

SAFETY DATA SHEET

according to Regulation (EC) No. 1907/2006, as amended by
Commission Regulation (EU) 2020/878



Opteon™ YF (R-1234yf) Refrigerant

Version 12.0 Revision Date: 29.06.2023 SDS Number: 1335662-00042 Date of last issue: 18.04.2023
Date of first issue: 27.02.2017

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifier

Trade name : Opteon™ YF (R-1234yf) Refrigerant
SDS-Identcode : 130000043292
REACH Registration Number : 01-0000019665-61-0001
Substance name : 2,3,3,3-Tetrafluoropropene
EC-No. : 468-710-7

1.2 Relevant identified uses of the substance or mixture and uses advised against

Use of the Sub-stance/Mixture : For professional and industrial use only., Formulation of preparations, Heat transfer fluids, Refrigerant for stationary and mobile air conditioning systems (MACs - all types of vehicles) For further information see Annex - Exposure scenario.
Recommended restrictions on use : Open evaporation applications., Direct use of the substance by consumers., Consumer filling of mobile air conditioning units.

1.3 Details of the supplier of the safety data sheet

Company : Chemours Netherlands B.V.
Baanhoekweg 22
3313 LA Dordrecht Netherlands
Telephone : +31-(0)-78-630-1011
Telefax : +31-78-6163737
E-mail address of person responsible for the SDS : sds-support@chemours.com

1.4 Emergency telephone number

+(353)-19014670 (CHEMTREC - Recommended) ; +353-(01) 809 2166 (Poison Information Center of Ireland)

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

Classification (REGULATION (EC) No 1272/2008)

Flammable gases, Category 1B H221: Flammable gas.

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Gases under pressure, Liquefied gas

H280: Contains gas under pressure; may explode if heated.

2.2 Label elements

Labelling (REGULATION (EC) No 1272/2008)

Hazard pictograms :



Signal word : Danger

Hazard statements : H221 Flammable gas.
H280 Contains gas under pressure; may explode if heated.

Precautionary statements : **Prevention:**
P210 Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
Response:
P377 Leaking gas fire: Do not extinguish, unless leak can be stopped safely.
P381 In case of leakage, eliminate all ignition sources.
Storage:
P410 + P403 Protect from sunlight. Store in a well-ventilated place.

2.3 Other hazards

This substance/mixture contains no components considered to be either persistent, bioaccumulative and toxic (PBT), or very persistent and very bioaccumulative (vPvB) at levels of 0.1% or higher.

Ecological information: The substance/mixture does not contain components considered to have endocrine disrupting properties according to REACH Article 57(f) or Commission Delegated regulation (EU) 2017/2100 or Commission Regulation (EU) 2018/605 at levels of 0.1% or higher.

Toxicological information: The substance/mixture does not contain components considered to have endocrine disrupting properties according to REACH Article 57(f) or Commission Delegated regulation (EU) 2017/2100 or Commission Regulation (EU) 2018/605 at levels of 0.1% or higher.

Vapours are heavier than air and can cause suffocation by reducing oxygen available for breathing.

Misuse or intentional inhalation abuse may cause death without warning symptoms, due to cardiac effects.

Rapid evaporation of the product may cause frostbite.

May displace oxygen and cause rapid suffocation.

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SECTION 3: Composition/information on ingredients

3.1 Substances

Substance name : 2,3,3,3-Tetrafluoropropene
EC-No. : 468-710-7

Components

Chemical name	CAS-No. EC-No.	Concentration (% w/w)	M-Factor, SCL, ATE
2,3,3,3-Tetrafluoropropene	754-12-1 468-710-7	>= 99.5 - <= 100	

SECTION 4: First aid measures

4.1 Description of first aid measures

General advice : In the case of accident or if you feel unwell, seek medical advice immediately.
When symptoms persist or in all cases of doubt seek medical advice.

Protection of first-aiders : No special precautions are necessary for first aid responders.

If inhaled : If inhaled, remove to fresh air.
If not breathing, give artificial respiration.
If breathing is difficult, give oxygen.
Get medical attention immediately.

In case of skin contact : Thaw frosted parts with lukewarm water. Do not rub affected area.
Get medical attention immediately.

In case of eye contact : Get medical attention immediately.

If swallowed : Ingestion is not considered a potential route of exposure.

4.2 Most important symptoms and effects, both acute and delayed

Symptoms : May cause cardiac arrhythmia.

Other symptoms potentially related to misuse or inhalation abuse are
Cardiac sensitisation
Anaesthetic effects
Light-headedness
Dizziness
confusion
Lack of coordination

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Drowsiness
Unconsciousness

Risks : Gas reduces oxygen available for breathing.
Contact with liquid or refrigerated gas can cause cold burns and frostbite.

4.3 Indication of any immediate medical attention and special treatment needed

Treatment : Because of possible disturbances of cardiac rhythm, catecholamine drugs, such as epinephrine, that may be used in situations of emergency life support should be used with special caution.

SECTION 5: Firefighting measures

5.1 Extinguishing media

Suitable extinguishing media : Water spray
Alcohol-resistant foam
Carbon dioxide (CO₂)
Dry chemical

Unsuitable extinguishing media : None known.

5.2 Special hazards arising from the substance or mixture

Specific hazards during fire-fighting : Vapours may form flammable mixture with air
Exposure to combustion products may be a hazard to health.
If the temperature rises there is danger of the vessels bursting due to the high vapor pressure.

Hazardous combustion products : Hydrogen fluoride
Fluorine compounds
Carbon oxides

5.3 Advice for firefighters

Special protective equipment for firefighters : Wear self-contained breathing apparatus for firefighting if necessary. Use personal protective equipment.

Specific extinguishing methods : Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.
Fight fire remotely due to the risk of explosion.
Use water spray to cool unopened containers.
Leaking gas fire: Do not extinguish, unless leak can be stopped safely.
Remove undamaged containers from fire area if it is safe to do so.
Evacuate area.

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SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Personal precautions : Evacuate personnel to safe areas.
Only trained personnel should re-enter the area.
Remove all sources of ignition.
Avoid skin contact with leaking liquid (danger of frostbite).
Ventilate the area.
Follow safe handling advice (see section 7) and personal protective equipment recommendations (see section 8).

6.2 Environmental precautions

Environmental precautions : Avoid release to the environment.
Prevent further leakage or spillage if safe to do so.
Retain and dispose of contaminated wash water.

6.3 Methods and material for containment and cleaning up

Methods for cleaning up : Ventilate the area.
Non-sparking tools should be used.
Suppress (knock down) gases/vapours/mists with a water spray jet.
Local or national regulations may apply to releases and disposal of this material, as well as those materials and items employed in the cleanup of releases. You will need to determine which regulations are applicable.
Sections 13 and 15 of this SDS provide information regarding certain local or national requirements.

6.4 Reference to other sections

See sections: 7, 8, 11, 12 and 13.

SECTION 7: Handling and storage

7.1 Precautions for safe handling

Technical measures : Use equipment rated for cylinder pressure. Use a backflow preventative device in piping. Close valve after each use and when empty.

Local/Total ventilation : If sufficient ventilation is unavailable, use with local exhaust ventilation.
If advised by assessment of the local exposure potential, use only in an area equipped with explosion-proof exhaust ventilation.

Advice on safe handling : Avoid breathing gas.
Handle in accordance with good industrial hygiene and safety practice, based on the results of the workplace exposure assessment
Keep container tightly closed.

