

R1234yf Explained

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Why the change to a new Refrigerant? Where R12 the original Refrigerant used in Automotive applications was shown to be damaging the Ozone layer, R134a which was brought into replace it was found to have a Global Warming Potential. R1234yf has been created to be the new refrigerant in most vehicles that has neither Ozone damaging or Global Warming properties.

Will Vehicles need to be retrofitted? The short answer is No. R134a unlike R12 is not being phased out but rather phased down so over time it will become more expensive but will still be available.

Main characteristics of R1234yf

Low toxicity

Low GWP; GWP = <1

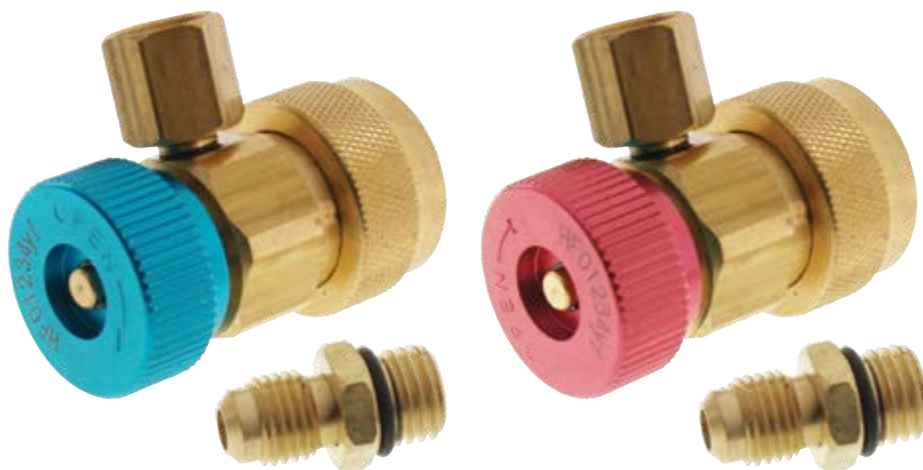
Zero ozone-depleting potential

Class A2L Refrigerant - Mildly flammable

Low total contribution to climate change

Same operating pressures as R134a system

Will your current equipment be suitable – again No. R1234yf is listed as “mildly flammable” so to stop possible cross contamination for a start the Couplings are different. Reclaim equipment needs to be approved for flammable refrigerant.



A18-4511 R1234yf Couplers

Equipment requirements for R1234yf must be A2L Compliant.

A R1234yf calibrated gauge set with dedicated R1234yf couplers. As R1234yf is an A2L mildly flammable substance, SAE standards have been developed for hoses and couplings.



A18-4547 R1234yf Manifold and Gauge set

Red and blue service hoses, the fittings are 12mm O Ring fittings male with a hexagon nut, (R134a is 1/2" acme female. R12 - commercial industry standard - is 1/4" flare female with a knurled nut).

R1234yf has a unique vehicle quick release fitting, to prevent use of incorrect equipment not fit for this type of refrigerant. Yellow service hose 1/2" LH acme thread (an adaptor is available to fit a universal vacuum pump).

The manifold gauge set is designed to take the male fittings of the hose set and are calibrated to read R1234yf temperatures.

Electronic refrigerant leak detector (A2L compliant).



A18-5079 Robinair R1234yf Leak Detector

ROBINAIR

Vacuum pump (A2L compliant).



A18-5119 Single Cylinder Vacuum Pump

Recovery/reclamation equipment (A2L compliant). Although it is not mandatory to recover R1234yf, it is still good environmental practice and, due to the cost of this refrigerant, it would be advisable to do so. Some suppliers can clean recovered refrigerant for re-use.

A18-5120 Single Cylinder R1234yf Reclaim unit



Dedicated cylinders for recovered or new R1234yf have a left-hand valve thread and require a suitable adaptor to connect to the gauge set charge hose. As R1234yf is a mildly flammable gas, cylinder storage and transport practices will differ to R134a cylinders. Check out the relevant dangerous goods handling and storage requirements for your State or Territory.



A20-8997 R1234yf Refrigerant 4.5Kg Cylinder

A refrigerant identifier is also recommended to ensure you are handling pure R1234yf, free of contaminants such as air or other refrigerants.



Is R1234yf compatible with existing R134a equipment?

No. The R1234yf system refrigerant circuit is accessed using service couplers that are a different size to those of a R134a system.

The service coupler hose connection also has a left-hand thread that requires a matching hose for connection. Hence the need for an R1234yf gauge set.

R1234yf is classified as an A2L mildly flammable refrigerant, and requires the use of equipment designed for use with such a refrigerant.

The exception is an electronic leak detector. Several manufacturers produce detectors that are suited to both refrigerants. Check with your refrigerant wholesaler.

Can I convert an R134a system to R1234yf?

No. R134a systems were not designed to operate using a flammable refrigerant.

