAKING**

1.1. Product identifier

- Product name
- **USED SULFUR HEXAFLUORIDE** :
- Chemical Name Sulfur hexafluoride :
- Molecular formula - Type of product
- SF6 : : Mixture
- 1.2. Relevant identified uses of the substance or mixture and uses advised against :

-

- Identified uses

- Recycling
- 1.3. Details of the supplier of the safety data sheet
 - SOLVAY FLUOR GmbH - Company • - Address HANS-BOECKLER-ALLEE 20 D-30173 HANNOVER - Telephone
 - Fax
- +495118570

manager.sds@solvay.com

- +495118572146 :
- E-mail address
- 1.4. Emergency telephone number
 - Emergency telephone number

+44(0)1235 239 670 [CareChem 24] (Europe)

SECTION 2. HAZARDS IDENTIFICATION

2.1. Classification of the substance or mixture

2.1.1. European regulation (EC) 1272/2008, as amended

Classified as hazardous according to the European regulation (EC) 1272/2008, as amended

Hazard class	Hazard category	Route of exposure	H Phrases
Gases under pressure	Liquefied gas		H280
Acute toxicity	Category 3	Inhalation	H331
Acute toxicity	Category 4	Oral	H302
Acute toxicity	Category 4	Dermal	H312
Eye irritation	Category 2		H319
Skin irritation	Category 2		H315
Target Organ Systemic	Category 1	Inhalation	H335
i oxicant - Single exposure			

2.1.2. European Directive 67/548/EEC or 1999/45/EC, as amended

Hazard class / Hazard category	R-phrase(s)
Т	R23
Xn	R21/22
Xi	R36/37/38



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2.2. Label elements

2.2.1. Name(s) on label

Hazardous components

: Hydrogen fluoride Thionyl difluoride Disulfur decafluoride

2.2.2. Signal word

Danger

2.2.3. Hazard pictograms



2.2.4. Hazard statements

H280	-	Contains gas under pressure; may explode if heated.
H331	-	Toxic if inhaled.
H302	-	Harmful if swallowed.
H312	-	Harmful in contact with skin.
H315	-	Causes skin irritation.
H319	-	Causes serious eye irritation.
H335	-	May cause respiratory irritation.

2.2.5. Precautionary statements

Prevention	P261 P280	-	Avoid breathing dust/ fume/ gas/ mist/ vapours/ spray. Wear protective gloves/ protective clothing/ eye protection/ face protection.
Response	P305 + P351 + P338	-	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
	P302 + P352	-	IF ON SKIN: Wash with plenty of soap and water.
	P309 + P311	-	IF exposed or if you feel unwell: Call a POISON CENTER or doctor/ physician.
Storage	P410 + P403	-	Protect from sunlight. Store in a well-ventilated place.

2.3. Other hazards

- Causes asphyxiation in high concentrations.

Hazardous decomposition products formed under fire conditions.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

3.2 Mixtures

3.2.1.Concentration

Substance name:	Concentration
Sulfur hexafluoride	>= 95 %
CAS-No.: 2551-62-4 / EC-No.: 219-854-2 / Index-No.: - REACH Registration Number: 01-2119458769-17	
Hydrogen fluoride (Impurities) CAS-No.: 7664-39-3 / EC-No.: 231-634-8 / Index-No.: 009-002-00-6	<= 0.1 %



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Thionyl difluoride (Impurities) CAS-No.: 7783-42-8 / EC-No.: 231-997-2 / Index-No.: -	<= 2 %
Disulfur decafluoride (Impurities) CAS-No.: 5714-22-7 / EC-No.: 227-204-4 / Index-No.: -	< 1 %
Carbon tetrafluoride (Impurities) CAS-No.: 75-73-0 / EC-No.: 200-896-5 / Index-No.: -	<= 3 %