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Wear cold insulating gloves/ face shield/ eye protection.
Valve protection caps and valve outlet threaded plugs must remain in place unless container is secured with valve outlet piped to use point.
Prevent backflow into the gas tank.
Use a check valve or trap in the discharge line to prevent hazardous back flow into the cylinder.
Use a pressure reducing regulator when connecting cylinder to lower pressure (<3000 psig) piping or systems.
Close valve after each use and when empty. Do NOT change or force fit connections.
Prevent the intrusion of water into the gas tank.
Never attempt to lift cylinder by its cap.
Do not drag, slide or roll cylinders.
Use a suitable hand truck for cylinder movement.
Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
Take precautionary measures against static discharges.
Take care to prevent spills, waste and minimize release to the environment.

Hygiene measures : If exposure to chemical is likely during typical use, provide eye flushing systems and safety showers close to the working place. When using do not eat, drink or smoke. Wash contaminated clothing before re-use.

7.2 Conditions for safe storage, including any incompatibilities

Requirements for storage areas and containers : Cylinders should be stored upright and firmly secured to prevent falling or being knocked over. Separate full containers from empty containers. Do not store near combustible materials. Avoid area where salt or other corrosive materials are present. Keep in properly labelled containers. Keep tightly closed. Keep in a cool, well-ventilated place. Keep away from direct sunlight. Store in accordance with the particular national regulations. Keep away from heat and sources of ignition.

Advice on common storage : Do not store with the following product types:
Self-reactive substances and mixtures
Organic peroxides
Oxidizing agents
Flammable liquids
Flammable solids
Pyrophoric liquids
Pyrophoric solids
Self-heating substances and mixtures
Substances and mixtures, which in contact with water, emit flammable gases
Explosives
Very acutely toxic substances and mixtures
Acutely toxic substances and mixtures
Substances and mixtures with chronic toxicity

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Storage period : > 10 yr

Recommended storage temperature : < 52 °C

Further information on storage stability : The product has an indefinite shelf life when stored properly.

7.3 Specific end use(s)

Specific use(s) : No data available

SECTION 8: Exposure controls/personal protection

8.1 Control parameters

Contains no substances with occupational exposure limit values.

Derived No Effect Level (DNEL) according to Regulation (EC) No. 1907/2006:

Substance name	End Use	Exposure routes	Potential health effects	Value
2,3,3,3-Tetrafluoropropene	Workers	Inhalation	Long-term systemic effects	950 mg/m ³

Predicted No Effect Concentration (PNEC) according to Regulation (EC) No. 1907/2006:

Substance name	Environmental Compartment	Value
2,3,3,3-Tetrafluoropropene	Fresh water	0.1 mg/l
	Intermittent use/release	1 mg/l
	Fresh water sediment	1.51 mg/kg dry weight (d.w.)
	Soil	1.49 mg/kg dry weight (d.w.)
	Marine water	0.01 mg/l
	Marine sediment	0.151 mg/kg dry weight (d.w.)

8.2 Exposure controls

Engineering measures

Minimize workplace exposure concentrations.

If sufficient ventilation is unavailable, use with local exhaust ventilation.

If advised by assessment of the local exposure potential, use only in an area equipped with explosion-proof exhaust ventilation.

Personal protective equipment

Eye/face protection : Wear the following personal protective equipment:
Chemical resistant goggles must be worn.
Face-shield
Equipment should conform to I.S. EN 166

Hand protection
Material : Low temperature resistant gloves

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Remarks	: Choose gloves to protect hands against chemicals depending on the concentration and quantity of the hazardous substance and specific to place of work. For special applications, we recommend clarifying the resistance to chemicals of the aforementioned protective gloves with the glove manufacturer. Wash hands before breaks and at the end of workday. Breakthrough time is not determined for the product. Change gloves often!
Skin and body protection	: Wear the following personal protective equipment: If assessment demonstrates that there is a risk of explosive atmospheres or flash fires, use flame retardant antistatic protective clothing.
Respiratory protection	: If adequate local exhaust ventilation is not available or exposure assessment demonstrates exposures outside the recommended guidelines, use respiratory protection. Equipment should conform to I.S. EN 14387
Filter type	: Organic gas and low boiling vapour type (AX)
Protective measures	: Wear cold insulating gloves/ face shield/ eye protection.

SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties

Physical state	: Liquefied gas
Colour	: colourless, clear
Odour	: slight, ether-like
Odour Threshold	: No data available
Melting point/freezing point	: -152.2 °C
Initial boiling point and boiling range	: -29 °C
Flammability (solid, gas)	: Flammable
Upper explosion limit / Upper flammability limit	: Upper flammability limit 12.3 %(V) Method: ASTM E681
Lower explosion limit / Lower flammability limit	: Lower flammability limit 6.2 %(V) Method: ASTM E681

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Flash point	:	Not applicable
Auto-ignition temperature	:	405 °C
Decomposition temperature	:	No data available
pH	:	No data available
Viscosity		
Viscosity, kinematic	:	Not applicable
Solubility(ies)		
Water solubility	:	0.1982 g/l (24 °C)
Partition coefficient: n-octanol/water	:	log Pow: 2 (25 °C)
Vapour pressure	:	5,800 hPa (20 °C)
Density	:	0.0048 g/cm ³ (20 °C)
		Vapour density
Relative vapour density	:	4 (Air = 1.0)
Particle characteristics		
Particle size	:	Not applicable

9.2 Other information

Explosives	:	Not explosive
Oxidizing properties	:	The substance or mixture is not classified as oxidizing.
Flammable solids		
Burning rate	:	15 mm/s
Self-ignition	:	The substance or mixture is not classified as pyrophoric.
Evaporation rate	:	Not applicable
Minimum ignition energy	:	5 - 10 J

SECTION 10: Stability and reactivity

10.1 Reactivity

Not classified as a reactivity hazard.

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10.2 Chemical stability

Stable if used as directed. Follow precautionary advice and avoid incompatible materials and conditions.

10.3 Possibility of hazardous reactions

Hazardous reactions : Vapours may form flammable mixture with air
Can react with strong oxidizing agents.
Flammable gas.

10.4 Conditions to avoid

Conditions to avoid : Heat, flames and sparks.

10.5 Incompatible materials

Materials to avoid : Avoid impurities (e.g. rust, dust, ash), risk of decomposition.
Incompatible with acids and bases.
Incompatible with oxidizing agents.
Oxygen
Peroxides
peroxide compounds
Powdered metals

10.6 Hazardous decomposition products

No hazardous decomposition products are known.

SECTION 11: Toxicological information

11.1 Information on hazard classes as defined in Regulation (EC) No 1272/2008

Information on likely routes of exposure : Inhalation
Skin contact
Eye contact

Acute toxicity

Not classified based on available information.

Components:

2,3,3,3-Tetrafluoropropene:

Acute inhalation toxicity : LC50 (Rat): > 405800 ppm
Exposure time: 4 h
Test atmosphere: gas
Method: OECD Test Guideline 403

No observed adverse effect concentration (Dog): 120000 ppm
Test atmosphere: gas
Remarks: Cardiac sensitisation

Lowest observed adverse effect concentration (Dog): > 120000 ppm
Test atmosphere: gas
Remarks: Cardiac sensitisation

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Cardiac sensitisation threshold limit (Dog): > 559,509 mg/m³
Test atmosphere: gas
Remarks: Cardiac sensitisation

Skin corrosion/irritation

Not classified based on available information.