R134a systems should not be converted to use R1234yf as these systems are unable to be converted to a level that satisfies the requirements of international standards (SAE J639 and SAE J2842) set for systems that use R1234yf.

The standards lay down specific requirements for system design. For example, the R1234yf evaporator is significantly stronger than the one you would commonly find in an R134a system.

Aside from the safety aspects, although the two refrigerants have similar thermodynamic properties, they are not the same. Therefore, compressor damage or system performance limitations may be experienced by attempting to convert an R134a system to R1234yf.

Where can I buy R1234yf?

R1234yf is available from JAS Branches nationwide.

Do I need an ARCTick Authorisation and Licence to buy and handle R1234yf?

No. R1234yf is not controlled under Australia's Ozone Protection and Synthetic Greenhouse Gas legislation. However, a licence is required if it is part of a blend containing a controlled HFC refrigerant. In addition, R134a will still be available, and in older systems, for years to come. It is a legal requirement that automotive workshops who provide air conditioning services (including recovery) continue to hold a refrigerant handling licence and refrigerant trading authorisation if R134a is being used.

For additional licensing requirements, check with your relevant state-based licensing authorities.

Safety issues to be aware of when handling R1234yf

R1234yf is classified as A2L mildly flammable. Technicians need to take the relevant safety measures for the correct transport, storage and handling of a flammable gas. This would include, but is not limited to, ensuring no open flames (including smoking) near the system. It is also worth noting that highly toxic substances are created when this gas is burnt.

Asphyxiation and freeze burns are also a risk. It is advised to check with your state-based Worksafe agency and refer to the relevant material safety data sheets available from your refrigerant wholesalers for specific safeguards when handling this refrigerant. Suitable Personal Protective Equipment (PPE) is to be worn when handling this refrigerant. Suitable trade training in flammable refrigerants is recommended prior to working on systems containing flammable refrigerants.

Workshop Safety with R1234yf

As R134A refrigerant is phased down R1234yf will become the common refrigerant used by Vehicle manufacturers in new vehicles.

R1234yf is a Flammable gas and therefore needs to be treated differently to R134A.

The SDS that accompanies this Tech Tip will cover safety aspects of R1234yf in a more comprehensive fashion but this information is designed to cover the basic equipment requirements for a workshop using this refrigerant.

As R1234yf is classified as a flammable refrigerant there was a decision made to differentiate the equipment required from previous R12 and R134A equipment by having the screw on fittings left hand thread so the 2 different gases cannot be substituted for each other.

This is also to prevent R134A equipment from being used for R1234yf due to the Flammability of R1234yf and the possibility of fire and explosion from any potential sparks created by equipment that is not designed specifically for working with flammable gasses.

Specific equipment is required for R1234yf to work safely with it.

A18-5120

Recovery Unit for R1234yf



Workshop Safety with R1234yf

A18-4547

Manifold and Gauges with R1234yf specific couplers



A18-5119

Vacuum Pump suitable for R1234yf



A18-5079

Refrigerant Leak Tester



A18-5010

Refrigerant Identifier



All of the above pieces of equipment have been manufactured to be used with R1234yf. The main risks in a workshop environment are:

- Leaking Refrigerant being ignited and causing an explosion and
- Asphyxiation due to oxygen displacement by heavier than air refrigerants

To remove the risk of both of these situations it is important that re gassing is done in an open environment and ideally storage of refrigerant cylinders is in a sun and weather protected, secure, outside area to prevent a build up of gas if there was a leak.

Please read the attached SDS for further safety information.

R1234YF

A-Gas (Australia) Pty Ltd

Chemwatch: 9270681

Version No: 3.1.1.1

Safety Data Sheet according to WHS and ADG requirements

Chemwatch Hazard Alert Code: 4

Issue Date: 27/08/2019

Print Date: 28/11/2019

L.GHS.AUS.EN

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

Product Identifier

Product name	R1234YF
Chemical Name	2,3,3,3-tetrafluoropropene
Synonyms	C3-H2-F4; CF3CH=CHF; (E)-CF3CH=CHF; (Z)-CF3CH=CHF; 2,3,3,3-tetrafluoropropene; 2,3,3,3-tetrafluoroprop-1-ene; 1,1,1,2-tetrafluoro-2-propene; 1H,1H-perfluoroprop-1-ene; 2,3,3,3-tetrafluoropropene-1; 2,3,3,3-tetrafluoro-1-propene; 2,3,3,3-tetrafluoropropylene; tetrafluoropropene; HFC-1234yf; HCFC-1234yf; HFO-1234ze; R 1234yf; 1234-yf; Opteon YF; blowing agent; fluoropropene
Proper shipping name	LIQUEFIED GAS, FLAMMABLE, N.O.S. (contains R1234yf)
Chemical formula	C3H2F4
Other means of identification	Not Available
CAS number	754-12-1