3.2.2. Hazardous components - According to Regulation (EC) 1272/2008, as amended

Substance name	Hazard class	Hazard category	Route of exposure	H Phrases
Sulfur hexafluoride	Gases under pressure	Liquefied gas		H280
Hydrogen fluoride	Acute toxicity	Category 2	Inhalation	H330
	Acute toxicity	Category 1	Dermal	H310
	Acute toxicity	Category 2	Oral	H300
	Skin corrosion	Category 1A		H314
Thionyl difluoride	Acute toxicity	Category 3	Oral	H301
	Acute toxicity	Category 3	Inhalation	H331
Eye irritation		Category 2		H319
	Skin irritation		Dermal	H315
	Target Organ Systemic Toxicant - Single exposure	Category 3		H335
Disulfur decafluoride	Acute toxicity	Category 2	Inhalation	H330
	Skin corrosion	Category 1A	Dermal	H314

3.2.3. Hazardous components - European Directive 67/548/EEC or 1999/45/EC, as amended

Substance name	Classification	Hazard category	R-phrase(s)
Hydrogen fluoride	T+	Very toxic	R26/27/28
	С	Corrosive	R35
Thionyl difluoride	Т	Toxic	R23/25
	Xi	Irritant	R36/37/38
Disulfur decafluoride	T+	Very toxic	R26
	С	Corrosive	R34

SECTION 4. FIRST AID MEASURES

4.1. Description of first aid measures

- 4.1.1. If inhaled
 - Remove to fresh air.
 - Oxygen or artificial respiration if needed.
 - If symptoms persist, call a physician.
 - Exposure to decomposition products:
 - If inhaled
 - Remove to fresh air.
 - Immediate medical attention is required.

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4.1.2. In case of eye contact

- Keep eyelids open to allow evaporation of product.
- Rinse thoroughly with plenty of water, also under the eyelids.
- If eye irritation persists, consult a specialist.

4.1.3. In case of skin contact

- Allow to evapourate.
 - Rinse with lukewarm running water.
 - If symptoms persist, call a physician.
- 4.1.4. If swallowed
 - not applicable

4.2. Most important symptoms and effects, both acute and delayed

4.2.1. Inhalation

- Risk of cardiac and nervous disorders.
- Symptoms: narcosis, Cough, Asphyxia
- Risk of: Lung oedema
- In case of higher concentrations: chemical pneumonitis, chronic bronchitis

4.2.2. Skin contact

- Cold sensation followed by redness of the skin.
- Prolonged skin contact may defat the skin and produce dermatitis.

4.2.3. Eye contact

- Severe eye irritation
- Symptoms: Lachrymation, Redness, Swelling of tissue

4.2.4. Ingestion

- gas
- not applicable

4.3. Indication of any immediate medical attention and special treatment needed

- Immediate medical attention is not required.
- When symptoms persist or in all cases of doubt seek medical advice.

SECTION 5. FIREFIGHTING MEASURES

5.1. Extinguishing media

- 5.1.1. Suitable extinguishing media
 - Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.
- 5.1.2. Unsuitable extinguishing media
 - None.

5.2. Special hazards arising from the substance or mixture

- The product is not flammable.
- Heating can release hazardous gases.
- Container may explode if heated.

5.3. Advice for firefighters

- Wear self-contained breathing apparatus and protective suit.
- Fire fighters must wear fire resistant personnel protective equipment.
- Wear chemical resistant oversuit
- Protect intervention team with a water spray as they approach the fire.
- Clean contaminated surface thoroughly.



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SECTION 6. ACCIDENTAL RELEASE MEASURES

6.1. Personal precautions, protective equipment and emergency procedures

6.1.1. Advice for non-emergency personnel

- Prevent further leakage or spillage if safe to do so.
- Keep away from Incompatible products.

6.1.2. Advice for emergency responders

- Approach from upwind.
- Suppress (knock down) gases/vapours/mists with a water spray jet.
- Avoid spraying the leak source.
- Try to re-position leaking containers, to have the leak in the gaseous phase.
- Vapours are heavier than air and can cause suffocation by reducing oxygen available for breathing.
- Keep away from open flames, hot surfaces and sources of ignition.

6.2. Environmental precautions

- Should not be released into the environment.

6.3. Methods and materials for containment and cleaning up

- Allow to evapourate.
- Prevent product from entering drains.

6.4. Reference to other sections

- Refer to protective measures listed in sections 7 and 8.