Components:

2,3,3,3-Tetrafluoropropene:

Result : No skin irritation

Serious eye damage/eye irritation

Not classified based on available information.

Components:

2,3,3,3-Tetrafluoropropene:

Result : No eye irritation

Respiratory or skin sensitisation

Skin sensitisation

Not classified based on available information.

Respiratory sensitisation

Not classified based on available information.

Components:

2,3,3,3-Tetrafluoropropene:

Exposure routes : Skin contact
Result : negative

Germ cell mutagenicity

Not classified based on available information.

Components:

2,3,3,3-Tetrafluoropropene:

Genotoxicity in vitro : Test Type: Bacterial reverse mutation assay (AMES)
Method: OECD Test Guideline 471
Result: positive

Test Type: Chromosome aberration test in vitro
Method: OECD Test Guideline 473
Result: negative

Genotoxicity in vivo : Test Type: Mammalian erythrocyte micronucleus test (in vivo
cytogenetic assay)
Species: Mouse
Application Route: inhalation (gas)

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Method: OECD Test Guideline 474
Result: negative

Test Type: In vivo mammalian alkaline comet assay
Species: Rat
Application Route: inhalation (gas)
Method: OECD Test Guideline 489
Result: negative

Test Type: Mammalian erythrocyte micronucleus test (in vivo
cytogenetic assay)
Species: Rat
Application Route: inhalation (gas)
Method: OECD Test Guideline 474
Result: negative

Germ cell mutagenicity- Assessment : Weight of evidence does not support classification as a germ cell mutagen.

Carcinogenicity

Not classified based on available information.

Components:

2,3,3,3-Tetrafluoropropene:

Result : negative

Carcinogenicity - Assessment : Weight of evidence does not support classification as a carcinogen

Reproductive toxicity

Not classified based on available information.

Components:

2,3,3,3-Tetrafluoropropene:

Effects on fertility : Test Type: Two-generation reproduction toxicity study
Species: Rat
Application Route: inhalation (gas)
Method: OECD Test Guideline 416
Result: negative

Effects on foetal development : Test Type: Prenatal development toxicity study (teratogenicity)
Species: Rat
Application Route: inhalation (gas)
Method: OECD Test Guideline 414
Result: negative

Reproductive toxicity - Assessment : Weight of evidence does not support classification for reproductive toxicity, No effects on or via lactation

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STOT - single exposure

Not classified based on available information.

Components:

2,3,3,3-Tetrafluoropropene:

Exposure routes	:	inhalation (gas)
Assessment	:	No significant health effects observed in animals at concentrations of 20000 ppmV/4h or less

STOT - repeated exposure

Not classified based on available information.

Components:

2,3,3,3-Tetrafluoropropene:

Exposure routes	:	inhalation (gas)
Assessment	:	No significant health effects observed in animals at concentrations of 250 ppmV/6h/d or less.

Repeated dose toxicity

Components:

2,3,3,3-Tetrafluoropropene:

Species	:	Rat, male and female
NOAEL	:	50000 ppm
LOAEL	:	>50000 ppm
Application Route	:	inhalation (gas)
Exposure time	:	13 Weeks
Method	:	OECD Test Guideline 413

Aspiration toxicity

Not classified based on available information.

Components:

2,3,3,3-Tetrafluoropropene:

No aspiration toxicity classification

11.2 Information on other hazards

Endocrine disrupting properties

Product:

Assessment	:	The substance/mixture does not contain components considered to have endocrine disrupting properties according to REACH Article 57(f) or Commission Delegated regulation (EU) 2017/2100 or Commission Regulation (EU) 2018/605 at levels of 0.1% or higher.
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SECTION 12: Ecological information

12.1 Toxicity

Components:

2,3,3,3-Tetrafluoropropene:

- Toxicity to fish : LC50 (Cyprinus carpio (Carp)): > 197 mg/l
Exposure time: 96 h
Method: OECD Test Guideline 203
- Toxicity to daphnia and other aquatic invertebrates : EC50 (Daphnia magna (Water flea)): > 100 mg/l
Exposure time: 48 h
Method: OECD Test Guideline 202
- Toxicity to algae/aquatic plants : EC50 (Selenastrum capricornutum (green algae)): > 100 mg/l
Exposure time: 72 h
Method: OECD Test Guideline 201
- NOEC (Selenastrum capricornutum (green algae)): > 75 mg/l
Exposure time: 3 d
Method: OECD Test Guideline 201

12.2 Persistence and degradability

Components:

2,3,3,3-Tetrafluoropropene:

- Biodegradability : Result: Not readily biodegradable.
Method: OECD Test Guideline 301F

12.3 Bioaccumulative potential

Components:

2,3,3,3-Tetrafluoropropene:

- Bioaccumulation : Remarks: Bioaccumulation is unlikely.
- Partition coefficient: n-octanol/water : log Pow: 2 (25 °C)

12.4 Mobility in soil

No data available

12.5 Results of PBT and vPvB assessment

Product:

- Assessment : This substance/mixture contains no components considered to be either persistent, bioaccumulative and toxic (PBT), or very persistent and very bioaccumulative (vPvB) at levels of 0.1% or higher.

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12.6 Endocrine disrupting properties

Product:

Assessment : The substance/mixture does not contain components considered to have endocrine disrupting properties according to REACH Article 57(f) or Commission Delegated regulation (EU) 2017/2100 or Commission Regulation (EU) 2018/605 at levels of 0.1% or higher.

12.7 Other adverse effects

Global warming potential

The Fifth Assessment Report of the United Nations Intergovernmental Panel on Climate Change (IPCC)

Product:

100-year global warming potential: < 1

SECTION 13: Disposal considerations

13.1 Waste treatment methods

Product : Dispose of in accordance with local regulations.
According to the European Waste Catalogue, Waste Codes are not product specific, but application specific.
Waste codes should be assigned by the user, preferably in discussion with the waste disposal authorities.

Contaminated packaging : Empty containers should be taken to an approved waste handling site for recycling or disposal.
Empty pressure vessels should be returned to the supplier.
Empty containers retain residue and can be dangerous.
Do not pressurize, cut, weld, braze, solder, drill, grind, or expose such containers to heat, flame, sparks, or other sources of ignition. They may explode and cause injury and/or death.
If not otherwise specified: Dispose of as unused product.