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

Relevant identified uses	Has been proposed as a replacement for R-134a as a refrigerant in automobile air conditioners. Although the product is classified slightly flammable, several years of testing by SAE proved that the product could not be ignited under conditions normally experienced by a vehicle. In addition, several independent authorities evaluated the safety of the product in vehicles and some of them concluded that it was as safe to use as a substitute R-134a, a product used in many cars. However, it was reported that tests by Mercedes-Benz showed that the substance ignited when researchers sprayed it and A/C compressor oil onto a car's hot engine. Combustion occurred in more than two thirds of simulated head-on collisions. The engineers also noticed etching on the windshield caused by the corrosive gases. BMW and VW-Audi agreed with Mercedes and left the SAE R-1234yf CRP Team, stating that the performed tests are not sufficient to fully judge the safety of their vehicles. HFO-1234yf, which has a 100 year GWP of 4, could be used as a "near drop-in replacement" for R-134a, a product used in automobile AC systems, which has a 100 year GWP of 1430. This means that automakers would not have to make significant modifications in assembly lines or in vehicle system designs to accommodate the product. HFO-1234yf has the lowest switching cost for automakers among the currently proposed alternatives, although the initial cost of the product is much higher than that of R-134a. The product could be handled in repair shops in the same way as R-134a, although it would require different, specialized equipment to perform the service. The use of a quantity of material in an unventilated or confined space may result in increased exposure and an irritating atmosphere developing. Before starting, consider control of exposure by mechanical ventilation.
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Details of the supplier of the safety data sheet

Registered company name	A-Gas (Australia) Pty Ltd
Address	9-11 Oxford Rd, Laverton North Victoria 3026 Australia
Telephone	93689208
Fax	Not Available
Website	Not Available
Email	Not Available

Emergency telephone number

Association / Organisation	TOLL CHEMICAL LOGISTICS
Emergency telephone numbers	1800024973
Other emergency telephone numbers	Not Available

SECTION 2 HAZARDS IDENTIFICATION

Classification of the substance or mixture

Poisons Schedule	Not Applicable
Classification ^[1]	Gas under Pressure (Liquefied gas), Flammable Gas Category 1
Legend:	1. Classified by Chemwatch; 2. Classification drawn from HCIS; 3. Classification drawn from Regulation (EU) No 1272/2008 - Annex VI

Label elements

Hazard pictogram(s)	 
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SIGNAL WORD	DANGER
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Hazard statement(s)

AUH044	Risk of explosion if heated under confinement.
AUH019	May form explosive peroxides.
H280	Contains gas under pressure; may explode if heated.
H220	Extremely flammable gas.

Precautionary statement(s) Prevention

P210	Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
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Precautionary statement(s) Response

P377	Leaking gas fire: Do not extinguish, unless leak can be stopped safely.
P381	Eliminate all ignition sources if safe to do so.

Precautionary statement(s) Storage

P410+P403	Protect from sunlight. Store in a well-ventilated place.
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Precautionary statement(s) Disposal

Not Applicable

SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS

Substances

CAS No	%[weight]	Name
754-12-1	>99.5	R1234yf

Mixtures

See section above for composition of Substances

SECTION 4 FIRST AID MEASURES

Description of first aid measures

Eye Contact	▶ If product comes in contact with eyes remove the patient from gas source or contaminated area. ▶ Take the patient to the nearest eye wash, shower or other source of clean water. ▶ Open the eyelid(s) wide to allow the material to evaporate. ▶ Gently rinse the affected eye(s) with clean, cool water for at least 15 minutes. Have the patient lie or sit down and tilt the head back. Hold the eyelid(s) open and pour water slowly over the eyeball(s) at the inner corners, letting the water run out of the outer corners. ▶ The patient may be in great pain and wish to keep the eyes closed. It is important that the material is rinsed from the eyes to prevent further damage. ▶ Ensure that the patient looks up, and side to side as the eye is rinsed in order to better reach all parts of the eye(s) ▶ Transport to hospital or doctor. ▶ Even when no pain persists and vision is good, a doctor should examine the eye as delayed damage may occur. ▶ If the patient cannot tolerate light, protect the eyes with a clean, loosely tied bandage. ▶ Ensure verbal communication and physical contact with the patient. DO NOT allow the patient to rub the eyes DO NOT allow the patient to tightly shut the eyes DO NOT introduce oil or ointment into the eye(s) without medical advice DO NOT use hot or tepid water.
Skin Contact	If skin contact occurs: ▶ Immediately remove all contaminated clothing, including footwear. ▶ Flush skin and hair with running water (and soap if available). ▶ Seek medical attention in event of irritation.
Inhalation	▶ Following exposure to gas, remove the patient from the gas source or contaminated area. ▶ NOTE: Personal Protective Equipment (PPE), including positive pressure self-contained breathing apparatus may be required to assure the safety of the rescuer. ▶ Prosthesis such as false teeth, which may block the airway, should be removed, where possible, prior to initiating first aid procedures. ▶ If the patient is not breathing spontaneously, administer rescue breathing. ▶ If the patient does not have a pulse, administer CPR.