SECTION 7. HANDLING AND STORAGE

7.1. Precautions for safe handling

- Used in closed system
- Use only in well-ventilated areas.
- Use only equipment and materials which are compatible with the product.
- Prevent any product decomposition from contacting hot spots.
- Prevent product vapours decomposition from electric arc action (welding).
- Keep away from Incompatible products.

7.2. Conditions for storage, including incompatibilities

7.2.1. Storage

- Keep in a well-ventilated place.
- Keep only in the original container at a temperature not exceeding 50 °C.
- Keep away from Incompatible products.
- Refer to protective measures listed in sections 7 and 8.

7.2.2. Packaging material

- 7.2.2.1. Suitable material
- Steel drum

7.3. Specific end use(s)

For further information, please contact: Supplier

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1. Control parameters

8.1.1. Exposure Limit Values

Sulfur hexafluoride

- UK. EH40 Workplace Exposure Limits (WELs) 12 2011
- time weighted average = 1,000 ppm time weighted average = 6,070 mg/m3



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-	UK. EH40 Workplace Exposure Limits (WELs) 12 2011
	Short term exposure limit = 1,250 ppm
	Short term exposure limit = 7,590 mg/m3
-	US. ACGIH Threshold Limit Values 03 2013
	time weighted average = 1,000 ppm
Hy	drogen fluoride
-	UK. EH40 Workplace Exposure Limits (WELs) 12 2011
	time weighted average = 1.8 ppm
	time weighted average = 1.5 mg/m3
_	Nellidiks. ds F LIK EH40 Workplace Exposure Limits (WELs), 12,2011
-	Short term exposure limit -3 ppm
	Short term exposure limit = 2.5 mg/m^3
	Remarks: as F
-	US. ACGIH Threshold Limit Values 03 2013
	time weighted average = 0.5 ppm
	Remarks: as F
-	US. ACGIH Threshold Limit Values 03 2013
	Ceiling Limit Value = 2 ppm
	Remarks: as F
-	EU. Indicative Exposure Limit Values in Directives 91/322/EEC, 2000/39/EC, 2006/15/EC, 2009/161/EU 12
	<u>2009</u> time weighted everyone 1.9 ppm
	time weighted average = 1.6 ppm time weighted average = 1.5 mg/m3
	Remarks: Indicative
-	EU Indicative Exposure Limit Values in Directives 91/322/EEC 2000/39/EC 2006/15/EC 2009/161/EU 12
	2009
	Short term exposure limit = 3 ppm
	Short term exposure limit = $2.5 \text{ mg/m}3$
	Remarks: Indicative
-	US. ACGIH Threshold Limit Values 03 2013
	Remarks: as F, Can be absorbed through skin.
Th	ionyl difluoride
-	UK. EH40 Workplace Exposure Limits (WELs) 12 2011
	time weighted average = 2.5 mg/m3
	Remarks: as F
-	US. ACGIH Threshold Limit Values 03 2013
	time weighted average = 2.5 mg/m3
-	FU Indicative Exposure Limit Values in Directives 91/322/EEC 2000/39/EC 2006/15/EC 2009/161/EU 12
	2009
	time weighted average = 2.5 mg/m3
	Remarks: Indicative
Dis	sulfur decafluoride
-	US. ACGIH Threshold Limit Values 03 2013
	Ceiling Limit Value = 0.01 ppm
-	UK. EH40 Workplace Exposure Limits (WELs) 12 2011
	time weighted average = 2.5 mg/m3
	Remarks: as F
-	EU. Indicative Exposure Limit Values in Directives 91/322/EEC, 2000/39/EC, 2006/15/EC, 2009/161/EU 12
	ume weignieu average = 2.5 mg/m3 Remarks: Indicative
-	
Ca -	rbon tetratluoride

US. ACGIH Threshold Limit Values

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Remarks: none established

8.1.2. Other information on limit values

8.1.2.1. Predicted No Effect Concentration

Sulfur hexafluoride

- Fresh water, 0.15 mg/l, Water
- Intermittent use/release, 1.5 mg/l, Water
- 8.1.2.2. Derived No Effect Level / Derived minimal effect level

Sulfur hexafluoride

- Workers, Inhalation, Long-term exposure, 77900 mg/m3, Systemic effects, Local effects
- Consumers, Inhalation, Long-term exposure, 23254 mg/m3, Systemic effects, Local effects

8.2. Exposure controls

- 8.2.1. Appropriate engineering controls
 - Ensure adequate ventilation.
 - Apply technical measures to comply with the occupational exposure limits.