SECTION 14: Transport information

14.1 UN number or ID number

ADN	: UN 3161
ADR	: UN 3161
RID	: UN 3161
IMDG	: UN 3161
IATA (Cargo)	: UN 3161
IATA (Passenger)	: UN 3161

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Not permitted for transport

14.2 UN proper shipping name

ADN : LIQUEFIED GAS, FLAMMABLE, N.O.S.
(2,3,3,3-Tetrafluoropropene)

ADR : LIQUEFIED GAS, FLAMMABLE, N.O.S.
(2,3,3,3-Tetrafluoropropene)

RID : LIQUEFIED GAS, FLAMMABLE, N.O.S.
(2,3,3,3-Tetrafluoropropene)

IMDG : LIQUEFIED GAS, FLAMMABLE, N.O.S.
(2,3,3,3-Tetrafluoropropene)

IATA (Cargo) : Liquefied gas, flammable, n.o.s.
(2,3,3,3-Tetrafluoropropene)

IATA (Passenger) : Liquefied gas, flammable, n.o.s.
Not permitted for transport

14.3 Transport hazard class(es)

	Class	Subsidiary risks
ADN	: 2	2.1
ADR	: 2	2.1
RID	: 2	2.1, (13)
IMDG	: 2.1	
IATA (Cargo)	: 2.1	
IATA (Passenger)	: Not permitted for transport	

14.4 Packing group

ADN
Packing group : Not assigned by regulation
Classification Code : 2F
Hazard Identification Number : 23
Labels : 2.1

ADR
Packing group : Not assigned by regulation
Classification Code : 2F
Hazard Identification Number : 23
Labels : 2.1
Tunnel restriction code : (B/D)

RID
Packing group : Not assigned by regulation
Classification Code : 2F
Hazard Identification Number : 23
Labels : 2.1 ((13))

IMDG
Packing group : Not assigned by regulation

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Labels : 2.1
EmS Code : F-D, S-U

IATA (Cargo)

Packing instruction (cargo aircraft) : 200
Packing group : Not assigned by regulation
Labels : Flammable Gas

IATA (Passenger) : Not permitted for transport

14.5 Environmental hazards

ADN

Environmentally hazardous : no

ADR

Environmentally hazardous : no

RID

Environmentally hazardous : no

IMDG

Marine pollutant : no

14.6 Special precautions for user

The transport classification(s) provided herein are for informational purposes only, and solely based upon the properties of the unpackaged material as it is described within this Safety Data Sheet. Transportation classifications may vary by mode of transportation, package sizes, and variations in regional or country regulations.

14.7 Maritime transport in bulk according to IMO instruments

Remarks : Not applicable for product as supplied.

SECTION 15: Regulatory information

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

REACH - Restrictions on the manufacture, placing on the market and use of certain dangerous substances, mixtures and articles (Annex XVII) : Conditions of restriction for the following entries should be considered: Number on list 40

REACH - Candidate List of Substances of Very High Concern for Authorisation (Article 59). : Not applicable

Regulation (EC) No 1005/2009 on substances that deplete the ozone layer : Not applicable

Regulation (EU) 2019/1021 on persistent organic pollutants (recast) : Not applicable

Regulation (EC) No 649/2012 of the European Parliament and the Council concerning the export and import of dangerous chemicals : Not applicable

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REACH - List of substances subject to authorisation (Annex XIV) : Not applicable

Seveso III: Directive 2012/18/EU of the European Parliament and of the Council on the control of major-accident hazards involving dangerous substances.

P2	FLAMMABLE GASES	Quantity 1 10 t	Quantity 2 50 t
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Other regulations:

Take note of Directive 94/33/EC on the protection of young people at work or stricter national regulations, where applicable.

15.2 Chemical safety assessment

A Chemical Safety Assessment has been carried out for this substance.

SECTION 16: Other information

Other information : Opteon™ and any associated logos are trademarks or copyrights of The Chemours Company FC, LLC. Chemours™ and the Chemours Logo are trademarks of The Chemours Company. Before use read Chemours safety information. For further information contact the local Chemours office or nominated distributors.

Items where changes have been made to the previous version are highlighted in the body of this document by two vertical lines.

Full text of other abbreviations

ADN - European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways; ADR - Agreement concerning the International Carriage of Dangerous Goods by Road; AIIC - Australian Inventory of Industrial Chemicals; ASTM - American Society for the Testing of Materials; bw - Body weight; CLP - Classification Labelling Packaging Regulation; Regulation (EC) No 1272/2008; CMR - Carcinogen, Mutagen or Reproductive Toxicant; DIN - Standard of the German Institute for Standardisation; DSL - Domestic Substances List (Canada); ECHA - European Chemicals Agency; EC-Number - European Community number; ECx - Concentration associated with x% response; ELx - Loading rate associated with x% response; EmS - Emergency Schedule; ENCS - Existing and New Chemical Substances (Japan); ErCx - Concentration associated with x% growth rate response; GHS - Globally Harmonized System; GLP - Good Laboratory Practice; IARC - International Agency for Research on Cancer; IATA - International Air Transport Association; IBC - International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk; IC50 - Half maximal inhibitory concentration; ICAO - International Civil Aviation Organization; IECSC - Inventory of Existing Chemical Substances in China; IMDG - International Maritime Dangerous Goods; IMO - International Maritime Organization; ISHL - Industrial Safety and Health Law (Japan); ISO - International Organisation for Standardization; KECI - Korea Existing Chemicals Inventory; LC50 - Lethal Concentration to 50 % of a test population; LD50 - Lethal Dose to 50% of a test population (Median Lethal Dose); MARPOL - Interna-

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tional Convention for the Prevention of Pollution from Ships; n.o.s. - Not Otherwise Specified; NO(A)EC - No Observed (Adverse) Effect Concentration; NO(A)EL - No Observed (Adverse) Effect Level; NOELR - No Observable Effect Loading Rate; NZIoC - New Zealand Inventory of Chemicals; OECD - Organization for Economic Co-operation and Development; OPPTS - Office of Chemical Safety and Pollution Prevention; PBT - Persistent, Bioaccumulative and Toxic substance; PICCS - Philippines Inventory of Chemicals and Chemical Substances; (Q)SAR - (Quantitative) Structure Activity Relationship; REACH - Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals; RID - Regulations concerning the International Carriage of Dangerous Goods by Rail; SADT - Self-Accelerating Decomposition Temperature; SDS - Safety Data Sheet; SVHC - Substance of Very High Concern; TCSI - Taiwan Chemical Substance Inventory; TECI - Thailand Existing Chemicals Inventory; TRGS - Technical Rule for Hazardous Substances; TSCA - Toxic Substances Control Act (United States); UN - United Nations; vPvB - Very Persistent and Very Bioaccumulative

Further information

Sources of key data used to compile the Safety Data Sheet : Internal technical data, data from raw material SDSs, OECD eChem Portal search results and European Chemicals Agency, <http://echa.europa.eu/>

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The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and shall not be considered a warranty or quality specification of any type. The information provided relates only to the specific material identified at the top of this SDS and may not be valid when the SDS material is used in combination with any other materials or in any process, unless specified in the text. Material users should review the information and recommendations in the specific context of their intended manner of handling, use, processing and storage, including an assessment of the appropriateness of the SDS material in the user's end product, if applicable.

IE / EN

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Annex: Exposure Scenarios

Table of Contents

Number	Title
ES1	Industrial use; Formulation [mixing] of preparations and/ or re-packaging (excluding alloys).; Heat transfer fluids (PC16).
ES2	Industrial use; Filling of articles/equipment.; Heat transfer fluids (PC16).; General manufacturing, e.g. machinery, equipment, vehicles, other transport equipment (SU17).
ES3	professional use; Heat transfer fluids - Refrigerants, coolants.; Heat transfer fluids (PC16).; General manufacturing, e.g. machinery, equipment, vehicles, other transport equipment (SU17).
ES4	professional use; professional use.; Vehicles covered by End of Life Vehicles (ELV) directive (AC1a).; Other vehicles (AC1b).; Machinery, mechanical appliances, electrical/electronic articles (AC2).
ES5	Consumer use; Vehicles covered by End of Life Vehicles (ELV) directive (AC1a).; Other vehicles (AC1b).