	▶ If medical oxygen and appropriately trained personnel are available, administer 100% oxygen. ▶ Summon an emergency ambulance. If an ambulance is not available, contact a physician, hospital, or Poison Control Centre for further instruction. ▶ Keep the patient warm, comfortable and at rest while awaiting medical care. ▶ MONITOR THE BREATHING AND PULSE, CONTINUOUSLY. ▶ Administer rescue breathing (preferably with a demand-valve resuscitator, bag-valve mask-device, or pocket mask as trained) or CPR if necessary.
Ingestion	▶ Not considered a normal route of entry. ▶ Avoid giving milk or oils. ▶ Avoid giving alcohol.

Indication of any immediate medical attention and special treatment needed

for intoxication due to Freons/ Halons;

A: Emergency and Supportive Measures

- ▶ Maintain an open airway and assist ventilation if necessary
- ▶ Treat coma and arrhythmias if they occur. Avoid (adrenaline) epinephrine or other sympathomimetic amines that may precipitate ventricular arrhythmias. Tachyarrhythmias caused by increased myocardial sensitisation may be treated with propranolol, 1-2 mg IV or esmolol 25-100 microgm/kg/min IV.
- ▶ Monitor the ECG for 4-6 hours

B: Specific drugs and antidotes:

- ▶ There is no specific antidote

C: Decontamination

- ▶ Inhalation; remove victim from exposure, and give supplemental oxygen if available.
- ▶ Ingestion; (a) Prehospital: Administer activated charcoal, if available. **DO NOT** induce vomiting because of rapid absorption and the risk of abrupt onset CNS depression. (b) Hospital: Administer activated charcoal, although the efficacy of charcoal is unknown. Perform gastric lavage only if the ingestion was very large and recent (less than 30 minutes)

D: Enhanced elimination:

- ▶ There is no documented efficacy for diuresis, haemodialysis, haemoperfusion, or repeat-dose charcoal.

POISONING and DRUG OVERDOSE, Californian Poison Control System Ed. Kent R Olson; 3rd Edition

- ▶ Do not administer sympathomimetic drugs unless absolutely necessary as material may increase myocardial irritability.
- ▶ No specific antidote.
- ▶ Because rapid absorption may occur through lungs if aspirated and cause systematic effects, the decision of whether to induce vomiting or not should be made by an attending physician.
- ▶ If lavage is performed, suggest endotracheal and/or esophageal control.
- ▶ Danger from lung aspiration must be weighed against toxicity when considering emptying the stomach.
- ▶ Treatment based on judgment of the physician in response to reactions of the patient

For frost-bite caused by liquefied petroleum gas:

- ▶ If part has not thawed, place in warm water bath (41-46 C) for 15-20 minutes, until the skin turns pink or red.
- ▶ Analgesia may be necessary while thawing.
- ▶ If there has been a massive exposure, the general body temperature must be depressed, and the patient must be immediately rewarmed by whole-body immersion, in a bath at the above temperature.
- ▶ Shock may occur during rewarming.
- ▶ Administer tetanus toxoid booster after hospitalization.
- ▶ Prophylactic antibiotics may be useful.
- ▶ The patient may require anticoagulants and oxygen.

[Shell Australia 22/12/87]

For gas exposures:

BASIC TREATMENT

- ▶ Establish a patent airway with suction where necessary.
- ▶ Watch for signs of respiratory insufficiency and assist ventilation as necessary.
- ▶ Administer oxygen by non-rebreather mask at 10 to 15 l/min.
- ▶ Monitor and treat, where necessary, for pulmonary oedema .
- ▶ Monitor and treat, where necessary, for shock.
- ▶ Anticipate seizures.

ADVANCED TREATMENT

- ▶ Consider orotracheal or nasotracheal intubation for airway control in unconscious patient or where respiratory arrest has occurred.
- ▶ Positive-pressure ventilation using a bag-valve mask might be of use.
- ▶ Monitor and treat, where necessary, for arrhythmias.
- ▶ Start an IV D5W TKO. If signs of hypovolaemia are present use lactated Ringers solution. Fluid overload might create complications.
- ▶ Drug therapy should be considered for pulmonary oedema.
- ▶ Hypotension with signs of hypovolaemia requires the cautious administration of fluids. Fluid overload might create complications.
- ▶ Treat seizures with diazepam.
- ▶ Proparacaine hydrochloride should be used to assist eye irrigation.

BRONSTEIN, A.C. and CURRRANCE, P.L.

EMERGENCY CARE FOR HAZARDOUS MATERIALS EXPOSURE: 2nd Ed. 1994

SECTION 5 FIREFIGHTING MEASURES

Extinguishing media

**DO NOT EXTINGUISH BURNING GAS UNLESS LEAK CAN BE STOPPED SAFELY:
OTHERWISE: LEAVE GAS TO BURN.**

FOR SMALL FIRE:

- ▶ Dry chemical, CO2 or water spray to extinguish gas (only if absolutely necessary and safe to do so).