8.2.2. Individual protection measures

- 8.2.2.1. Respiratory protection
 - Self-contained breathing apparatus in confined spaces/insufficient oxygen/in case of large uncontrolled emissions/in all circumstances when the mask and cartridge do not give adequate protection.
 - Use only respiratory protection that conforms to international/ national standards.

8.2.2.2. Hand protection

- Take note of the information given by the producer concerning permeability and break through times, and of special workplace conditions (mechanical strain, duration of contact).
- Protective gloves
- Suitable material: Copolymer VF2-HFP (fluoroelastomer)
- 8.2.2.3. Eye protection
- Chemical resistant goggles must be worn.
- 8.2.2.4. Skin and body protection
 - Wear suitable protective clothing.
- 8.2.2.5. Hygiene measures
 - When using, do not eat, drink or smoke.
 - Gloves, overalls and boots have to be double layered (protection against cold temperature).
 - Handle in accordance with good industrial hygiene and safety practice.
- 8.2.3. Environmental exposure controls
 - Dispose of rinse water in accordance with local and national regulations.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

9.1. Information on basic physical and chemical properties

9.1.1. General Information

-		
	Appearance	Liquefied gas
	Colour	colourless

- Odour
 Dungent
- Molecular weight
 146 g/mol

9.1.2. Important health safety and environmental information

■ pH 2·	- 5
----------------	-----

- pKa
 not applicable
- Melting point/freezing point -50.8 °C (Sulfur hexafluoride)
- Boiling point/boiling range -63.8 °C, Sublimation point (Sulfur hexafluoride)
- Flash point not applicable





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•	Evaporation rate	No data
-	Flammability (solid, gas)	The product is not flammable.
-	Flammability	not applicable
•	Explosive properties	Not explosive
-	Vapour pressure	21.4 bar, at 20 °C
•	Vapour density	5.1 (Sulfur hexafluoride)
-	Density	no data available
	Relative density	no data available
•	Bulk density	not applicable
	Solubility(ies)	0.04 g/l, at 20 °C, Water
•	Solubility/qualitative	slightly soluble, Water, Alcohol, Ether
•	Partition coefficient: n- octanol/water	log Pow: 1.68
-	Auto-ignition temperature	No data
•	Decomposition temperature	200 °C, Decomposition under influence of moisture is highly accelerated by heating.
		800 °C
•	Viscosity	not applicable
•	Oxidizing properties	No data
9.2. Ot	her information	
R	emarks	no data available

SECTION 10. STABILITY AND REACTIVITY

10.1. Reactivity

- Decomposition under influence of moisture is highly accelerated by heating.

10.2. Chemical stability

- Stable under recommended storage conditions.
- Vapours are heavier than air and may spread along floors.
- Hazardous Polymerisation/Polymerization: no

10.3. Possibility of hazardous reactions

- no data available

10.4. Conditions to avoid

- Heat.

10.5. Incompatible materials

- Oxidizing agents

10.6. Hazardous decomposition products

- Gaseous hydrogen fluoride (HF)., Sulphur oxides, Sulphur compounds, Thionyl difluoride, Disulfur decafluoride
- The release of other hazardous decomposition products is possible.