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ES 1: Industrial use; Formulation [mixing] of preparations and/ or re-packaging (excluding alloys).; Heat transfer fluids (PC16).

1.1. Title section

Exposure Scenario name	: Industrial, Formulation & (re)packing of substances and mixtures
Structured Short Title	: Industrial use; Formulation [mixing] of preparations and/ or re-packaging (excluding alloys).; Heat transfer fluids (PC16).

Environment		
CS 1	Formulation [mixing] of preparations and/ or re-packaging (excluding alloys)	ERC2
Worker		
CS 2	Formulation	PROC3
CS 3	Material transfers	PROC8b
CS 4	Material transfers, Small scale	PROC9
CS 5	Laboratory activities	PROC15

1.2. Conditions of use affecting exposure

1.2.1. Control of environmental exposure: Formulation into mixture (ERC2)

Product (article) characteristics	
Covers concentrations up to 100 %	
Physical form of product	: Liquefied gas Low global warming potential. Not biodegradable
Amount used (or contained in articles), frequency and duration of use/exposure	
Annual amount per site	: 8300 tonnes/year
Daily amount per site	: 41.5 tonnes/day
Release type	: Intermittent release
Emission days	: 200
Technical and organisational conditions and measures	

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Process designed to minimize releases to wastewater. Process designed to minimize releases to soil. Ensure that the valves of the cylinders are tightly closed and not leaking. Handle substance within a closed system. Transfer via enclosed lines. Clear transfer lines prior to de-coupling.	
Conditions and measures related to sewage treatment plant	
STP type	: No sewage treatment plant
Conditions and measures related to treatment of waste (including article waste)	
Negligible air emissions as process operates in a contained system.	
Other conditions affecting environmental exposure	
Indoor or outdoor use	: Outdoor use

1.2.2. Control of worker exposure: Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition (PROC3)

Product (article) characteristics	
Covers concentrations up to 100 %	
Physical form of product	: Liquefied gas
Amount used (or contained in articles), frequency and duration of use/exposure	
Duration	: Covers exposure up to 15 min
Use frequency	: Intermittent release. 8 h/day
Technical and organisational conditions and measures	
Use in closed process Ensure that the valves of the cylinders are tightly closed and not leaking. Handle substance within a closed system. Transfer via enclosed lines. Clear transfer lines prior to de-coupling.	
Supervision in place to check that the risk management measures in place are being used correctly and operation conditions followed. Directive 1999/92/EC of the European Parliament and of the Council of 16 December 1999 on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres - ATEX 137. DIRECTIVE 2014/34/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres - ATEX 114.	

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Take note of Directive 98/24/EC on the protection of the health and safety of workers from the risks related to chemical agents at work.
EN 378: Refrigerating systems and heat pumps. Safety and environmental requirements.
Regular inspection and maintenance of equipment and machines
Ensure operatives are trained to minimise exposures.

Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour).

Conditions and measures related to personal protection, hygiene and health evaluation

Use eye protection to EN 166, designed to protect against liquid splashes.
or
ANSI Z87.1
Wear safety goggles.
Wear suitable face shield.
Use eye protection according to EN 166.

Low temperature resistant gloves

If assessment demonstrates that there is a risk of explosive atmospheres or flash fires, use flame retardant antistatic protective clothing.

Wear cold-insulating gloves/face shield/eye protection.

Other conditions affecting workers exposure

Indoor or outdoor use : Outdoor use

Temperature : < 40 °C

1.2.3. Control of worker exposure: Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)

Product (article) characteristics

Covers concentrations up to 100 %

Physical form of product : Liquefied gas

Amount used (or contained in articles), frequency and duration of use/exposure

Use frequency : 8 h/day

Technical and organisational conditions and measures

Supervision in place to check that the risk management measures in place are being used correctly and operation conditions followed.
Ensure operatives are trained to minimise exposures.

Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour).

Use in closed process
Ensure that the valves of the cylinders are tightly closed and not leaking.
Handle substance within a closed system.

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Transfer via enclosed lines. Clear transfer lines prior to de-coupling.	
Conditions and measures related to personal protection, hygiene and health evaluation	
Wear safety goggles. Wear suitable face shield. Use eye protection according to EN 166.	
Low temperature resistant gloves	
If assessment demonstrates that there is a risk of explosive atmospheres or flash fires, use flame retardant antistatic protective clothing.	
Wear cold-insulating gloves/face shield/eye protection.	
Other conditions affecting workers exposure	
Indoor or outdoor use	: Outdoor use
Temperature	: < 40 °C

1.2.4. Control of worker exposure: Transfer of substance or mixture into small containers (dedicated filling line, including weighing) (PROC9)

Product (article) characteristics	
Covers concentrations up to 100 %	
Physical form of product	: Liquefied gas
Amount used (or contained in articles), frequency and duration of use/exposure	
Use frequency	: 8 h/day
Technical and organisational conditions and measures	
Supervision in place to check that the risk management measures in place are being used correctly and operation conditions followed. Ensure operatives are trained to minimise exposures.	
Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour).	
Use in closed process Ensure that the valves of the cylinders are tightly closed and not leaking. Handle substance within a closed system. Transfer via enclosed lines. Clear transfer lines prior to de-coupling.	
Conditions and measures related to personal protection, hygiene and health evaluation	
Wear safety goggles. Wear suitable face shield.	

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Use eye protection according to EN 166.	
Low temperature resistant gloves	
If assessment demonstrates that there is a risk of explosive atmospheres or flash fires, use flame retardant antistatic protective clothing.	
Wear cold-insulating gloves/face shield/eye protection.	
Other conditions affecting workers exposure	
Indoor or outdoor use	: Outdoor use
Temperature	: < 40 °C

1.2.5. Control of worker exposure: Use as laboratory reagent (PROC15)

Product (article) characteristics	
Covers concentrations up to 100 %	
Physical form of product	: Liquefied gas
Amount used (or contained in articles), frequency and duration of use/exposure	
Amount per use	: 150 g/event
Use frequency	: 1 events per day
Use frequency	: 8 h/day
Technical and organisational conditions and measures	
Supervision in place to check that the risk management measures in place are being used correctly and operation conditions followed. Ensure operatives are trained to minimise exposures.	
Provide a basic standard of general ventilation (1 to 3 air changes per hour).	
Local exhaust ventilation Provide the operation with a properly sited receiving hood. Inhalation - minimum efficiency of 90 %	
Conditions and measures related to personal protection, hygiene and health evaluation	
Use eye protection according to EN 166.	
Other conditions affecting workers exposure	
Indoor or outdoor use	: Indoor use
Room size	: 50 m ³
Temperature	: < 40 °C

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Ventilation rate per hour : 3

1.3. Exposure estimation and reference to its source

1.3.1. Environmental release and exposure: Formulation into mixture (ERC2)

Release route	Release rate	Release estimation method
Water	0 kg/day	
Air	190 kg/day	
Soil	0 kg/day	
Waste	0 kg/day	

Protection Target	Exposure estimate	RCR
Freshwater	< 0.0000001 mg/L (EUSES v2.1)	< 0.01
Freshwater sediment	< 0.0000001 mg/kg dry weight (EUSES v2.1)	< 0.01
Marine water	< 0.0000001 mg/L (EUSES v2.1)	< 0.01
Marine sediment	< 0.0000001 mg/kg dry weight (EUSES v2.1)	< 0.01
Agricultural soil	0.04 mg/kg dry weight (EUSES v2.1)	0.027
Man via environment - Inhalation	0.029 mg/m ³ (EUSES v2.1)	< 0.01

Additional information on exposure estimation

The calculated exposure value is negligibly low.

