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Scheda di dati di sicurezza ai sensi del regolamento (CE) n. 1907/2006, allegato II  
Data della revisione / Versione: 07.03.2017 / 0004  
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Agente frigorifero R1234yf  
8887100019/8887100016

## Scheda di dati di sicurezza ai sensi del regolamento (CE) n. 1907/2006, allegato II

### SEZIONE 1: identificazione della sostanza/miscela e della società/impresa

#### 1.1 Identificatore del prodotto

##### **Agente frigorifero R1234yf 8887100019/8887100016**

2,3,3,3-Tetrafluoropropene  
Numero di registrazione (ECHA): 01-0000019665-61-XXXX  
Index: ---  
EINECS, ELINCS, NLP: 468-710-7  
CAS: 754-12-1

#### 1.2 Usi identificati pertinenti della sostanza o della miscela e usi sconsigliati

##### **Usi pertinenti identificati della sostanza o miscela:**

Agente refrigerante

##### **Usi sconsigliati:**

Al momento non sono presenti informazioni.

#### 1.3 Informazioni sul fornitore della scheda di dati di sicurezza

Dometic WAECO International GmbH, Hollefeldstr. 63, 48282 Emsdetten, Germania  
Telefono:+49 (0) 2572 879 0, Telefax:+49 (0) 2572 879 300

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Dometic Switzerland AG, Riedackerstrasse 7a, 8153 Rümlang, Svizzera  
Telefono:+41 448187171, Telefax:+41 44 8187191  
www.waeco.de

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Dometic Italy S.p.A. Sede Commerciale di Torino, Strada Carignano 48/bis, 10024 MONCALIERI (TO), Italia  
Telefono:+39.011.645045, Telefax:+39.011.645047  
www.waeco.de

Indirizzo e-mail del perito esperto: info@chemical-check.de, k.schnurbusch@chemical-check.de - Si prega di NON usare questo indirizzo per richiedere le schede tecniche sulla sicurezza.

#### 1.4 Numero telefonico di emergenza

##### **Servizio informazioni di emergenza / ufficio pubblico di consulenza:**

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Centro Antiveleni di Milano - Azienda Ospedaliera Niguarda Ca' Granda - Piazza Ospedale Maggiore 3, I-20162 Milano. In caso di intossicazione chiamare 24 ore su 24, 365 giorni il: +39 02 - 66 10 10 29  
Centro Antiveleni di Pavia - Centro Nazionale per l'Informazione Tossicologica (C.N.I.T) - IRCCS Fondazione Maugeri - via Salvatore Maugeri 10, I-27100 Pavia. IL NUMERO ATTIVO PER LE EMERGENZE: +39 0382-24444  
Centro Antiveleni di Bergamo - Azienda Ospedaliera Ospedaliera Papa Giovanni XXIII, I-24128 Bergamo - Servizio attivo 24 ore su 24 - Telefono:  
Per chi chiama da Bergamo e provincia: 118  
Per chi chiama da fuori provincia: 800.883300  
Centro Antiveleni di Firenze - Azienda Ospedaliero Universitaria Careggi, Firenze - Servizio di consulenza telefonica ad accesso diretto nelle 24 ore su ogni sospetto di intossicazione - Telefono: +39 055 - 794 7819  
Centro Antiveleni di Roma, Policlinico A. Gemelli - Università Cattolica del Sacro Cuore, Dipartimento di Tossicologia Clinica - Largo Agostino Gemelli 8, I-00168 Roma. Telefono: +39 06-3054343 (disponibilità 24 ore)  
Centro Antiveleni di Roma, Policlinico Umberto I - Università di Roma, Dipartimento di Scienze Anestesiologiche, Medicina Critica e Terapia del Dolore - Viale del Policlinico 155, I-00161 Roma. Telefono: +39 06 - 49978000 (disponibilità 24 ore)  
Centro Antiveleni di Napoli - Azienda Ospedaliera di Rilievo Nazionale A.Cardarelli - Via Cardarelli 9, I-80131 Napoli. Telefono: +39 081-5453333 oppure +39 081-7472870 (disponibilità 24 ore)

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Centro Antiveleni di Foggia - Azienda Ospedaliero Universitaria di Foggia - Viale Pinto 1, Plesso Maternità - Piano Terra - 71121

Foggia. Telefono: +39 0881/732326 (Attivo H/24 su 365 giorni)

Centro Antiveleni pediatrico di Roma, Ospedale Pediatrico Bambino Gesù, Dipartimento Emergenza e Accettazione (DEA) - Piazza Sant'Onofrio 4, I-00165 Roma. Telefono: +39 06 - 68593726 (24 ore su 24)

CH

Tox Info Suisse, Freiestrasse 16, CH-8032 Zurigo. Telefono di emergenza nazionale (24 ore): 145 (dall'estero: +41 44 251 51 51)

**No. di telefono di emergenza della società:**

+49 (0) 700 / 24 112 112 (CCWA)

## SEZIONE 2: identificazione dei pericoli

### 2.1 Classificazione della sostanza o della miscela

**Classificazione secondo Regolamento (CE) 1272/2008 (CLP)**

Classe di pericolo	Categoria di pericolo	Indicazione di pericolo
Flam. Gas	1	H220-Gas altamente infiammabile.
Press. Gas	(Liq.)	H280-Contiene gas sotto pressione, può esplodere se riscaldato.

### 2.2 Elementi dell'etichetta

**Etichettatura secondo Regolamento (CE) 1272/2008 (CLP)**



2,3,3,3-Tetrafluoropropene

CAS: 754-12-1, Index:--- EC: 468-710-7

Pericolo

H220-Gas altamente infiammabile. H280-Contiene gas sotto pressione, può esplodere se riscaldato.

P210-Tenere lontano da fonti di calore, superfici calde, scintille, fiamme libere o altre fonti di accensione. Non fumare. P281-Utilizzare il dispositivo di protezione individuale richiesto.

P377-In caso d'incendio dovuto a perdita di gas, non estinguere a meno che non sia possibile bloccare la perdita senza pericolo.

P381-In caso di perdita, eliminare ogni fonte di accensione.

P410+P403-Proteggere dai raggi solari. Conservare in luogo ben ventilato.

### 2.3 Altri pericoli

Nessuna sostanza vPvB

Nessuna sostanza PBT

Spruzzi di liquido o nuvola di polverizzazione possono causare congelamenti.

Rischio di scoppio in caso di riscaldamento

## SEZIONE 3: composizione/informazioni sugli ingredienti

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### 3.1 Sostanza

<b>2,3,3,3-Tetrafluoropropene</b>	
<b>Numero di registrazione (REACH)</b>	01-0000019665-61-XXXX
<b>Index</b>	---
<b>EINECS, ELINCS, NLP</b>	468-710-7
<b>CAS</b>	754-12-1
<b>Conc. %</b>	
<b>Classificazione secondo Regolamento (CE) 1272/2008 (CLP)</b>	Flam. Gas 1, H220 Press. Gas (Liq.), H280

### 3.2 Miscela

n.a.

Testo delle frasi H e le sigle di classificazione (GHS/CLP) vedi sezione 16.

Le sostanze contenute in questa sezione vengono denominate in base alla vostra effettiva classificazione corrispondente!

Questo vuol dire che in presenza di sostanze elencate all'allegato VI tabella 3.1 del regolamento (CE) n. 1272/2008 (regolamento CLP), sono state prese in considerazione tutte le note eventualmente citate per la classificazione in questione.

## SEZIONE 4: misure di primo soccorso

### 4.1 Descrizione delle misure di primo soccorso

I primi soccorritori dovranno prestare attenzione alla tutela personale!

Mai far ingurgitare qualcosa ad una persona svenuta!

#### Inalazione

Allontanare la persona dall'area di pericolo.

Far respirare aria fresca alla persona, consultare subito un medico.

In caso di perdita della coscienza mettere su un fianco in posizione ferma e consultare un medico.

Arresto respiratorio - necessaria respirazione artificiale tramite apparecchio.

#### Contatto con la pelle

Lavare accuratamente con molta acqua, allontanare immediatamente gli abiti inquinati, in caso di irritazione della pelle (arrossamento, ecc.) consultare il medico.

Coprire in modo antisettico i congelamenti.

#### Contatto con gli occhi

Togliere le lenti a contatto.

Sciacquare accuratamente ed abbondantemente con acqua per parecchi minuti, chiamare subito il medico - fornire scheda dati.

#### Ingestione

Abitualmente non ci sono vie di assorbimento.