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SECTION 11. TOXICOLOGICAL INFORMATION

11.1. Acute toxicity

11.1.1. Acute oral toxicity

not applicable

- 11.1.2. Acute inhalation toxicity
 - LC50, 10 min, Various species , 0.1 0.9 mg/l (Disulfur decafluoride)
 - LC50, 1 h, rat , 2240 2340 ppm (Hydrogen fluoride)
- 11.1.3. Acute dermal toxicity
 - not applicable

11.2. Skin corrosion/irritation

corrosive effects (Hydrogen fluoride)

11.3. Serious eye damage/eye irritation

Corrosive (Hydrogen fluoride)

11.4. Sensitisation

not applicable

11.5. Mutagenicity

- In vitro tests did not show mutagenic effects (Sulfur hexafluoride)
- In vivo tests did not show mutagenic effects (Sulfur hexafluoride)

11.6. Carcinogenicity

Animal testing did not show any mutagenic effects. (Sulfur hexafluoride)

11.7. Toxicity for reproduction

no data available

11.8. Specific target organ toxicity - single exposure

Remarks: Corrosive to respiratory system (Thionyl difluoride)

11.9. Repeated dose toxicity

Inhalation, 28-day, rat, no observed effect (Sulfur hexafluoride)

11.10. Other information

Presents a risk due to the presence of possible contaminants.

SECTION 12. ECOLOGICAL INFORMATION

12.1. Toxicity

- Fishes, LC50, 96 d, 236 mg/l, calculated value (Sulfur hexafluoride)
- Crustaceans, LC50, 48 h, 247 mg/l (Sulfur hexafluoride)
- Algae, EC50, 96 h, 151 mg/l (Sulfur hexafluoride)

12.2. Persistence and degradability

12.2.1. Abiotic degradation

- Air, t 1/2 > 1,000 y
 - Result: non-significant photolysis (Sulfur hexafluoride)
- Water/soil, t 1/2 (Hydrolysis) 1,000 y
 - Result: non-significant hydrolysis (Sulfur hexafluoride)

12.2.2. Biodegradation

The methods for determining biodegradability are not applicable to inorganic substances. -

12.3. Bioaccumulative potential

Does not bioaccumulate.





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12.4. Mobility in soil

- <u>Soil/sediments</u>, non-significant adsorption (Sulfur hexafluoride)
 <u>Water</u>, t1/2: 3.5 h Conditions: calculated value
- The product evapourates readily. (Sulfur hexafluoride)
 <u>Air</u>, Henry's law constant (H), ca. 458 kPa.m³/mol , 25 °C Conditions: calculated value
 - considerable volatility (Sulfur hexafluoride)

12.5. Results of PBT and vPvB assessment

- This mixture contains no substance considered to be persistent, bioaccumulating nor toxic (PBT).
- This mixture contains no substance considered to be very persistent nor very bioaccumulating (vPvB).

12.6. Other adverse effects

- Global Warming Potential : = 23,900
 - Halocarbon global warming potential; HGWP; (R-11 = 1) (Sulfur hexafluoride)

SECTION 13. DISPOSAL CONSIDERATIONS

13.1. Waste treatment methods

- In accordance with local and national regulations.
- · Refer to manufacturer/supplier for information on recovery/recycling.

13.2. Contaminated packaging

- To avoid treatments, as far as possible, use dedicated containers.

SECTION 14. TRANSPORT INFORMATION

International transport regulations

- IATA-DGR

14.1. UN number 14.2. UN proper shipping name	UN 3308 LIQUEFIED GAS, TOXIC, CORROSIVE, N.O.S.(MIXTURE, CONTAINS SULPHUR HEXAFLUORIDE AND HYDROFLUORIC ACID)
14.3. Transport hazard class(es)	
Hazard class	FORBIDDEN
Labels	2.3 - Toxic gas 8 - Corrosive
14.4. Packing group	
14.5. Environmental hazards	
14.6. Special precautions for user	
- IMDG	
14.1. UN number	UN 3308
14.2. UN proper shipping name	LIQUEFIED GAS, TOXIC, CORROSIVE, N.O.S.(MIXTURE, CONTAINS SULPHUR HEXAFLUORIDE AND HYDROFLUORIC ACID)