1.3.2. Worker exposure: Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition (PROC3)

Exposure route	Health effect	Exposure indicator	Exposure estimate	RCR
inhalative	systemic	long-term	93.25 mg/m ³ (measured data)	0.098

1.3.3. Worker exposure: Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)

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Exposure route	Health effect	Exposure indicator	Exposure estimate	RCR
inhalative	systemic	long-term	93.25 mg/m ³ (measured data)	0.098

1.3.4. Worker exposure: Transfer of substance or mixture into small containers (dedicated filling line, including weighing) (PROC9)

Exposure route	Health effect	Exposure indicator	Exposure estimate	RCR
inhalative	systemic	long-term	93.25 mg/m ³ (measured data)	0.098

1.3.5. Worker exposure: Use as laboratory reagent (PROC15)

Exposure route	Health effect	Exposure indicator	Exposure estimate	RCR
inhalative	systemic	long-term	12 mg/m ³ (Consex-po v4.1)	0.013

1.4. Guidance to DU to evaluate whether he works inside the boundaries set by the ES

For further information, please contact sds-support@chemours.com.

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ES 2: Industrial use; Filling of articles/equipment.; Heat transfer fluids (PC16).; General manufacturing, e.g. machinery, equipment, vehicles, other transport equipment (SU17).

2.1. Title section

Exposure Scenario name	: Industrial, Filling of articles/equipment
Structured Short Title	: Industrial use; Filling of articles/equipment.; Heat transfer fluids (PC16).; General manufacturing, e.g. machinery, equipment, vehicles, other transport equipment (SU17).

Environment		
CS 1	Filling of equipment from drums or containers	ERC7
Worker		
CS 2	Material transfers	PROC8b
CS 3	Filling of articles/equipment	PROC9

2.2. Conditions of use affecting exposure

2.2.1. Control of environmental exposure: Use of functional fluid at industrial site (ERC7)

Product (article) characteristics	
Covers concentrations up to 100 %	
Physical form of product	: Liquefied gas
Amount used (or contained in articles), frequency and duration of use/exposure	
Annual amount per site	: 9000 tonnes/year
Daily amount per site	: 45 tonnes/day
Release type	: Intermittent release
Emission days	: 200
Technical and organisational conditions and measures	
Process designed to minimize releases to wastewater. Process designed to minimize releases to soil. Ensure that the valves of the cylinders are tightly closed and not leaking. Handle substance within a closed system. Transfer via enclosed lines.	

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Clear transfer lines prior to de-coupling.	
Regular inspection and maintenance of equipment and machines	
Conditions and measures related to sewage treatment plant	
STP type	: No sewage treatment plant
Conditions and measures related to treatment of waste (including article waste)	
Waste treatment	: No waste from process
Other conditions affecting environmental exposure	
Receiving surface water flow	: 18,000 m ³ /d
Indoor or outdoor use	: Indoor use

2.2.2. Control of worker exposure: Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)

Product (article) characteristics	
Covers concentrations up to 100 %	
Physical form of product	: Liquefied gas
Amount used (or contained in articles), frequency and duration of use/exposure	
Duration	: Covers exposure up to 15 min
Technical and organisational conditions and measures	
Supervision in place to check that the risk management measures in place are being used correctly and operation conditions followed. Directive 1999/92/EC of the European Parliament and of the Council of 16 December 1999 on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres - ATEX 137. DIRECTIVE 2014/34/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres - ATEX 114. Take note of Directive 98/24/EC on the protection of the health and safety of workers from the risks related to chemical agents at work. ISO 13043:2011 - Road vehicles - Refrigerant systems used in mobile air conditioning systems (MAC) - Safety requirements SAE J639 - Safety Standards for Motor Vehicle Refrigerant Vapor Compressions Systems SAE J2843 - R-1234yf [HFO-1234yf] Recovery/Recycling/Recharging Equipment for Flammable Refrigerants for Mobile Air-Conditioning Systems SAE J2845 - R-1234yf [HFO-1234yf] and R-744 Technician Training for Service and Containment of Refrigerants Used in Mobile A/C Systems Regular inspection and maintenance of equipment and machines	

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Ensure operatives are trained to minimise exposures.
Provide a good standard of controlled ventilation (5 to 10 air changes per hour).
Use in closed process Ensure that the valves of the cylinders are tightly closed and not leaking. Handle substance within a closed system. Transfer via enclosed lines. Clear transfer lines prior to de-coupling.
Conditions and measures related to personal protection, hygiene and health evaluation
Use eye protection to EN 166, designed to protect against liquid splashes. or ANSI Z87.1
Wear safety goggles. Wear suitable face shield. Use eye protection according to EN 166.
Low temperature resistant gloves
If assessment demonstrates that there is a risk of explosive atmospheres or flash fires, use flame retardant antistatic protective clothing.
Wear cold-insulating gloves/face shield/eye protection.
Other conditions affecting workers exposure
Indoor or outdoor use : Indoor use
Temperature : < 40 °C

2.2.3. Control of worker exposure: Transfer of substance or mixture into small containers (dedicated filling line, including weighing) (PROC9)

Product (article) characteristics
Covers concentrations up to 100 %
Physical form of product : Liquefied gas
Amount used (or contained in articles), frequency and duration of use/exposure
Duration : Under normal operation exposure occurs only at ending of filling process (disconnection), estimated at 0.083 min (5 sec) per disconnecting process*1 processes/fill*30 fills/hr*8 hr/shift.
Use frequency : Intermittent release. 0.33 h/day
Technical and organisational conditions and measures
Supervision in place to check that the risk management measures in place are being used correctly and operation conditions followed.

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Ensure operatives are trained to minimise exposures.
Provide a basic standard of general ventilation (1 to 3 air changes per hour).
Use in closed process Ensure that the valves of the cylinders are tightly closed and not leaking. Handle substance within a closed system. Transfer via enclosed lines. Clear transfer lines prior to de-coupling.
Conditions and measures related to personal protection, hygiene and health evaluation
Use eye protection to EN 166, designed to protect against liquid splashes. or ANSI Z87.1
Wear safety goggles. Wear suitable face shield. Use eye protection according to EN 166.
Low temperature resistant gloves
If assessment demonstrates that there is a risk of explosive atmospheres or flash fires, use flame retardant antistatic protective clothing.
Wear cold-insulating gloves/face shield/eye protection.
Other conditions affecting workers exposure
Indoor or outdoor use : Indoor use
Temperature : < 40 °C

2.3. Exposure estimation and reference to its source

2.3.1. Environmental release and exposure: Use of functional fluid at industrial site (ERC7)

Release route	Release rate	Release estimation method
Water	0 kg/day	
Air	135 kg/day	
Soil	0 kg/day	

Protection Target	Exposure estimate	RCR
Freshwater	< 0.0000001 mg/L (EUSES v2.1)	< 0.01
Freshwater sediment	< 0.0000001 mg/kg dry weight (EUSES v2.1)	< 0.01
Marine water	< 0.0000001 mg/L (EUSES v2.1)	< 0.01

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Marine sediment	< 0.0000001 mg/kg dry weight (EUSES v2.1)	< 0.01
Agricultural soil	0.043 mg/kg dry weight (EUSES v2.1)	0.029
Man via environment - Inhalation	0.031 mg/m ³ (EUSES v2.1)	< 0.01

Additional information on exposure estimation

The calculated exposure value is negligibly low.