### 4.2 Principali sintomi ed effetti, sia acuti che ritardati

Se pertinenti alla sezione 11. ovvero per quanto riguarda le vie di somministrazione descritte alla sezione 4.1. possono verificarsi sintomi ed effetti ad azione ritardata.

In casi specifici può accadere che i sintomi di avvelenamento si verifichino soltanto dopo un periodo di tempo più lungo/dopo diverse ore.

stordimento

Mal di testa

intossicazione

Per concentrazioni elevate:

Effetto di soffocamento.

La vittima non nota il soffocamento.

### 4.3 Indicazione dell'eventuale necessità di consultare immediatamente un medico e di trattamenti speciali

Trattamento sintomatico.

Non somministrare preparati contenenti adrenalina/efedrina.

## SEZIONE 5: misure antincendio

### 5.1 Mezzi di estinzione

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### **Mezzi di estinzione idonei**

Getto d'acqua a spruzzo/schiuma resistente all'alcool/CO2/estintore a secco

### **Mezzi di estinzione non idonei**

Getto d'acqua pieno

### **5.2 Pericoli speciali derivanti dalla sostanza o dalla miscela**

In caso di incendio possono formarsi:

Acido fluoridrico

Ossidi di carbonio

Gas tossici

Rischio di scoppio in caso di riscaldamento

### **5.3 Raccomandazioni per gli addetti all'estinzione degli incendi**

In caso di incendio e/o esplosione non respirare i fumi.

È necessario un apparecchio respiratorio indipendentemente dalla ventilazione.

Protezione totale

Raffreddare i recipienti in pericolo con acqua.

Smaltire l'acqua contaminata usata per spegnere incendi conformemente alla normativa vigente.

## **SEZIONE 6: misure in caso di rilascio accidentale**

### **6.1 Precauzioni personali, dispositivi di protezione e procedure in caso di emergenza**

Tenere lontano il personale non necessario.

Allontanare i focolai, non fumare.

Aerare abbondantemente.

Evitare il contatto con occhi e pelle e l'inalazione.

### **6.2 Precauzioni ambientali**

Evitare l'infiltrazione nelle acque di superficie, nelle falde freatiche e nel terreno.

Evitare che penetri nella canalizzazione, in cantina, in fosse per lavori in corso o altri luoghi in cui l'accumulo può essere pericoloso.

Informare le autorità competenti in caso di fortuita infiltrazione nella rete fognaria.

### **6.3 Metodi e materiali per il contenimento e per la bonifica**

In caso di fuga di aerosol/gas, ventilare abbondantemente.

Lasciar evaporare.

### **6.4 Riferimenti ad altre sezioni**

Attrezzatura protettiva personale vedi sezione 8 ed anche le indicazioni relative allo smaltimento sezione 13.

## **SEZIONE 7: manipolazione e immagazzinamento**

Oltre alle informazioni fornite in tale sezione, altre informazioni pertinenti si possono trovare nella sezione 8 e 6.1.

### **7.1 Precauzioni per la manipolazione sicura**

#### **7.1.1 Consigli generali**

Procurare una buona ventilazione locale.

Ventilazione dell'ambiente anche in prossimità del suolo.

Non inalare i vapori.

Evitare il contatto con occhi e pelle.

Allontanare i focolai - Non fumare.

Prendere misure contro l'accumulo di cariche elettrostatiche.

Utilizzare apparecchi protetti dalle esplosioni.

Non usare su superfici molto calde.

È vietato mangiare, bere, fumare e conservare generi alimentari nel locale di lavoro.

Osservare le indicazioni sull'etichetta e le istruzioni per l'uso.

Per la lavorazione seguire le istruzioni per l'uso.

#### **7.1.2 Indicazioni sulle generali norme igieniche sul posto di lavoro**

Seguire le norme igieniche generali relative ai prodotti chimici.

Prima delle pause e al termine del lavoro lavare le mani.

Conservare lontano da alimenti o mangimi e da bevande.

Prima di accedere alle aree in cui si mangia, togliersi l'abbigliamento contaminato e le apparecchiature di protezione.

### **7.2 Condizioni per lo stoccaggio sicuro, comprese eventuali incompatibilità**

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Conservare in un luogo non accessibile a persone non autorizzate.

Immagazzinare il prodotto solo in imballaggi originali e chiusi.

Non immagazzinare il prodotto in corridoi e scale.

Non immagazzinare insieme a sostanze comburenti o autoinfiammabili.

Proteggere dai raggi del sole e da temperature superiori a 50° C.

Immagazzinare al fresco.

Immagazzinare in luogo ben ventilato.

Rispettare regolamenti speciale per gas.

### 7.3 Usi finali particolari

Al momento non sono presenti informazioni.

## SEZIONE 8: controllo dell'esposizione/protezione individuale

### 8.1 Parametri di controllo

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### 8.2 Controlli dell'esposizione

#### 8.2.1 Controlli tecnici idonei

Assicurare una buona ventilazione. Ciò si può ottenere anche con l'aspirazione locale o con lo scarico generico dell'aria viziata.

Se non basta a tenere la concentrazione sotto i valori TLV / AGW, portare una protezione adatta per le vie respiratorie.

Vale soltanto, se qui vengono riportati dei valori d'esposizione.

#### 8.2.2 Misure di protezione individuale, quali dispositivi di protezione individuale

Seguire le norme igieniche generali relative ai prodotti chimici.

Prima delle pause e al termine del lavoro lavare le mani.

Conservare lontano da alimenti o mangimi e da bevande.

Prima di accedere alle aree in cui si mangia, togliersi l'abbigliamento contaminato e le apparecchiature di protezione.

Protezione degli occhi/del volto:

Occhiali di protezione ermetici con protezione laterale (EN 166).

Protezione della pelle - Protezione delle mani:

Guanti di pelle

Eventualmente

Guanti isolanti EN 511 (freddo)

I tempi di traforo accertati secondo EN 374 Parte 3 non sono stati effettuati alle condizioni pratiche.

Si raccomanda un periodo massimo di gestazione che corrisponde al 50% del periodo di traforo.

Protezione della pelle - Altro:

Abbigliamento di protezione (p.es. scarpe di sicurezza EN ISO 20345, abito da lavoro protettivo con maniche lunghe).

Protezione respiratoria:

In caso di aerazione insufficiente indossare un respiratore.

È necessario un apparecchio respiratorio indipendentemente dalla ventilazione.

Osservare i limiti d'impiego dei respiratori.

Pericoli termici:

Se pertinenti, queste saranno riportate con le singole misure di sicurezza (protezione per occhi/viso, pelle, vie respiratorie).

Informazioni aggiuntive per la protezione delle mani - Non sono stati condotti test.

Nelle miscele è stata eseguita una scelta in base alla migliore conoscenza specifica e alle informazioni relative alle sostanze contenute a disposizione.

La scelta delle sostanze si basa sulle indicazioni dei fabbricanti di guanti.

Per la scelta definitiva del materiale dei guanti, si deve tenere conto dei tempi di rottura, delle percentuali di permeazione e della degradazione.

La scelta del guanto idoneo dipende non solo dal materiale, ma anche da altre caratteristiche di qualità, che variano da fabbricante a fabbricante.

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Nelle miscele la resistenza dei materiali dei guanti non può essere calcolata in anticipo e per questo deve essere controllata prima dell'uso.  
Il fabbricante deve accertare il tempo esatto di rottura del materiale dei guanti e far sì che sia rispettato.

### 8.2.3 Controlli dell'esposizione ambientale

Al momento non sono presenti informazioni.