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14.3. Transport hazard class(es)	
Hazard class	2.3
Labels	2.3 - Toxic gasses 8 - Corrosive
14.4. Packing group	
14.5. Environmental hazards	
14.6. Special precautions for user	
EmS	F-C S-U
- ADR	
14.1. UN number	UN 3308
14.2. UN proper shipping name	LIQUEFIED GAS, TOXIC, CORROSIVE, N.O.S.(MIXTURE, CONTAINS SULPHUR HEXAFLUORIDE AND HYDROFLUORIC ACID)
14.3. Transport hazard class(es)	
Hazard class	2
Labels	2.3 - Toxic gas 8 - Corrosive
14.4. Packing group	
14.5. Environmental hazards	
14.6. Special precautions for user	
HI/UN No.	268 / 3308
Tunnel restriction code	C/D
- RID	
14.1. UN number	UN 3308
14.2. UN proper shipping name	LIQUEFIED GAS, TOXIC, CORROSIVE, N.O.S.(MIXTURE, CONTAINS SULPHUR HEXAFLUORIDE AND HYDROFLUORIC ACID)
14.3. Transport hazard class(es)	
Hazard class	2
Labels	2.3 - Toxic gas 8 - Corrosive
14.4. Packing group	
14.5. Environmental hazards	
14.6. Special precautions for user	
HI/UN No.	268 / 3308
- ADN	
14.1. UN number	UN 3308
14.2. UN proper shipping name	LIQUEFIED GAS, TOXIC, CORROSIVE, N.O.S.(MIXTURE, CONTAINS SULPHUR HEXAFLUORIDE AND HYDROFLUORIC ACID)



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14.3. Transport hazard class(es)

Hazard class

Labels

2 2.3 - Toxic gas 8 - Corrosive

14.4. Packing group

14.5. Environmental hazards

14.6. Special precautions for user

SECTION 15. REGULATORY INFORMATION

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

- Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), as amended
- Directive 1999/45/EC of the European Parliament and of the Council of 31 May 1999 concerning the approximation of the laws, regulations and administrative provisions of the Member States relating to the classification, packaging and labelling of dangerous preparations, as amended
- Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, as amended
- Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste

15.1.1. Notification status

Inventory Information	Status
USA. Toxic Substances Control Act (TSCA)	 In compliance with inventory
Australia. Inventory of Chemical Substances (AICS)	- One or more components not
	listed on inventory
Canada. Domestic Substances List (DSL)	 In compliance with inventory
	- =>CAS: 2551-62-4 & 75-73-0
Canada. Non-Domestic Substances List (NDSL)	 In compliance with inventory
	- => CAS: 7783-42-8
China. Inventory of Existing Chemical Substances (IECSC)	- One or more components not
	listed on inventory
EU list of existing chemical substances (EINECS)	 In compliance with inventory
Japan. Inventory of Existing & New Chemical Substances (ENCS)	- One or more components not
	listed on inventory
New Zealand. Inventory of Chemicals (NZIOC)	- In compliance with inventory
Korea. Existing Chemicals Inventory (KECI (KR))	- One or more components not
	listed on inventory
Philippine. Inventory of Chemicals and Chemical Substances (PICCS)	- One or more components not
	listed on inventory
Mexico INSQ (INSQ)	- One or more components not
	listed on inventory

15.2. Chemical Safety Assessment

no data available

SECTION 16. OTHER INFORMATION

16.1. Full text of H-Statements referred to under section 3



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H319	- (Causes serious eye irritation.
H330	- 1	Fatal if inhaled.
H331		Toxic if inhaled.
H335	- 1	May cause respiratory irritation.
16.2. Full text of R-phrases referre	d to u	nder sections 2 and 3
16.2.1. Full text of R-phrases referred	d to un	nder section 2
R23		Toxic by inhalation.
R21/22	- 1	Harmful in contact with skin and if swallowed.
R36/37/38	- 1	Irritating to eyes, respiratory system and skin.
16.2.2. Full text of R-phrases referred to under section 3		
R23/25		Toxic by inhalation and if swallowed.
R26	- /	Also very toxic by inhalation.
R26/27/28	- `	Very toxic by inhalation, in contact with skin and if swallowed.
R34	- (Causes burns.
R35	- (Causes severe burns.
R36/37/38	-	Irritating to eyes, respiratory system and skin.
16.3. Other information		

Update

This data sheet contains changes from the previous version in section(s): 1.3,2.1.1,8.1.1,8.1.2.2,15.1

This SDS is only intended for the indicated country to which it is applicable. The European SDS format compliant with the applicable European legislation is not intended for use nor distribution in countries outside the European Union with the exception of Norway and Switzerland. Safety datasheets applicable in other countries/regions are available upon request.