2.3.2. Worker exposure: Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)

Exposure route	Health effect	Exposure indicator	Exposure estimate	RCR
inhalative	systemic	long-term	37 mg/m ³ (measured data)	0.039

2.3.3. Worker exposure: Transfer of substance or mixture into small containers (dedicated filling line, including weighing) (PROC9)

Exposure route	Health effect	Exposure indicator	Exposure estimate	RCR
inhalative	systemic	long-term	37 mg/m ³ (measured data)	0.039

2.4. Guidance to DU to evaluate whether he works inside the boundaries set by the ES

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ES 3: professional use; Heat transfer fluids - Refrigerants, coolants.; Heat transfer fluids (PC16).; General manufacturing, e.g. machinery, equipment, vehicles, other transport equipment (SU17).

3.1. Title section

Exposure Scenario name	: Professional, Heat transfer fluids - Refrigerants, coolants
Structured Short Title	: professional use; Heat transfer fluids - Refrigerants, coolants.; Heat transfer fluids (PC16).; General manufacturing, e.g. machinery, equipment, vehicles, other transport equipment (SU17).

Environment		
CS 1	Filling of equipment from drums or containers	ERC9b
Worker		
CS 2	Material transfers	PROC8b

3.2. Conditions of use affecting exposure

3.2.1. Control of environmental exposure: Widespread use of functional fluid (outdoor) (ERC9b)

Product (article) characteristics	
Covers concentrations up to 100 %	
Physical form of product	: Liquefied gas
Amount used (or contained in articles), frequency and duration of use/exposure	
Daily amount for wide dispersive uses	: 0.000548 tonnes/day
Fraction of EU tonnage used in region	: 0.1
Fraction of Regional tonnage used locally	: 0.0005
Emission days	: 365
Technical and organisational conditions and measures	
Process designed to minimize releases to wastewater. Process designed to minimize releases to soil.	

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Ensure that the valves of the cylinders are tightly closed and not leaking. Handle substance within a closed system. Transfer via enclosed lines. Clear transfer lines prior to de-coupling.	
Release fraction to air from process (initial release after RMM) 5 % No water contact during use.	
Conditions and measures related to sewage treatment plant	
STP type	: Municipal Sewage Treatment Plant
Conditions and measures related to treatment of waste (including article waste)	
Waste treatment	: No waste from process

3.2.2. Control of worker exposure: Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)

Product (article) characteristics	
Covers concentrations up to 100 %	
Physical form of product	: Liquefied gas
Amount used (or contained in articles), frequency and duration of use/exposure	
Use frequency	: 8 h/day
Duration	: Mobile A/C: ~1 minute/ 8-hour shift (0.083 minutes (5 seconds) per connecting process *2 connecting processes per vacuuming/re-charging procedure *1 servicing event per hour *8 hours per shift)
Duration	: Stationary Equipment: ~< 1 minute/8-hour shift (0.083 minutes (5 seconds) per connecting process *2 connecting processes per vacuuming/ re-charging procedure *up to 4 servicing events per 8-hour shift)
Technical and organisational conditions and measures	
Directive 1999/92/EC of the European Parliament and of the Council of 16 December 1999 on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres - ATEX 137. DIRECTIVE 2014/34/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres - ATEX 114. Take note of Directive 98/24/EC on the protection of the health and safety of workers from the risks related to chemical agents at work. ISO 13043:2011 - Road vehicles - Refrigerant systems used in mobile air conditioning systems (MAC) - Safety requirements SAE J639 - Safety Standards for Motor Vehicle Refrigerant Vapor Compressions Systems	

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SAE J2843 - R-1234yf [HFO-1234yf] Recovery/Recycling/Recharging Equipment for Flammable Refrigerants for Mobile Air-Conditioning Systems SAE J2845 - R-1234yf [HFO-1234yf] and R-744 Technician Training for Service and Containment of Refrigerants Used in Mobile A/C Systems EN 378: Refrigerating systems and heat pumps. Safety and environmental requirements. Regular inspection and maintenance of equipment and machines Ensure operatives are trained to minimise exposures.	
Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour).	
Use in closed process Ensure that the valves of the cylinders are tightly closed and not leaking. Handle substance within a closed system. Transfer via enclosed lines. Clear transfer lines prior to de-coupling.	
Conditions and measures related to personal protection, hygiene and health evaluation	
Use eye protection to EN 166, designed to protect against liquid splashes. or ANSI Z87.1	
Wear suitable gloves tested to EN374. or US OSHA guidelines Dermal - minimum efficiency of 80 %	
Other conditions affecting workers exposure	
Indoor or outdoor use	: Indoor use
Temperature	: < 40 °C

3.3. Exposure estimation and reference to its source

3.3.1. Environmental release and exposure: Widespread use of functional fluid (outdoor) (ERC9b)

Protection Target	Exposure estimate	RCR
Freshwater	< 0.0000001 mg/L (EUSES v2.1)	< 0.01
Freshwater sediment	< 0.0000001 mg/kg dry weight (EUSES v2.1)	< 0.01
Marine water	< 0.0000001 mg/L (EUSES v2.1)	< 0.01
Marine sediment	< 0.0000001 mg/kg dry weight (EUSES v2.1)	< 0.01
Agricultural soil	< 0.0000001 mg/kg dry weight (EUSES v2.1)	< 0.01

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Man via environment - Inhalation	0.0000233 mg/m ³ (EUSES v2.1)	< 0.01
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Additional information on exposure estimation

The calculated exposure value is negligibly low.

3.3.2. Worker exposure: Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)

Exposure route	Health effect	Exposure indicator	Exposure estimate	RCR
inhalative	systemic	long-term	85.6 mg/m ³ (measured data)	0.09

3.4. Guidance to DU to evaluate whether he works inside the boundaries set by the ES

For further information, please contact sds-support@chemours.com.

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ES 4: professional use; professional use.; Vehicles covered by End of Life Vehicles (ELV) directive (AC1a).; Other vehicles (AC1b).; Machinery, mechanical appliances, electrical/electronic articles (AC2).

4.1. Title section

Exposure Scenario name	: Professional, Article service life
Structured Short Title	: professional use; professional use.; Vehicles covered by End of Life Vehicles (ELV) directive (AC1a).; Other vehicles (AC1b).; Machinery, mechanical appliances, electrical/electronic articles (AC2).