## SEZIONE 9: proprietà fisiche e chimiche

### 9.1 Informazioni sulle proprietà fisiche e chimiche fondamentali

Stato fisico:	Gas liquefatto
Colore:	Incolore
Odore:	Debole
Soglia olfattiva:	Non determinato
pH:	n.a.
Punto di fusione/punto di congelamento:	Non determinato
Punto di ebollizione iniziale e intervallo di ebollizione:	-29,4 °C
Punto di infiammabilità:	n.a.
Velocità di evaporazione:	Non determinato
Infiammabilità (solidi, gas):	Estremamente infiammabile
Limite inferiore di esplosività:	6,2 Vol-%
Limite superiore di esplosività:	12,3 Vol-%
Tensione di vapore:	6067 hPa (21°C)
Tensione di vapore:	14203 hPa (54°C)
Densità di vapore (Aria = 1):	4
Densità:	1,1 g/cm <sup>3</sup> (25°C)
Densità sfuso:	Non determinato
Solubilità (le solubilità):	Non determinato
Idrosolubilità:	198,2 mg/l (24°C, Regulation (EC) 440/2008 A.6. (WATER SOLUBILITY))
Coefficiente di ripartizione (n-ottanolo/acqua):	2,15 (Regulation (EC) 440/2008 A.8. (PARTITION COEFFICIENT))
Temperatura di autoaccensione:	405 °C
Temperatura di decomposizione:	Non determinato
Viscosità:	Non determinato
Proprietà esplosive:	Prodotto non esplosivo. Uso: possibile formazione di miscele esplosive vapore/aria.
Proprietà ossidanti:	Non determinato

### 9.2 Altre informazioni

Miscibilità:	Non determinato
Liposolubilità / solvente:	Non determinato
Conducibilità:	Non determinato
Tensione superficiale:	Non determinato
Contenuto di solvente:	Non determinato
Massa molare:	114 g/mol

## SEZIONE 10: stabilità e reattività

### 10.1 Reattività

Il prodotto non è stato sottoposto a controllo.

### 10.2 Stabilità chimica

Stabile se stoccato e utilizzato in maniera appropriata.

### 10.3 Possibilità di reazioni pericolose

Nessuna reazione pericolosa nota.

### 10.4 Condizioni da evitare

Vedi anche sezione 7.

Caldo, in prossimità di fiamme, fonti d'accensione

### 10.5 Materiali incompatibili





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12.5. Risultati della valutazione PBT e vPvB:							n.d.d.
12.6. Altri effetti avversi:							n.d.d.

## SEZIONE 13: considerazioni sullo smaltimento

### 13.1 Metodi di trattamento dei rifiuti

#### Per il materiale / la miscela / le quantità residue

No. chiave CE:

I codici indicanti il tipo di rifiuti vanno considerati come raccomandazioni sulla base dell'utilizzo prevedibile di questo prodotto. A seconda dell'utilizzo particolare e delle caratteristiche di smaltimento dell'utente possono essere assegnati codici diversi. (2014/955/UE)

14 06 01 clorofluorocarburi, HCFC, HFC

Si raccomanda:

Lo smaltimento attraverso le acque reflue va sconsigliato.

Osservare le normative locali.

P.es. impianto di incenerimento adeguato.

Osservare la ordinanza sulla prevenzione e lo smaltimento dei rifiuti (Ordinanza sui rifiuti, OPSR, RS 814.600, Svizzera).

Osservare la ordinanza sul traffico di rifiuti (OTRif, RS 814.610, Svizzera).

Osservare la ordinanza del DATEC sulle liste per il traffico di rifiuti (LTR, RS 814.610.1, Svizzera).

#### Per contenitori contaminati

Osservare le normative locali.

Si raccomanda:

Ritornare al produttore con pressione residua.

15 01 04 imballaggi metallici

Osservare la ordinanza sulla prevenzione e lo smaltimento dei rifiuti (Ordinanza sui rifiuti, OPSR, RS 814.600, Svizzera).

Osservare la ordinanza sul traffico di rifiuti (OTRif, RS 814.610, Svizzera).

Osservare la ordinanza del DATEC sulle liste per il traffico di rifiuti (LTR, RS 814.610.1, Svizzera).

## SEZIONE 14: informazioni sul trasporto


### Indicazioni generali

14.1. Numero ONU: 3161

#### Trasporto su strada/su ferrovia (ADR/RID)

14.2. Nome di spedizione dell'ONU:

UN 3161 LIQUEFIED GAS, FLAMMABLE, N.O.S. (R-1234YF)

14.3. Classe/i di pericolo connesse al trasporto: 2.1 

14.4. Gruppo di imballaggio: -

Codice di classificazione: 2F

LQ: 0


14.5. Pericoli per l'ambiente: Non applicabile

Tunnel restriction code: B/D

#### Trasporto via mare (Codice IMDG)

14.2. Nome di spedizione dell'ONU:

LIQUEFIED GAS, FLAMMABLE, N.O.S. (R-1234YF)

14.3. Classe/i di pericolo connesse al trasporto: 2.1 

14.4. Gruppo di imballaggio: -

EmS: F-D, S-U


Inquinante marino (Marine Pollutant): n.a.

14.5. Pericoli per l'ambiente: Non applicabile

#### Trasporto via aerea (IATA)

14.2. Nome di spedizione dell'ONU:

Liquefied gas, flammable, n.o.s. (R-1234YF)

14.3. Classe/i di pericolo connesse al trasporto: 2.1 

14.4. Gruppo di imballaggio: -



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14.5. Pericoli per l'ambiente:

Non applicabile

**14.6. Precauzioni speciali per gli utilizzatori**

Le persone interessate dovranno essere istruite al trasporto di sostanze pericolose.

Tutte le persone coinvolte nel trasporto dovranno rispettare le specifiche per la messa in sicurezza.

Per evitare eventuali danni dovranno essere prese le rispettive misure preventive.

**14.7. Trasporto di rinfuse secondo l'allegato II di MARPOL ed il codice IBC**

Il carico non viene eseguito con materiale sfuso ma in collettame, per questo non pertinente.

Non si osservano le disposizioni relative a quantità ridotte.

Codice pericolosa e codice imballo su richiesta.

Rispettare le norme specifiche (special provisions).

**SEZIONE 15: informazioni sulla regolamentazione****15.1 Disposizioni legislative e regolamentari su salute, sicurezza e ambiente specifiche per la sostanza o la miscela**

Rispettare restrizioni:

Osservare le disposizioni emesse dall'associazione di categoria e quelle della medicina del lavoro.

Direttiva 2012/18/UE ("Seveso-III"), allegato I, parte 1 - le seguenti categorie sono adatte per questo prodotto (eventualmente dovranno essere utilizzate altre categorie in base allo stoccaggio e all'utilizzo ecc.):

Categorie di pericolo	Note all'allegato I	Quantità limite (tonnellate) delle sostanze pericolose di cui all'articolo 3, paragrafo 10, per l'applicazione di - Requisiti di soglia inferiore	Quantità limite (tonnellate) delle sostanze pericolose di cui all'articolo 3, paragrafo 10, per l'applicazione di - Requisiti di soglia superiore
P2		10	50

Per la classificazione delle categorie e delle soglie quantitative si dovranno rispettare sempre le note riportate all'allegato I della direttiva 2012/18/UE, in particolare le note contenute in queste tabelle e le note 1 - 6.

Direttiva 2010/75/UE (COV):

100 %

MAK / BAT, VME/VLE / VBT:

Vedi sezione 8.

Rispettare la ordinanza sui prodotti chimici, OPChim (RS 813.11, Svizzera).

Rispettare la ordinanza sulla riduzione dei rischi inerenti ai prodotti chimici, ORRPChim (RS 814.81, Svizzera).

Osservare la ordinanza contro l'inquinamento atmosferico, OIAt (RS 814.318.142.1, Svizzera).

Rispettare la ordinanza sulla protezione contro gli incidenti rilevanti (OPIR) (RS 814.12, Svizzera).

**15.2 Valutazione della sicurezza chimica**

È stata eseguita una valutazione sulla sicurezza chimica.

**SEZIONE 16: altre informazioni**

Sezioni rielaborate:

2,16

Richiesta formazione dei collaboratori per il trattamento di merce pericolosa.

Queste informazioni si riferiscono al prodotto in condizioni di fornitura.

Richiesta formazione dei collaboratori per il trattamento di sostanze pericolose.

Le seguenti frasi rappresentano le frasi H scritte per esteso, i codici della classe e della categoria dei pericoli (GHS/CLP) del prodotto e delle sostanze contenute (denominate al paragrafo 2 e 3).

H280 Contiene gas sotto pressione, può esplodere se riscaldato.

H220 Gas altamente infiammabile.