- ▶ **DO NOT** use water jets.

FOR LARGE FIRE:

- ▶ Cool cylinder by direct flooding quantities of water onto upper surface until well after fire is out.

Special hazards arising from the substrate or mixture

Fire Incompatibility	▶ Avoid contamination with oxidising agents i.e. nitrates, oxidising acids, chlorine bleaches, pool chlorine etc. as ignition may result
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Advice for firefighters

Fire Fighting	FOR FIRES INVOLVING MANY GAS CYLINDERS: ▶ To stop the flow of gas, specifically trained personnel may inert the atmosphere to reduce oxygen levels thus allowing the capping of leaking container(s). ▶ Reduce the rate of flow and inject an inert gas, if possible, before completely stopping the flow to prevent flashback. ▶ DO NOT extinguish the fire until the supply is shut off otherwise an explosive re-ignition may occur. ▶ If the fire is extinguished and the flow of gas continues, used increased ventilation to prevent build-up, of explosive atmosphere. ----- GENERAL ----- ▶ Alert Fire Brigade and tell them location and nature of hazard. ▶ May be violently or explosively reactive. ▶ Wear breathing apparatus plus protective gloves. ▶ Consider evacuation ▶ Fight fire from a safe distance, with adequate cover.
Fire/Explosion Hazard	▶ HIGHLY FLAMMABLE: will be easily ignited by heat, sparks or flames. ▶ Will form explosive mixtures with air ▶ Fire exposed containers may vent contents through pressure relief valves thereby increasing fire intensity and/ or vapour concentration. ▶ Vapours may travel to source of ignition and flash back. ▶ Containers may explode when heated - Ruptured cylinders may rocket ▶ Fire may produce irritating, poisonous or corrosive gases. Combustion products include: carbon monoxide (CO) carbon dioxide (CO2) hydrogen fluoride other pyrolysis products typical of burning organic material. Contains low boiling substance: Closed containers may rupture due to pressure buildup under fire conditions. ▶ Vented gas is more dense than air and may collect in pits, basements.
HAZCHEM	2YE

SECTION 6 ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

See section 8

Environmental precautions

See section 12

Methods and material for containment and cleaning up

Minor Spills	▶ Avoid breathing vapour and any contact with liquid or gas. Protective equipment including respirator should be used. ▶ DO NOT enter confined spaces where gas may have accumulated. ▶ Shut off all sources of possible ignition and increase ventilation.
Major Spills	▶ Clear area of all unprotected personnel and move upwind. ▶ Alert Emergency Authority and advise them of the location and nature of hazard. ▶ May be violently or explosively reactive. ▶ Wear full body clothing with breathing apparatus. ▶ Remove leaking cylinders to a safe place. ▶ Fit vent pipes. Release pressure under safe, controlled conditions ▶ Burn issuing gas at vent pipes. ▶ DO NOT exert excessive pressure on valve; DO NOT attempt to operate damaged valve.

Personal Protective Equipment advice is contained in Section 8 of the SDS.

SECTION 7 HANDLING AND STORAGE

Precautions for safe handling

Safe handling	·Consider use in closed pressurised systems, fitted with temperature, pressure and safety relief valves which are vented for safe dispersal. Use only properly specified equipment which is suitable for this product, its supply pressure and temperature ·The tubing network design connecting gas cylinders to the delivery system should include appropriate pressure indicators and vacuum or suction lines. ·Fully-welded types of pressure gauges, where the bourdon tube sensing element is welded to the gauge body, are recommended. ·Before connecting gas cylinders, ensure manifold is mechanically secure and does not containing another gas. ▶ Avoid generation of static electricity. Earth all lines and equipment. ▶ DO NOT transfer gas from one cylinder to another.
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Other information	‣ Polymerisation may occur slowly at room temperature. ‣ Cylinders should be stored in a purpose-built compound with good ventilation, preferably in the open. ‣ Such compounds should be sited and built in accordance with statutory requirements. ‣ The storage compound should be kept clear and access restricted to authorised personnel only. ‣ Cylinders stored in the open should be protected against rust and extremes of weather.
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Conditions for safe storage, including any incompatibilities

Suitable container	‣ DO NOT use aluminium or galvanised containers ‣ Cylinder: ‣ Ensure the use of equipment rated for cylinder pressure. ‣ Ensure the use of compatible materials of construction. ‣ Valve protection cap to be in place until cylinder is secured, connected. ‣ Cylinder must be properly secured either in use or in storage.
Storage incompatibility	As a general rule, hydrofluorocarbons tend to be flammable unless they contain more fluorine atoms than hydrogen atoms. ‣ Haloalkenes are highly reactive. ‣ Some of the more lightly substituted lower members are highly flammable; many members of the group are peroxidisable and polymerisable. ‣ Avoid reaction or contact with potassium or its alloys - although apparently stable on contact with a wide rage of halocarbons, reaction products may be shock-sensitive and may explode with great violence on light impact. Severity generally increases with the degree of halocarbon substitution and potassium-sodium alloys give extremely sensitive mixtures. ‣ Compressed gases may contain a large amount of kinetic energy over and above that potentially available from the energy of reaction produced by the gas in chemical reaction with other substances

SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

Control parameters

OCCUPATIONAL EXPOSURE LIMITS (OEL)

INGREDIENT DATA

Not Available

EMERGENCY LIMITS

Ingredient	Material name	TEEL-1	TEEL-2	TEEL-3
R1234yf	HFO-1234yf; 2,3,3,3-Tetrafluoropropene	2,200 ppm	Not Available	1.40E+05 ppm

Ingredient	Original IDLH	Revised IDLH
R1234yf	Not Available	Not Available

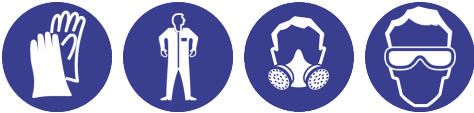
MATERIAL DATA

Sensory irritants are chemicals that produce temporary and undesirable side-effects on the eyes, nose or throat. Historically occupational exposure standards for these irritants have been based on observation of workers' responses to various airborne concentrations. Present day expectations require that nearly every individual should be protected against even minor sensory irritation and exposure standards are established using uncertainty factors or safety factors of 5 to 10 or more. On occasion animal no-observable-effect-levels (NOEL) are used to determine these limits where human results are unavailable.

May act as a simple asphyxiants; these are gases which, when present in high concentrations, reduce the oxygen content in air below that required to support breathing, consciousness and life; loss of consciousness, with death by suffocation may rapidly occur in an oxygen deficient atmosphere.

CARE: Most simple asphyxiants are odourless or possess low odour and there is no warning on entry into an oxygen deficient atmosphere. If there is any doubt, oxygen content can be checked simply and quickly. It may not be appropriate to only recommend an exposure standard for simple asphyxiants rather it is essential that sufficient oxygen be maintained.

Exposure controls

Appropriate engineering controls	Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection. The basic types of engineering controls are: Process controls which involve changing the way a job activity or process is done to reduce the risk. Enclosure and/or isolation of emission source which keeps a selected hazard "physically" away from the worker and ventilation that strategically "adds" and "removes" air in the work environment.
Personal protection	
Eye and face protection	‣ Safety glasses with side shields. ‣ Chemical goggles. ‣ Contact lenses may pose a special hazard; soft contact lenses may absorb and concentrate irritants. A written policy document, describing the wearing of lenses or restrictions on use, should be created for each workplace or task.
Skin protection	See Hand protection below
Hands/feet protection	‣ When handling sealed and suitably insulated cylinders wear cloth or leather gloves.
Body protection	See Other protection below
Other protection	‣ The clothing worn by process operators insulated from earth may develop static charges far higher (up to 100 times) than the minimum ignition energies for various flammable gas-air mixtures. This holds true for a wide range of clothing materials including cotton. ‣ Avoid dangerous levels of charge by ensuring a low resistivity of the surface material worn outermost.

BREThERICK: Handbook of Reactive Chemical Hazards.

- ▶ Protective overalls, closely fitted at neck and wrist.
- ▶ Eye-wash unit.

IN CONFINED SPACES:

- ▶ Non-sparking protective boots
- ▶ Static-free clothing.
- ▶ Ensure availability of lifeline.
- ▶ Some plastic personal protective equipment (PPE) (e.g. gloves, aprons, overshoes) are not recommended as they may produce static electricity.
- ▶ For large scale or continuous use wear tight-weave non-static clothing (no metallic fasteners, cuffs or pockets).
- ▶ Non sparking safety or conductive footwear should be considered. Conductive footwear describes a boot or shoe with a sole made from a conductive compound chemically bound to the bottom components, for permanent control to electrically ground the foot and shall dissipate static electricity from the body to reduce the possibility of ignition of volatile compounds.

Respiratory protection

Type A Filter of sufficient capacity. (AS/NZS 1716 & 1715, EN 143:2000 & 149:2001, ANSI Z88 or national equivalent)

Selection of the Class and Type of respirator will depend upon the level of breathing zone contaminant and the chemical nature of the contaminant. Protection Factors (defined as the ratio of contaminant outside and inside the mask) may also be important.