The information given corresponds to the current state of our knowledge and experience of the product, and is not exhaustive. This applies to product which conforms to the specification, unless otherwise stated. In this case of combinations and mixtures one must make sure that no new dangers can arise. In any case, the user is not exempt from observing all legal, administrative and regulatory procedures relating to the product, personal hygiene, and protection of human welfare and the environment.

Print Date: 13.03.2014



APPENDIX 2: LABEL FOR SF6 - REUSE - PACKAGING



A Absender (Name, Anschrift, Land) Expéditeur (nom, adresse, pays) Empfänger (Name, Anschrift, Land) Destinataire (nom, adresse, pays)	Versandort Ort/Lieu Beladestelle Gemeinde- Bereich Land / Pays F Bestimmungsort Ort/Lieu Entladestelle Gemeinde- Bereich Land/Pays Weitere Beladestellen		FRACHTBR Für den gewerblichen Güterkraftverkehr national*/international* *Nichtzutreffendes streicher Nr. Amtliches Kennz. LKW Anhänger Fahrzeug- Führer Begleiter Entfer- nung km	Nutzlast Nutzlast
L Erklärungen, Vereinbarungen (ggl. Hinweis auf Spezialfahrzeug Anweisungen des Absenders (Zoll-und sonstige amtliche Behandlung) Instructions de l'expéditeur (formalités et autres)	e) Weitere Entladestellen KFZ-Wechsel In		Ordnungs-Nr. der Genehn Beladung Fahrzg. Tag Beladung beendet Tag Entladung Fahrzg. Tag Entladung beendet Tag	bereitgestellt Stunde Stunde bereitgestellt Stunde Stunde
Kennzeichen/Nr. Anzahl der Art der Verpackung Bezeich Marques et Packstücke Mode d'emballage Nature numéros No. des colis	nnung des Gutes de la marchandise		Bruttogewicht kg Poids brut kg	Umfang m³ Cubage m³
1 1 Druckfass Schwe	efelhexafluorid aus elekt	rischen Anlagen		
2 Gefahrgut netto:	kg			
3 UN 3308 verflüssigtes Gas, giftig, ätzend, N.A.G. (Mischung				
4 aus Schwefelhex	afluorid und Fluorwasse	rstoff), 2.3 (8) (C/D)		
5				
Statistiknummer No. statistique Bez	3	4	5	
S.H Numéro d'etiquette Nom Voit H	Numéro UN Group UN D'emballage	M Freivermerk:	Prachtzanlungsanweisungen Prescription d'affranchissement M Freivermerk:	
Sondervorschriften Prescriptions particulières		Nachnahme		
D Ausgefertigt in Etablie à Emp Réc Q , den, den R Unterschrift und Stempel des Absenders (Signature et timbre de l'expéditeur) T	Empfang der Sendung bescheinigt Réception des marchandises Gut und Frachtbrief übernommen , den, den, den Tag T Unterschrift und Stempel des Empfängers (Signature et timbre du destinataire) SN Unterschrift und Anschrift des Frachtführers (Signature et adresse du transporteur)			
Frachtpfl. Gew.kg Bezeichnung	Vereinbarte Fracht	Zusätzliche	Betrag Summe	
	Betrag	Vereinbarungen		
		Zenie staar en een		
O Paletten-Absender – Expéditeur des palettes Pal Kein Kein Kein Kein	Paletten-Empfänger – Destinataire des palettes Zwischensumm			
Art Anzahl Tausch Tausch Art Euro-Palette	Anzahl Tausch Euro-Palette	Tausch		
Einfach-Palette	Einfach-Palette			
		Nettobetrag		
Bestätigung des Empfängers/Datum/Unterschrift Bestätigung	des Fahrers/Datum/Unterschrift	+ % Umsatzsi Beförderungs- entgelt, Gesamtsumr	me	



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