Flam. Gas — Gas infiammabili (ivi compresi i gas chimicamente instabili)

Press. Gas (Liq.) — Gas sotto pressione-Gas compresso

**Abbreviazioni e acronimi utilizzati in questo documento:**

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AC Article Categories (= Categorie degli articoli)  
ACGIH American Conference of Governmental Industrial Hygienists  
ADR Accord européen relatif au transport international des marchandises Dangereuses par Route  
AOEL Acceptable Operator Exposure Level  
AOX Adsorbable organic halogen compounds (= Composti alogeni organici adsorbibili)  
ATE Acute Toxicity Estimate (= La stima della tossicità acuta - STA) secondo Regolamento (CE) 1272/2008 (CLP)  
BAM Bundesanstalt für Materialforschung und -prüfung (Germania)  
BAT (VBT) BAT = Biologischer Arbeitsstofftoleranzwert / VBT = Valeurs biologiques tolérables (Svizzera)  
BAuA Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (= Ente federale della prevenzione e della medicina del lavoro Germania)  
BCF Bioconcentration factor (= fattore di bioconcentrazione)  
BEI Indice biologico di esposizione (ACGIH, Stati Uniti d'America)  
BHT Butylhydroxytoluol (= 2,6-di-t-butil-4-metil-fenolo)  
BOD Biochemical oxygen demand (= Domanda biochimica di ossigeno)  
BSEF Bromine Science and Environmental Forum  
bw body weight (= peso corporeo)  
ca. circa  
CAS Chemical Abstracts Service  
CE Comunità Europea  
CEC Coordinating European Council for the Development of Performance Tests for Fuels, Lubricants and Other Fluids  
CEE Comunità Economica Europea  
CESIO Comité Européen des Agents de Surface et de leurs Intermédiaires Organiques  
ChemRRV (ORRPChim) Chemikalien-Risikoreduktions-Verordnung (= Ordinanza sulla riduzione dei rischi inerenti ai prodotti chimici - ORRPChim, Svizzera)  
CIPAC Collaborative International Pesticides Analytical Council  
CLP Classification, Labelling and Packaging (REGOLAMENTO (CE) N. 1272/2008 relativo alla classificazione, all'etichettatura e all'imballaggio delle sostanze e delle miscele)  
CMR carcinogenico, mutagenico, riproduttivo tossico  
CNIT Centro Nazionale Informazioni Tossicologiche (Pavia, Italia)  
COD Chemical oxygen demand (= Domanda chimica di ossigeno)  
Codice IMDG International Maritime Code for Dangerous Goods (IMDG-code)  
Conc. Concentrazione  
CTFA Cosmetic, Toiletry, and Fragrance Association  
DATEC Dipartimento federale dell'ambiente, dei trasporti, dell'energia e delle comunicazioni (Svizzera)  
DEFR Dipartimento federale dell'economia, della formazione e della ricerca (Svizzera)  
DMEL Derived Minimum Effect Level  
DNEL Derived No Effect Level (= il livello derivato senza effetto)  
DOC Dissolved organic carbon (= Carbonio organico disciolto)  
DT50 Dwell Time - 50% reduction of start concentration  
DVS Deutscher Verband für Schweißen und verwandte Verfahren e.V. (= documentazione dell'associazione tedesca di saldatura)  
dw dry weight (= massa secca)  
ecc. eccetera  
ECHA European Chemicals Agency (= Agenzia europea per le sostanze chimiche)  
EINECS European Inventory of Existing Commercial Chemical Substances  
ELINCS European List of Notified Chemical Substances  
EPA United States Environmental Protection Agency (United States of America)  
ERC Environmental Release Categories (= Categoria a rilascio nell'ambiente)  
Fax. Numero di fax  
GHS Globally Harmonized System of Classification and Labelling of Chemicals (= Sistema mondiale armonizzato di classificazione ed etichettatura delle sostanze chimiche)  
GWP Global warming potential (= Potenz. contributo al riscaldamento globale)  
HET-CAM Hen's Egg Test - Chorionallantoic Membrane  
HGWP Halocarbon Global Warming Potential  
IARC International Agency for Research on Cancer  
IATA International Air Transport Association  
IBC Intermediate Bulk Container  
IBC (Code) International Bulk Chemical (Code)  
incl. incluso  
IUCLID International Uniform Chemical Information Database  
LQ Limited Quantities  
LTR Le Liste per il traffico di rifiuti (Svizzera)

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MAK (VME/VLE) MAK = Maximale Arbeitsplatzkonzentrationswerte gesundheitsgefährdender Stoffe / VME/VLE = Valeurs limites d'exposition à des substances dangereuses pour la santé aux postes de travail (Svizzera)

n.a. non applicabile

n.d. nessun dato disponibile

n.d. non disponibile

n.t. non testato

NIOSH National Institute of Occupational Safety and Health (United States of America)

ODP Ozone Depletion Potential (= Il potenziale di riduzione dell'ozono)

OECD Organisation for Economic Co-operation and Development

org. organico

OTR Ordinanza tecnica sui rifiuti (Svizzera)

OTRif Ordinanza sul traffico di rifiuti (Svizzera)

p.es., per es., ad es., es. per esempio, esempio

PAK polyzyklischer aromatischer Kohlenwasserstoff (= idrocarburi aromatici policiclici)

PBT persistent, bioaccumulative and toxic (= persistenti, bioaccumulanti, tossiche)

PC Chemical product category (= Categoria dei prodotti chimici)

PE Polietilene

PNEC Predicted No Effect Concentration (= la prevedibile concentrazione priva di effetti)

PROC Process category (= Categoria dei processi)

PTFE Politetrafluoroetilene

REACH Registration, Evaluation, Authorisation and Restriction of Chemicals (REGOLAMENTO 1907/2006 (CE) concernente la registrazione, la valutazione, l'autorizzazione e la restrizione delle sostanze chimiche)

REACH-IT List-No. 9xx-xxx-x No. is automatically assigned, e.g. to pre-registrations without a CAS No. or other numerical identifier. List Numbers do not have any legal significance, rather they are purely technical identifiers for processing a submission via REACH-IT.

RID Règlement concernant le transport International ferroviaire de marchandises Dangereuses

SEE Spazio Economico Europeo

SU Sector of use (= Settore d'uso)

SVHC Substances of Very High Concern

TDAA Temperatura di decomposizione autoaccelerata (Self-Accelerating Decomposition Temperature - SADT)

Tel. Telefon

ThOD Theoretical oxygen demand (= Domanda teorica di ossigeno)

TLV-TWA, TLV-STEL, TLV-C "TLV-TWA = Valore limite - 8 h valore medio, TLV-STEL = Valore limite - limite per esposizioni di breve durata (15 min.), TLV-C = Valore limite - limite massimo ("Ceiling") (ACGIH, Stati Uniti d'America)."

TOC Total organic carbon (= Carbonio organico totale)

UE Unione Europea

UFAM Ufficio federale dell'ambiente (Svizzera)

UN RTDG United Nations Recommendations on the Transport of Dangerous Goods (raccomandazioni delle Nazioni Unite sul trasporto di merci pericolose)

VbF Verordnung über brennbare Flüssigkeiten (= Normativa circa i liquidi infiammabili (Austria))

VOC Volatile organic compounds (= composti organici volatili (COV))

vPvB very persistent and very bioaccumulative

wwt wet weight

Le notizie qui riportate descrivono il prodotto in riferimento alle necessarie misure di sicurezza, non servono a garantire determinate caratteristiche e si basano sulle nostre attuali conoscenze.

Senza responsabilità.

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# SAFETY DATA SHEET

according to Regulation (EC) No. 1907/2006



## Solstice® yf Refrigerant (R-1234yf)

Version 10.2

07.10.2017

Supersedes 9

### Annex of Safety data sheet

Identified use: ES and title	Sector of Use (SU)	Product Category (PC)  Article Category (AC)	Process category (PROC)	Environmental Release Category (ERC)
ES 1 : Industrial Use, Heat Transfer Fluids – Refrigerants, Coolants	SU 3, 10, 17	PC 16 AC 1, 2	PROC 8b, 9	ERC 7
ES 2 : Professional Use, Heat Transfer Fluids – Refrigerants, Coolants	SU 22	PC 16 AC 1, 2	PROC 8a	ERC 9b
ES 3 : Formulation of preparations	SU 3, 10, 17	PC 16 AC 1, 2	PROC 3	ERC 2
ES 4 : Use, service life, and waste stage environmental exposure	SU 3, 10, 17, 21, 22	Only environmental releases evaluated	Only environmental releases evaluated	ERC 2, 7, 9a, and 9b

### Overview of Uses and Exposure Scenarios

HFO-1234yf is used as a heat transfer fluid in mobile air conditioning (MAC) equipment and in stationary air conditioning and refrigeration equipment. It is imported into the European Union (EU) and used by workers at Original Equipment Manufacturers (OEMs) to charge MAC and stationary equipment. Workers also use HFO-1234yf when servicing charged equipment during its service life or when dismantling charged equipment at the end of its service life. In addition, workers use the substance during blending and repackaging activities. Worker exposure may potentially occur during the activities associated with these uses, but exclusively when disconnecting and/or connecting the tight seal shut-off valve coupler hoses during transfer operations. Therefore, the exposure potential is limited in time and minimized in amount due to the coupler system employed. Environmental exposure is also a possibility when conducting these transfer operations. Minimal releases to the ambient air may potentially occur during activities such as blending and repackaging of the substance, charging and servicing of equipment, dismantling of equipment, and if leakages occur from the charged equipment during its service life. Releases to other environmental compartments beside the ambient air are not possible because HFO-1234yf is a liquefied gas.