Required minimum protection factor	Maximum gas/vapour concentration present in air p.p.m. (by volume)	Half-face Respirator	Full-Face Respirator
up to 10	1000	A-AUS / Class1	-
up to 50	1000	-	A-AUS / Class 1
up to 50	5000	Airline *	-
up to 100	5000	-	A-2
up to 100	10000	-	A-3
100+			Airline**

* - Continuous Flow ** - Continuous-flow or positive pressure demand

A(All classes) = Organic vapours, B AUS or B1 = Acid gasses, B2 = Acid gas or hydrogen cyanide(HCN), B3 = Acid gas or hydrogen cyanide(HCN), E = Sulfur dioxide(SO₂), G = Agricultural chemicals, K = Ammonia(NH₃), Hg = Mercury, NO = Oxides of nitrogen, MB = Methyl bromide, AX = Low boiling point organic compounds(below 65 degC)

- ▶ Cartridge respirators should never be used for emergency ingress or in areas of unknown vapour concentrations or oxygen content.
- ▶ The wearer must be warned to leave the contaminated area immediately on detecting any odours through the respirator. The odour may indicate that the mask is not functioning properly, that the vapour concentration is too high, or that the mask is not properly fitted. Because of these limitations, only restricted use of cartridge respirators is considered appropriate.
- ▶ Cartridge performance is affected by humidity. Cartridges should be changed after 2 hr of continuous use unless it is determined that the humidity is less than 75%, in which case, cartridges can be used for 4 hr. Used cartridges should be discarded daily, regardless of the length of time used
- ▶ Positive pressure, full face, air-supplied breathing apparatus should be used for work in enclosed spaces if a leak is suspected or the primary containment is to be opened (e.g. for a cylinder change)
- ▶ Air-supplied breathing apparatus is required where release of gas from primary containment is either suspected or demonstrated.

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Appearance	Liquefied colourless, ether-like, gas; does not mix well with water (0.1982 g/l, 24 C).		
Physical state	Liquified Gas	Relative density (Water = 1)	0.0048 (20 C)
Odour	Not Available	Partition coefficient n-octanol / water	2.0
Odour threshold	Not Available	Auto-ignition temperature (°C)	405
pH (as supplied)	Not Applicable	Decomposition temperature	Not Available
Melting point / freezing point (°C)	-152.2	Viscosity (cSt)	Not Applicable
Initial boiling point and boiling range (°C)	-29.4	Molecular weight (g/mol)	114.04
Flash point (°C)	Not Available	Taste	Not Available
Evaporation rate	Not Available	Explosive properties	Not Available
Flammability	Not Available	Oxidising properties	Not Available
Upper Explosive Limit (%)	12.3 (21 C)	Surface Tension (dyn/cm or mN/m)	Not Available
Lower Explosive Limit (%)	6.2 (21 C)	Volatile Component (%vol)	100
Vapour pressure (kPa)	5.83	Gas group	Not Available
Solubility in water	Partly miscible	pH as a solution (1%)	Not Applicable
Vapour density (Air = 1)	4	VOC g/L	Not Available

SECTION 10 STABILITY AND REACTIVITY

Reactivity	See section 7
Chemical stability	▶ Unstable in the presence of incompatible materials. ▶ Product is considered stable. ▶ Hazardous polymerisation will not occur.
Possibility of hazardous reactions	See section 7
Conditions to avoid	See section 7
Incompatible materials	See section 7
Hazardous decomposition products	See section 5