Environment		
CS 1	Article service life	ERC10a
Worker		
CS 2	Train drivers	PROC0
CS 3	Bus drivers	PROC0
CS 4	Professional truck driver	PROC0
CS 5	Professional Heavy Duty Off-Road Vehicle driver	PROC0

4.2. Conditions of use affecting exposure

4.2.1. Control of environmental exposure: Widespread use of articles with low release (outdoor) (ERC10a)

Product (article) characteristics	
Covers concentrations up to 100 %	
Physical form of product	: Liquefied gas
Amount used (or contained in articles), frequency and duration of use/exposure	
Daily amount for wide dispersive uses	: < 0.000038 tonnes/day
Fraction of EU tonnage used in region	: 0.001
Technical and organisational conditions and measures	
Release fraction to air from process (initial release after RMM) 100 %	

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Worst case assumption	
Conditions and measures related to treatment of waste (including article waste)	
Waste treatment	: No waste from process

4.2.2. Control of worker exposure: Other (PROC0)

Product (article) characteristics	
Covers concentrations up to 100 %	
Physical form of product	: Liquefied gas
Amount used (or contained in articles), frequency and duration of use/exposure	
Release rate to cabin:	: 2 g/year
Use frequency	: 12 h/day
Use frequency	: 250 days per year
Technical and organisational conditions and measures	
Provide a good standard of controlled ventilation (5 to 10 air changes per hour).	
Other conditions affecting workers exposure	
Indoor or outdoor use	: Indoor use
Room size	: 5 m ³
Temperature	: < 40 °C
Ventilation rate per hour	: 6

4.2.3. Control of worker exposure: Other (PROC0)

Product (article) characteristics	
Covers concentrations up to 100 %	
Physical form of product	: Liquefied gas
Amount used (or contained in articles), frequency and duration of use/exposure	
Use frequency	: 8 h/day
Other conditions affecting workers exposure	

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Indoor or outdoor use	: Indoor use
Room size	: 50 m ³
Temperature	: < 40 °C

4.2.4. Control of worker exposure: Other (PROC0)

Product (article) characteristics	
Covers concentrations up to 100 %	
Physical form of product	: Liquefied gas
Amount used (or contained in articles), frequency and duration of use/exposure	
Use frequency	: 20 h/day
Technical and organisational conditions and measures	
Provide a basic standard of general ventilation (1 to 3 air changes per hour).	
Other conditions affecting workers exposure	
Indoor or outdoor use	: Indoor use
Room size	: 3.3 m ³
Temperature	: < 40 °C
Ventilation rate per hour	: 4

4.2.5. Control of worker exposure: Other (PROC0)

Product (article) characteristics	
Covers concentrations up to 100 %	
Physical form of product	: Liquefied gas
Amount used (or contained in articles), frequency and duration of use/exposure	
Use frequency	: 8 h/day
Technical and organisational conditions and measures	
Provide a good standard of controlled ventilation (5 to 10 air changes per hour).	
Other conditions affecting workers exposure	

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Indoor or outdoor use	: Indoor use
Room size	: 1.6 m ³
Temperature	: < 40 °C
Ventilation rate per hour	: 10

4.3. Exposure estimation and reference to its source

4.3.1. Environmental release and exposure: Widespread use of articles with low release (outdoor) (ERC10a)

Protection Target	Exposure estimate	RCR
Freshwater	< 0.0000001 mg/L (EUSES v2.1)	< 0.01
Freshwater sediment	< 0.0000001 mg/kg dry weight (EUSES v2.1)	< 0.01
Marine water	< 0.0000001 mg/L (EUSES v2.1)	< 0.01
Marine sediment	< 0.0000001 mg/kg dry weight (EUSES v2.1)	< 0.01
Agricultural soil	< 0.0000001 mg/kg dry weight (EUSES v2.1)	< 0.01
Man via environment - Inhalation	0.0000233 mg/m ³ (EUSES v2.1)	< 0.01

Additional information on exposure estimation
The calculated exposure value is negligibly low.

4.3.2. Worker exposure: Other (PROC0)

Exposure route	Health effect	Exposure indicator	Exposure estimate	RCR
inhalative	systemic	long-term	0.011 mg/m ³ (Consexpo v4.1)	< 0.01

4.3.3. Worker exposure: Other (PROC0)

Exposure route	Health effect	Exposure indicator	Exposure estimate	RCR
inhalative	systemic	long-term	0.086 mg/m ³ (Consexpo v4.1)	< 0.01

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4.3.4. Worker exposure: Other (PROC0)

Exposure route	Health effect	Exposure indicator	Exposure estimate	RCR
inhalative	systemic	long-term	0.096 mg/m ³ (Consexpo v4.1)	< 0.01

4.3.5. Worker exposure: Other (PROC0)

Exposure route	Health effect	Exposure indicator	Exposure estimate	RCR
inhalative	systemic	long-term	0.21 mg/m ³ (Consexpo v4.1)	< 0.01

4.4. Guidance to DU to evaluate whether he works inside the boundaries set by the ES

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ES 5: Consumer use; Vehicles covered by End of Life Vehicles (ELV) directive (AC1a).; Other vehicles (AC1b).

5.1. Title section

Exposure Scenario name	: Consumer, Article service life
Structured Short Title	: Consumer use; Vehicles covered by End of Life Vehicles (ELV) directive (AC1a).; Other vehicles (AC1b).

Environment		
CS 1	Article service life	ERC10a
Consumer		
CS 2	Train passengers	AC1b
CS 3	Car drivers and passengers	AC1b
CS 4	Bus passengers	AC1b

5.2. Conditions of use affecting exposure

5.2.1. Control of environmental exposure: Widespread use of articles with low release (outdoor) (ERC10a)

Product (article) characteristics	
Covers concentrations up to 100 %	
Physical form of product	: Liquefied gas
Conditions and measures related to treatment of waste (including article waste)	
Waste treatment	: No waste from process

5.2.2. Control of consumer exposure: Other vehicles (AC1b)

Product (article) characteristics	
Covers concentrations up to 100 %	
Physical form of product	: Liquefied gas
Amount used (or contained in articles), frequency and duration of use/exposure	

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Amounts used	:	0.03 g/event
Duration	:	12 h
Other conditions affecting consumers exposure		
Indoor or outdoor use	:	Indoor use
Room size	:	50 m ³
Ventilation rate	:	6

5.2.3. Control of consumer exposure: Other vehicles (AC1b)

Product (article) characteristics		
Covers concentrations up to 100 %		
Physical form of product	:	Liquefied gas
Amount used (or contained in articles), frequency and duration of use/exposure		
Amounts used	:	0.006 g/event
Duration	:	4 h
Other conditions affecting consumers exposure		
Indoor or outdoor use	:	Indoor use
Room size	:	1.25 m ³
Ventilation rate	:	1

5.2.4. Control of consumer exposure: Other vehicles (AC1b)

Product (article) characteristics		
Covers concentrations up to 100 %		
Physical form of product	:	Liquefied gas
Amount used (or contained in articles), frequency and duration of use/exposure		
Amounts used	:	1.04 g/event
Duration	:	8 h
Other conditions affecting consumers exposure		
Indoor or outdoor use	:	Indoor use

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Room size	: 50 m ³
Ventilation rate	: 30

5.3. Exposure estimation and reference to its source

Release estimation method:

5.3.2. Consumer exposure: Other vehicles (AC1b)

Exposure route	Health effect	Exposure indicator	Exposure estimate	RCR
inhalative	systemic	long-term	0.0082 mg/m ³ (ConsExpo)	< 0.01

5.3.3. Consumer exposure: Other vehicles (AC1b)

Exposure route	Health effect	Exposure indicator	Exposure estimate	RCR
inhalative	systemic	long-term	0.91 mg/m ³ (ConsExpo)	< 0.01

5.3.4. Consumer exposure: Other vehicles (AC1b)

Exposure route	Health effect	Exposure indicator	Exposure estimate	RCR
inhalative	systemic	long-term	0.086 mg/m ³ (ConsExpo)	< 0.01

5.4. Guidance to DU to evaluate whether he works inside the boundaries set by the ES

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