Potential consumer exposure is limited to those extremely rare occasions when all of the following conditions are met: the MAC is leaking, HFO-1234yf vents directly into the passenger compartment of the automobile, the passenger compartment remains totally closed, and passengers are present in the car.

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**1.1 Exposure Scenario ES1**

Industrial Use, Heat Transfer Fluids – Refrigerants, Coolants

Industrial uses : Uses of substances as such or in preparations at industrial sites (SU3) ; Formulation [mixing] or preparations and/or re-packaging (excluding alloys) (SU10) : General manufacturing, e.g., machinery, equipment, vehicles, other transport equipment (SU17) excluding buses

Contributing environmental scenario CS1: Industrial use of substances in closed systems (ERC7). Quantified in ES4

Contributing worker scenario CS2: Transfer of substance or preparation into small containers (dedicated filling line, including weighing) (PROC9)

Contributing worker scenario CS3: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities (PROC8b)

Exposure Scenario 1 (ES 1) describes the activities and processes covered when workers charge various types of packaging, A/C and refrigeration equipment in an industrial setting. It includes:

- Refrigerant packaging workers,
- Automobile original equipment manufacturer (OEM) assembly workers, and
- Stationary equipment OEM assembly workers.

**1.2.1 Contributing scenario CS1 controlling environmental exposure for ERC 7**

Industrial use of substances in closed systems

Assessed and quantified in ES4

Product characteristics

Low global warming potential (GWP) liquefied gas with a concentration of 100%; Not biodegradable

Amounts used

9000 tonnes per annum (tpa) – EU

Frequency and duration of use

Continuous use/8-hour shift, 200 operating days/year; Intermittent release

Environmental factors not influenced by risk management

None

Other given operational conditions affecting environmental exposure

Under normal conditions of use, exposure would primarily occur when workers disconnect the couplings. Conservatively assumed that approximately 1% (5 grams/mobile A/C) released to air (Henne et al., 2012; Reimann & Shallcross et al., 2011) (release fraction of 0.01).

Technical conditions and measures at process level (source) to prevent release

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.

Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil

None

Organizational measures to prevent/limit release from site

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Use of ATEX 137 and ATEX 95 Directives to mitigate flammability properties of HFO-1234yf and/or Chemical Substances at Work (Directive 98/24/EC); Regular inspection and maintenance of equipment and machines.
Conditions and measures related to municipal sewage treatment plant
No STP
Conditions and measures related to external treatment of waste for disposal
Not applicable
Conditions and measures related to external recovery of waste
Not applicable
<b>1.2.2 Contributing scenario CS2 controlling worker exposure for PROC 9</b>
Transfer of substance or preparation into small containers (dedicated filling line, including weighing)
Product characteristic
Liquefied gas; Covers percentage substance in the product up to 100 % (unless stated differently); Assumes activities are at room temperature.
Amounts used
120 kg/8-hour shift – worker; ~50 000 kg/y for plant site producing 100 000 vehicles per year
Frequency and duration of use/exposure
Duration of use/exposure: Intermittent; 20 min/8-hour shift (Under normal operation exposure occurs only at ending of filling process (disconnection), estimated at 0.083 min (5 sec) per disconnecting process x1 processes/fill x 30 fills/hr x 8 hr/shift) Frequency: 200 days/year
Human factors not influenced by risk management
Light work, respiration volume = 10 m <sup>3</sup> /8-hour shift
Other given operational conditions affecting workers exposure
Indoor use; Under normal conditions of use, exposure would primarily occur when workers disconnect the couplings.
Technical conditions and measures at process level (source) to prevent release
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.
Technical conditions and measures to control dispersion from source towards the worker
Mechanical ventilation giving at least [ACH]: 3; Room volume: >50 m <sup>3</sup> .; Local exhaust ventilation (Effectiveness: < 10 ppm)
Organizational measures to prevent/limit releases, dispersion and exposure
Use of ATEX 137 and ATEX 95 Directives to mitigate flammability properties of HFO-1234yf and/or Chemical Substances at Work (Directive 98/24/EC); Use of ISO 13043 (April 15, 2011) (Road vehicles – Refrigerant systems used in mobile air conditioning systems (MAC) – Safety requirements) and SAE J639 (Safety Standards for Motor Vehicle Refrigerant Vapor Compression Systems), SAE J2843 (R-1234yf [HFO-1234yf] Recovery/Recycling/Recharging Equipment for Flammable Refrigerants for Mobile Air-Conditioning Systems) and SAE J2845 (Technician Certification for Service and Containment of Refrigerants Used in Mobile A/C Systems); Regular inspection and maintenance of equipment and machines.; Ensure operatives are trained to minimise



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exposures.
Conditions and measures related to personal protection, hygiene and health evaluation
Use eye protection to EN 166 or ANSI Z87.1, designed to protect against liquid splashes. Wear suitable gloves tested to EN374 or complying with U.S. OSHA guidelines.
<b>1.2.3 Contributing scenario CS3 controlling worker exposure for PROC 8b.</b>
Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities
Product characteristic
Liquefied gas; Covers percentage substance in the product up to 100 % (unless stated differently); Assumes activities are at room temperature.
Amounts used
Not applicable
Frequency and duration of use/exposure
Duration of use/exposure: Intermittent; Conservatively assumed less than 15 minutes/day Frequency: 200 days/year
Human factors not influenced by risk management
Light work, respiration volume = 10 m <sup>3</sup> /8-hour shift
Other given operational conditions affecting workers exposure
Outdoor use; Under normal conditions of use, exposure would primarily occur when workers connect and disconnect the couplings.
Technical conditions and measures at process level (source) to prevent release
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.
Technical conditions and measures to control dispersion from source towards the worker
None
Organizational measures to prevent/limit releases, dispersion and exposure
Use of ATEX 137 and ATEX 95 Directives to mitigate flammability properties of HFO-1234yf and/or Chemical Substances at Work (Directive 98/24/EC); Use of ISO 13043 (April 15, 2011) (Road vehicles – Refrigerant systems used in mobile air conditioning systems (MAC) – Safety requirements) and SAE J639 (Safety Standards for Motor Vehicle Refrigerant Vapor Compression Systems), SAE J2843 (R-1234yf [HFO-1234yf] Recovery/Recycling/Recharging Equipment for Flammable Refrigerants for Mobile Air-Conditioning Systems) and SAE J2845 (Technician Certification for Service and Containment of Refrigerants Used in Mobile A/C Systems); Regular inspection and maintenance of equipment and machines.; Ensure operatives are trained to minimise exposures.
Conditions and measures related to personal protection, hygiene and health evaluation
Use eye protection to EN 166 or ANSI Z87.1, designed to protect against liquid splashes. Wear suitable gloves tested to EN374 or complying with U.S. OSHA guidelines.
<b>1.3. Exposure estimation and reference to its source</b>
ASSESSMENT METHOD: CS1: ECETOC TRA v.3. ; CS2 and CS3: Available measured data for HFC-134a were used to evaluate the worker exposure to HFO-1234yf. For comparison purposes only, ECETOC TRA v.3 was also used to estimate inhalation exposure for workers.



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Information for CS1: Local releases to the environment

Release	Release factor estimation method	Explanation / Justification
Water	Process and substance knowledge	<b>Initial release factor:</b> ERC7 assumes 5% <b>Final release factor:</b> 0% <b>Local release rate:</b> 0 kg/day <b>Explanation / Justification:</b> Substance is a liquefied gas.
Air	Henne et al., 2012; Reimann & Shallcross et al., 2011	<b>Initial release factor:</b> ERC7 assumes 5% <b>Final release factor:</b> ~1% <b>Local release rate:</b> ~350 kg/day across entire 27 EU countries plus Croatia, Norway, Switzerland, and Turkey (EU-27+) after 90% of fleet is converted and at a steady state. <b>Explanation / Justification:</b> 5 grams/charging event, which is approximately 1% of the total charge volume (500+ or – grams); Henne et al, 2012; Reimann & Shallcross et al., 2011.
Soil	Process and substance knowledge	<b>Initial release factor:</b> ERC7 assumes 5% <b>Final release factor:</b> 0% <b>Local release rate:</b> 0 kg/day <b>Explanation / Justification:</b> Substance is a liquefied gas.

The exposure concentrations and RCRs for both HFO-1234yf and its potential degradation product TFA are reported in ES4.

Information for CS2: Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Source for exposure concentration	Exposure concentration and DNEL (or DMEL) units	DNEL (or DMEL)	Risk characterisation
Inhalation, systemic, long-term	37	Bureau Veritas North America, 2008; data generated on HFC-134a	mg/m <sup>3</sup>	950	0.039
	190	TRA v.3 tool used to estimate exposure concentration for comparison purposes only			0.2
Inhalation, systemic, acute	Not needed	Not needed			Not needed
Inhalation, local, long-term	Not needed	Not needed			Not needed
Inhalation, local, acute	Not needed	Not needed			Not needed

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Dermal, systemic, long-term	Not needed	Not needed			Not needed
Dermal, systemic, acute	Not needed	Not needed			Not needed
Dermal, local, long-term	Not needed	Not needed			Not needed
Dermal, local, acute	Not needed	Not needed			Not needed
Combined routes, systemic, long-term					0.039
Combined routes, systemic, acute					Not needed

The RCR for inhalation exposure was <1. This indicates that adverse impact to workers is not expected.

### Information for CS3: Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Source for exposure concentration	Exposure concentration and DNEL (or DMEL) units	DNEL (or DMEL)	Risk characterisation
Inhalation, systemic, long-term	37	Bureau Veritas North America, 2008; data generated on HFC-134a	mg/m <sup>3</sup>	950	0.039
	50	TRA v.3 tool used to estimate exposure concentration for comparison purposes only			0.05
Inhalation, systemic, acute	Not needed	Not needed			Not needed
Inhalation, local, long-term	Not needed	Not needed			Not needed
Inhalation, local, acute	Not needed	Not needed			Not needed
Dermal, systemic, long-term	Not needed	Not needed			Not needed
Dermal, systemic, acute	Not needed	Not needed			Not needed
Dermal, local, long-term	Not needed	Not needed			Not needed
Dermal, local, acute	Not needed	Not needed			Not needed

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Combined routes, systemic, long-term					0.039
Combined routes, systemic, acute					Not needed

The RCR for inhalation exposure was <1. This indicates that adverse impact to workers is not expected.

**2.1. Exposure Scenario ES2**

Professional Use, Heat Transfer Fluids – Refrigerants, Coolants

Professional uses: Public domain (administration, education, entertainment, services, craftsmen) (SU22)

Contributing environmental scenario CS1: Wide dispersive outdoor use of substances in closed systems (ERC9b). Quantified in ES4.

Contributing worker scenario CS2: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities (PROC8a)

Exposure Scenario 2 (ES 2) describes the activities and processes covered when professional workers service mobile or stationary A/C or refrigeration equipment. Although each of these workers may use different charge quantities of HFO-1234yf at different frequencies and in different professional settings, they all use equipment during the servicing procedure that is similar to the equipment used during industrial refrigerant charging or packaging. Therefore, professional workers have a similar potential for exposure as do industrial workers, except professional users process fewer units during the work shift and they are more likely to perform the work outdoors. If working indoors, however, their work space would likely be smaller than for industrial users. Therefore, a separate exposure scenario was deemed warranted. In general, the potential release to the environment is also the same between the various servicing workers (mobile and stationary) and industrial workers, de minimus release to only air as described in detail in ES1.

**2.2.1 Contributing scenario CS1 controlling environmental exposure for ERC9b**

Wide dispersive outdoor use of substances in closed systems

Assessed and quantified in ES4

Product characteristics

Low global warming potential (GWP) liquefied gas with a concentration of 100%; Not biodegradable

Amounts used

4000 tonnes per annum (tpa) – EU

Frequency and duration of use

Continuous use/release, 365 operating days/year; Intermittent release

Environmental factors not influenced by risk management

None

Other given operational conditions affecting environmental exposure

Under normal conditions of use, exposure would primarily occur when workers connect and disconnect the couplings. Conservatively assumed that approximately 6.4% of charge would be released if servicing completed by a skilled worker and that approximately 64% of charge would be

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released if servicing completed by an unskilled worker (Henne et al, 2012) despite the fact that servicing is only allowed at professional service centers and completed by skilled workers.
Technical conditions and measures at process level (source) to prevent release
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.
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil
None
Organizational measures to prevent/limit release from site
None
Conditions and measures related to municipal sewage treatment plant
No STP
Conditions and measures related to external treatment of waste for disposal
Not applicable
Conditions and measures related to external recovery of waste
Not applicable
<b>2.2.2 Contributing scenario CS2 controlling worker exposure for PROC 8a</b>
Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities
Product characteristic
Liquefied gas; Covers percentage substance in the product up to 100 % (unless stated differently); Assumes activities are at room temperature.
Amounts used
Mobile A/C: 0.5 kg/service event; Stationary Equipment: 0.05 – 300 kg/service event
Frequency and duration of use/exposure
Duration of use/exposure: Intermittent; Mobile A/C: ~1 minute/ 8-hour shift (0.083 minutes (5 seconds) per connecting process x 2 connecting processes per vacuuming/re-charging procedure x 1 servicing event per hour x 8 hours per shift) Stationary Equipment: ~< 1 minute/8-hour shift (0.083 minutes (5 seconds) per connecting process x2 connecting processes per vacuuming/ re-charging procedure x up to 4 servicing events per 8-hour shift) Frequency: 200 days/year
Human factors not influenced by risk management
Light work, respiration volume = 10 m <sup>3</sup> /8-hour shift
Other given operational conditions affecting workers exposure
Indoor use; Under normal conditions of use, exposure would primarily occur when workers connect and disconnect the couplings.
Technical conditions and measures at process level (source) to prevent release
Ensure that the valves of the cylinders are tightly closed and not leaking; Handle substance within a

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closed system; Transfer via enclosed lines; Clear transfer lines prior to de-coupling.

Technical conditions and measures to control dispersion from source towards the worker

None

Organizational measures to prevent/limit releases, dispersion and exposure

Use of ATEX 137 and ATEX 95 Directives to mitigate flammability properties of HFO-1234yf and/or Chemical Substances at Work (Directive 98/24/EC); Use of ISO 13043 (April 15, 2011) (Road vehicles – Refrigerant systems used in mobile air conditioning systems (MAC) – Safety requirements) and SAE J639 (Safety Standards for Motor Vehicle Refrigerant Vapor Compression Systems), SAE J2843 (R-1234yf [HFO-1234yf] Recovery/Recycling/Recharging Equipment for Flammable Refrigerants for Mobile Air-Conditioning Systems) and SAE J2845 (Technician Certification 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.

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

Use eye protection to EN 166 or ANSI Z87.1, designed to protect against liquid splashes. Wear suitable gloves tested to EN374 or complying with U.S. OSHA guidelines.

**2.3. Exposure estimation and reference to its source**

**ASSESSMENT METHOD: CS1:** TRA v.3. **CS2:** Available measured data on HFC-134a were used to evaluate the professional worker exposure to HFO-1234yf. For comparison purposes only, TRA v.3 was also used to estimate inhalation exposure for workers.

Information for CS1: Local releases to the environment

Release	Release factor estimation method	Explanation / Justification
Water	Activity and substance knowledge	<b>Initial release factor:</b> ERC9b assumes 5% <b>Final release factor:</b> 0% <b>Local release rate:</b> 0 kg/day <b>Explanation / Justification:</b> Substance is a liquefied gas.
Air	Henne et al., 2012	<b>Initial release factor:</b> ERC9b assumes 5% <b>Final release factor:</b> ~6.4% of initial charge if servicing by skilled workers; ~64% of initial charge if servicing by unskilled workers <b>Local release rate:</b> 4 580 kg/day across entire EU-27+. <b>Explanation / Justification:</b> Release estimates made by Henne et al., 2012 under the assumption that 90% of entire EU-27+ fleet is converted and at a steady state.
Soil	Activity and substance knowledge	<b>Initial release factor:</b> ERC9b assumes 5% <b>Final release factor:</b> 0% <b>Local release rate:</b> 0 kg/day <b>Explanation / Justification:</b> Substance is a liquefied gas.

The exposure concentrations and RCRs for both HFO-1234yf and its potential degradation product TFA are reported in ES4.

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Information for CS2: Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Source for exposure concentration	Exposure concentration and DNEL (or DMEL) units	DNEL (or DMEL)	Risk characterisation
Inhalation, systemic, long-term	85.6	Gjølstad et al., 2003; refrigeration repair workers' data generated on HFC-134a	mg/m <sup>3</sup>	950	0.09
	5.1	Bureau Veritas North America, 2007; mobile A/C workers; data generated on HFC-134a			0.005
	240	TRA v.3 tool used to estimate exposure concentration for comparison purposes only			0.25
Inhalation, systemic, acute	Not needed	Not needed			Not needed
Inhalation, local, long-term	Not needed	Not needed			Not needed
Inhalation, local, acute	Not needed	Not needed			Not needed
Dermal, systemic, long-term	Not needed	Not needed			Not needed
Dermal, systemic, acute	Not needed	Not needed			Not needed
Dermal, local, long-term	Not needed	Not needed			Not needed
Dermal, local, acute	Not needed	Not needed			Not needed
Combined routes, systemic, long-term					0.09
Combined routes, systemic, acute					Not needed

The RCR for inhalation exposure was <1. This indicates that adverse impact to workers is not expected.

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### 3.1. Exposure Scenario ES3

Formulation of preparations

Industrial uses : Uses of substances as such or in preparations at industrial sites (SU3) ; Formulation [mixing] or preparations and/or re-packaging (excluding alloys) (SU10) : General manufacturing, e.g. machinery, equipment, vehicles, other transport equipment (SU17) excluding buses

Contributing environmental scenario CS1: Formulation of preparations (ERC2) (Covered by ES4)

Contributing worker scenario CS2: Use in closed batch process (synthesis or formulation) (PROC3)

Exposure Scenario 3 (ES 3) describes the activities and processes covered when workers blend various types of refrigeration substances and load the products into ISO containers or tanks. The blended products may contain up to nearly 100% of HFO-1234yf. Activities are expected to occur outdoors, but with the same equipment used during the charging and/or packaging procedures described in ES 1. In this process, however, yield rates are set at 99.75%. Therefore, potential releases to ambient air are expected to be < 0.25% and releases to wastewater and soil are expected to be at 0%.

The equipment used for refrigerant blending and loading employs shut-off valve couplers that do not permit release of refrigerant unless a tight seal is made between the blending/filling equipment and the unit. In addition, blending/filling hoses are designed to be connected with the system prior to opening the valve(s) of the containers holding the substances. After blending operations are finished or the containers are filled, the valve(s) are closed prior to decoupling the hoses.

### 3.2.1 Contributing scenario CS1 controlling environmental exposure for ERC2

Formulation of preparations

Assessed and quantified in ES4

Product characteristics

Low global warming potential (GWP) liquefied gas; Covers percentage substance in the product up to 100 % (unless stated differently); Not biodegradable

Amounts used

5000 tonnes per annum (tpa) – EU; Daily amount: 25 000 kg/day – EU

Frequency and duration of use

Continuous use/8-hour shift, 200 operating days/year; Intermittent release

Environmental factors not influenced by risk management

None

Other given operational conditions affecting environmental exposure

Under normal conditions of use, exposure would primarily occur when workers connect and disconnect the couplings. Assumed 0.25% released to air (12.5 tpa), 0% released to wastewater and 0% released to soil.

Technical conditions and measures at process level (source) to prevent release

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.

Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil

None



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Organizational measures to prevent/limit release from site
Use of ATEX 137 and ATEX 95 Directives to mitigate flammability properties of HFO-1234yf and/or Chemical Substances at Work (Directive 98/24/EC); Regular inspection and maintenance of equipment and machines.
Conditions and measures related to municipal sewage treatment plant
No STP
Conditions and measures related to external treatment of waste for disposal
Not applicable
Conditions and measures related to external recovery of waste
Not applicable
<b>3.2.2 Contributing scenario CS2 controlling worker exposure for PROC 3</b>
Use in closed batch process (synthesis or formulation)
Product characteristic
Liquefied gas; Covers percentage substance in the product up to 100 % (unless stated differently); Assumes activities are at ambient temperature (unless stated differently).
Amounts used
Up to 2 500 kg/shift – worker, based on conservative yearly volume estimate and two shifts/day with five workers/shift
Frequency and duration of use/exposure
Intermittent; 8-hour shift; 200 days/year; Conservatively assumed less than 15 minutes exposure duration/worker, which is based on 70 to 100 connections per day with two shifts/day, five workers/shift, and 30 seconds potential exposure/connection.
Human factors not influenced by risk management
Light work, respiration volume = 10 m <sup>3</sup> /8-hour shift
Other given operational conditions affecting workers exposure
Outdoor use; Under normal conditions of use, exposure would primarily occur when workers connect and disconnect the couplings.
Technical conditions and measures at process level (source) to prevent release
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.
Technical conditions and measures to control dispersion from source towards the worker
None
Organizational measures to prevent/limit releases, dispersion and exposure
Use of ATEX 137 and ATEX 95 Directives to mitigate flammability properties of HFO-1234yf and/or Chemical Substances at Work (Directive 98/24/EC); 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.
Conditions and measures related to personal protection, hygiene and health evaluation
Use eye protection to EN 166 or ANSI Z87.1, designed to protect against liquid splashes. Wear suitable gloves tested to EN374 or complying with U.S. OSHA guidelines.
<b>3.3. Exposure estimation and reference to its source</b>

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ASSESSMENT METHOD: CS1 and CS2: ECETOC TRA v.3

Information for CS1: Local releases to the environment

Release	Release factor estimation method	Explanation / Justification
Water	Process and substance knowledge	Initial release factor: ERC2 assumes 2% Final release factor: 0% Local release rate: 0 kg/day Explanation / Justification: Substance is a liquefied gas.
Air	Process and substance knowledge	Initial release factor: ERC2 assumes 2.5% Final release factor: ~0.25% Local release rate: 62.5 kg/day across EU-27+. Explanation / Justification: Based on process knowledge.
Soil	Process and substance knowledge	Initial release factor: ERC2 assumes 0.01% Final release factor: 0% Local release rate: 0 kg/day Explanation / Justification: Substance is a liquefied gas.

The exposure concentrations and RCRs for both HFO-1234yf and its potential degradation product TFA are covered and reported in ES4.

Information for CS2: Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Source for exposure concentration	Exposure concentration and DNEL (or DMEL) units	DNEL (or DMEL)	Risk characterisation
Inhalation, systemic, long-term	17	TRA v.3 tool used to estimate exposure concentration	mg/m <sup>3</sup>	950	0.018
Inhalation, systemic, acute	Not needed	Not needed			Not needed
Inhalation, local, long-term	Not needed	Not needed			Not needed
Inhalation, local, acute	Not needed	Not needed			Not needed
Dermal, systemic, long-term	Not needed	Not needed			Not needed
Dermal, systemic, acute	Not needed	Not needed			Not needed
Dermal, local, long-term	Not needed	Not needed			Not needed
Dermal, local, acute	Not needed	Not needed			Not needed
Combined routes, systemic, long-term					0.018

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Combined routes, systemic, acute					Not needed
The RCR for inhalation exposure was <1. This indicates that adverse impact to workers is not expected.					
<b>4.1 Exposure Scenario ES4</b>					
Use, Service Life, and Waste Stage Environmental Exposure					
Industrial uses : Uses of substances as such or in preparations at industrial sites (SU3) ; Formulation [mixing] or preparations and/or re-packaging (excluding alloys) (SU10) ; General manufacturing, e.g.. machinery, equipment, vehicles, other transport equipment (SU17) excluding buses; Consumer uses : Private households (=general public = consumers) (SU21) ; and Professional uses : Public domain (administration, education, entertainment, services, craftsmen) (SU22).					
Contributing environmental scenario CS1: HFO-1234yf: Wide dispersive outdoor use in closed systems (ERC9b); TFA: Wide dispersive outdoor use of long-life articles, high or intended release (ERC 10b).					
Contributing worker scenarios: CS2: HFO-1234yf: Use and Service life (PROC 8a, 9) related to physico-chemical properties					
According to Henne et al., 2012, an estimated 19.2 Gg/yr (19 200 tonnes per annum (tpa)) of HFO-1234yf may be emitted to the air from MACs once the conversion to HFO-1234yf in the automobile fleet is complete and at a steady-state (estimated to occur in the year 2020). This value represents the high emission scenario (95% confidence band) for the EU-27+. The 19 200 tonnes estimated to be released per year was based on a predicted car fleet of about 335 million, approximately 90% of which have the substance in the MAC, and on all the lifecycle activities for the HFO-1234yf, except for chemical manufacturing, which does not presently occur in the EU-27+.					
<b>4.2.1 Contributing scenario CS1 controlling environmental exposure for ERC9b, 10b</b>					
Wide dispersive use in closed systems (ERC9b); TFA: Wide dispersive outdoor use of long-life articles, high or intended release (ERC10b)					
See ES1, 2, 3 above, respectively for conditions of use covered by ES4.					

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Predicted yearly emissions based on Henne et al 2012 and ES3 estimated releases

Activity	Potential amount released (g/MAC)	Percentage of original fill amount potentially released (%)	Fraction of automobiles with release	Henne et al emission factor (g/yr/MAC)	How Henne et al emission factor and/or fraction of automobiles with release determined	Predicted emissions for activity (tpa)
MAC filling at Original Equipment Manufacturers	5	0.9	0.9	0.42	5 g/MAC divided by 12 years (average MAC lifetime)	127
MAC refilling by skilled personnel	35	6.4	0.81	2.92	35 g/MAC divided by 12 years	792
MAC refilling by unskilled personnel	350	64	0.09	29.2	350 g/MAC divided by 12 years	880
Regular automobile usage	35.8	6.5	0.9	35.8	In-use car data for 2002/2003 with no loss rate improvement	10 794
Irregular usage (sudden leaks from accidents, stone impacts, and component defects)	550	100	0.017	550	All or original fill released; 1.9% cars/year times 90% of cars with HFO-1234yf in MAC	3 132
MAC dismantling by skilled personnel	100	18	0.25	8.33	100 g/MAC divided by 12 years	698
MAC dismantling by unskilled personnel	400	73	0.25	33.3	400 g/MAC divided by 12 years	2 789
					<b><u>Total estimated emissions for ES1 and ES2</u></b>	<b>~19 212</b>
Formulation of preparations (ES3)	Not applicable	Not applicable	Not applicable	Not applicable	0.25% of 5 000 tpa	12.5
					<b>Total estimated emissions for ES1, ES2, and ES3</b>	<b>~19 225</b>

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**4.2.2 Contributing scenario CS2 controlling worker exposure for Use and Service life (PROC 8a, 9) related to physico-chemical properties**

Transfer of substance at non-dedicated facilities

Product characteristic

Extremely flammable liquefied gas; Covers percentage substance in the product up to 100 % (unless stated differently); Assumes activities are at ambient temperature (unless stated differently).

Amounts used

Mobile A/C: 0.5 kg/service event; Stationary Equipment: 0.05 – 300 kg/service event

Frequency and duration of use/exposure

Duration of use/exposure: Intermittent;  
 Mobile A/C: ~1 minute/ 8-hour shift (0.083 minutes (5 seconds) per connecting process x 2 connecting processes per vacuuming/re-charging procedure x 1 servicing event per hour x 8 hours per shift)  
 Stationary Equipment: ~< 1 minute/8-hour shift (0.083 minutes (5 seconds) per connecting process x2 connecting processes per vacuuming/ re-charging procedure x up to 4 servicing events per 8-hour shift)  
 Frequency: 200 days/year

Human factors not influenced by risk management

None

Other given operational conditions affecting workers exposure

Indoor use; Under normal conditions of use, exposure would primarily occur when workers connect and disconnect the couplings.

Technical conditions and measures at process level (source) to prevent release

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.

Technical conditions and measures to control dispersion from source towards the worker

None

Organizational measures to prevent/limit releases, dispersion and exposure

Use of ATEX 137 and ATEX 95 Directives to mitigate flammability properties of HFO-1234yf and/or Chemical Substances at Work (Directive 98/24/EC); Use of ISO 13043 (April 15, 2011) (Road vehicles – Refrigerant systems used in mobile air conditioning systems (MAC) – Safety requirements) and SAE J639 (Safety Standards for Motor Vehicle Refrigerant Vapor Compression Systems), SAE J2843 (R-1234yf [HFO-1234yf] Recovery/Recycling/Recharging Equipment for Flammable Refrigerants for Mobile Air-Conditioning Systems) and SAE J2845 (Technician Certification 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.

**4.3. Exposure estimation and reference to its source**

ASSESSMENT METHOD: CS1: ECETOC TRA v.3

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Information for CS1:

Predicted exposure concentrations and risk characterisation ratios for HFO-1234yf:

Protection target	Exposure concentration	Exposure concentration and PNEC units	PNEC	Risk characterisation
Sewage treatment plant (STP)	Not released to STP	mg/L	Not applicable	Not applicable
Freshwater	1.11E-10	mg/L	0.1	1E-09
Sediment (freshwater)	1.67E-09	mg/kg dry weight (dwt)	1.77	9E-10
Agricultural soil	1.97E-09	mg/kg dwt	1.54	1E-09
Marine water	3.19E-11	mg/L	0.01	3E-09
Sediment (marine water)	4.81E-10	mg/kg dwt	0.178	3E-09
Man via the environment (local)	3.28E-06	mg/kg body weight/day	271 (DNEL)†	1.21E-08

† The DNEL was derived by taking the worker inhalation, long-term, systemic DNEL of 950 mg/m<sup>3</sup> and converting it to a dose by multiplying by a presumed daily inhalation rate of 20 m<sup>3</sup>/day and dividing by an adult body weight of 70 kg.

The RCRs for HFO-1234yf for all protection targets were all much less than 1. This indicates that adverse impact to the environment and environmental receptors is not expected from potential releases of HFO-1234yf during original filling, refilling, regular usage, irregular usage, and dismantling.

Predicted exposure concentrations and risk characterisation ratios for TFA if instantaneous conversion after HFO-1234yf vented to air:

Protection target	Exposure concentration	Exposure concentration and PNEC units	PNEC (ECHA, 2014)	Risk characterisation
Sewage treatment plant (STP)	Not released to STP	mg/L	Not applicable	Not applicable
Freshwater	1.06E-05	mg/L	1	1E-05
Sediment (freshwater)	5.86E-05	mg/kg dry weight (dwt)	4.22	1E-05
Agricultural soil	9.23E-06	mg/kg dwt	0.0083	1E-03
Marine water	9.14E-05	mg/L	0.1	9E-05
Sediment (marine water)	5.03E-05	mg/kg dwt	0.422	1E-04
Man via the environment (local)	1.12E-04	mg/kg body weight/day	0.25 (DNEL)	4E-04

The RCRs for TFA for all protection targets were all much less than 1. This indicates that adverse impact to the environment and environmental receptors is not expected from the potential conversion of HFO-1234yf to TFA during original filling, refilling, regular usage, irregular usage, and dismantling.

Assessment method for CS2: SAE International Cooperative Research Program 1234

Information for CS2:

**Predicted exposure concentrations and physicochemical risk characterisation evaluation**

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HFO-1234yf is classified as an extremely flammable gas. This classification is based solely on the existence of a lower and upper flammability limit in air at 20°C. The flammability limits in air are 6.2%(V) and 12.3%(V) (method: ASTM E681-04). HFO-1234yf has a boiling point of -29,4 °C and an autoignition temperature of 405°C. The auto-ignition temperature is very high and is of no concern during normal handling and use.

As HFO-1234yf is not classified as dangerous on the basis of (eco) toxicological properties, only the risk due to its flammable properties is required to be characterized. Exposure to HFO-1234yf within the confines of an automobile as a consequence of leaks due to random collisions is the worst-case situation as higher concentrations are more easily attained because HFO-1234 may escape in a shorter period of time than during a corrosion-type leak. Again, following a collision situation, a Micro automobile with effective volume of 1.25 m<sup>3</sup> was used to determine if the refrigerant's lower flammability level would be attained. In the most severe situation, 70% of the refrigerant is potentially leaked into the passenger cabin after a side impact collision. According to SAE J2772, breakage of other components would more likely lead to a significant release of refrigerant to the ambient air rather than to the passenger cabin. Results from this evaluation suggest that the refrigerant reaches a maximum concentration of 127 000 mg/m<sup>3</sup> (27 200 ppm), well below the lower flammability level of 62 000 ppm.

Exposure to HFO-1234yf due to worst-case corrosion-type leaks (slower gradual leaks) has been shown to reach a maximum concentration of below 2% in the luxury vehicle (maximum was 1.8% as tested); typical commuter vehicles have higher body air leakage and thereby lower maximum refrigerant concentrations (maximum was 1.2% as tested) than luxury vehicles due to the reduced road noise requirement for the higher end vehicles.