SECTION 11 TOXICOLOGICAL INFORMATION

Information on toxicological effects

Inhaled	Inhalation of vapours may cause drowsiness and dizziness. This may be accompanied by narcosis, reduced alertness, loss of reflexes, lack of coordination and vertigo. Inhalation of vapours or aerosols (mists, fumes), generated by the material during the course of normal handling, may be damaging to the health of the individual. Limited evidence or practical experience suggests that the material may produce irritation of the respiratory system, in a significant number of individuals, following inhalation. In contrast to most organs, the lung is able to respond to a chemical insult by first removing or neutralising the irritant and then repairing the damage. The repair process, which initially evolved to protect mammalian lungs from foreign matter and antigens, may however, produce further lung damage resulting in the impairment of gas exchange, the primary function of the lungs. Respiratory tract irritation often results in an inflammatory response involving the recruitment and activation of many cell types, mainly derived from the vascular system. Exposure to high concentrations of fluorocarbons may produce cardiac arrhythmias or cardiac arrest due sensitisation of the heart to adrenalin or noradrenalin. Deaths associated with exposures to fluorocarbons (specifically halogenated aliphatics) have occurred in occupational settings and in inhalation of bronchodilator drugs. Bronchospasm consistently occurs in human subjects inhaling fluorocarbons. At a measured concentration of 1700 ppm of one of the commercially available aerosols there is a biphasic change in ventilatory capacity, the first reduction occurring within a few minutes and the second delayed up to 30 minutes. Material is highly volatile and may quickly form a concentrated atmosphere in confined or unventilated areas. The vapour may displace and replace air in breathing zone, acting as a simple asphyxiant. This may happen with little warning of overexposure. Symptoms of asphyxia (suffocation) may include headache, dizziness, shortness of breath, muscular weakness, drowsiness and ringing in the ears. If the asphyxia is allowed to progress, there may be nausea and vomiting, further physical weakness and unconsciousness and, finally, convulsions, coma and death. Significant concentrations of the non-toxic gas reduce the oxygen level in the air. As the amount of oxygen is reduced from 21 to 14 volume %, the pulse rate accelerates and the rate and volume of breathing increase. The use of a quantity of material in an unventilated or confined space may result in increased exposure and an irritating atmosphere developing. Before starting consider control of exposure by mechanical ventilation. Common, generalised symptoms associated with non-toxic gas inhalation include : ▶ central nervous system effects such as headache, confusion, dizziness, progressive stupor, coma and seizures; ▶ respiratory system complications may include tachypnoea and dyspnoea; ▶ cardiovascular effects may include circulatory collapse and arrhythmias; ▶ gastrointestinal effects may also be present and may include mucous membrane irritation and nausea and vomiting.
Ingestion	Overexposure is unlikely in this form. Not normally a hazard due to physical form of product. Considered an unlikely route of entry in commercial/industrial environments
Skin Contact	Skin contact is not thought to have harmful health effects (as classified under EC Directives); the material may still produce health damage following entry through wounds, lesions or abrasions. Repeated exposure may cause skin cracking, flaking or drying following normal handling and use. Limited evidence exists, or practical experience predicts, that the material either produces inflammation of the skin in a substantial number of individuals following direct contact, and/or produces significant inflammation when applied to the healthy intact skin of animals, for up to four hours, such inflammation being present twenty-four hours or more after the end of the exposure period. Skin irritation may also be present after prolonged or repeated exposure; this may result in a form of contact dermatitis (nonallergic). The dermatitis is often characterised by skin redness (erythema) and swelling (oedema) which may progress to blistering (vesiculation), scaling and thickening of the epidermis. At the microscopic level there may be intercellular oedema of the spongy layer of the skin (spongiosis) and intracellular oedema of the epidermis. In common with other halogenated aliphatics, fluorocarbons may cause dermal problems due to a tendency to remove natural oils from the skin causing irritation and the development of dry, sensitive skin. They do not appear to be appreciably absorbed. Open cuts, abraded or irritated skin should not be exposed to this material Entry into the blood-stream through, for example, cuts, abrasions, puncture wounds or lesions, may produce systemic injury with harmful effects. Examine the skin prior to the use of the material and ensure that any external damage is suitably protected.
Eye	Although the material is not thought to be an irritant (as classified by EC Directives), direct contact with the eye may produce transient discomfort characterised by tearing or conjunctival redness (as with windburn). Direct contact with the eye may not cause irritation because of the extreme volatility of the gas; however concentrated atmospheres may produce irritation after brief exposures..
Chronic	On the basis, primarily, of animal experiments, concern has been expressed by at least one classification body that the material may produce carcinogenic or mutagenic effects; in respect of the available information, however, there presently exists inadequate data for making a satisfactory assessment. Limited evidence suggests that repeated or long-term occupational exposure may produce cumulative health effects involving organs or

	biochemical systems. Halogenated oxiranes may arise following epoxidation of haloalkenes. The metabolism of haloethylenes by microsomal oxidation leading to epoxide formation across the double bond has been proposed. The resulting oxiranes are highly reactive and may covalently bind to nucleic acids leading to mutations and possible cancers A measure of such potential carcinogenicity is the development of significant preneoplastic foci in livers of treated rats. The carcinogenicity of halogenated oxiranes may lie in the reactivity of an epoxide intermediate. Principal route of occupational exposure to the gas is by inhalation. It is generally accepted that the fluorocarbons are less toxic than the corresponding halogenated aliphatic based on chlorine. Repeated inhalation exposure to the fluorocarbon FC-11 does not produce pathologic lesions of the liver and other visceral organs in experimental animals. There has been conjecture in non-scientific publications that fluorocarbons may cause leukemia, cancer, sterility and birth defects; these have not been verified by current research. The high incidence of cancer, spontaneous abortion and congenital anomalies amongst hospital personnel, repeatedly exposed to fluorine-containing general anaesthetics, has caused some scientists to call for a lowering of the fluorocarbon exposure standard to 5 ppm since some are mutagens.				
R1234yf	<table> <tr> <th>TOXICITY</th><th>IRRITATION</th></tr> <tr> <td>Not Available</td><td>Not Available</td></tr> </table>	TOXICITY	IRRITATION	Not Available	Not Available
TOXICITY	IRRITATION				
Not Available	Not Available				
Legend:	1. Value obtained from Europe ECHA Registered Substances - Acute toxicity 2. * Value obtained from manufacturer's SDS. Unless otherwise specified data extracted from RTECS - Register of Toxic Effect of chemical Substances				

R1234YF	Mutagenicity : Did not cause genetic damage in animals. Did not cause genetic damage in cultured mammalian cells. Experiments showed mutagenic effects in cultured bacterial cells. Reproductive toxicity : Animal testing showed no reproductive toxicity. Teratogenicity : Animal testing showed effects on embryo-fetal development at levels equal to or above those causing maternal toxicity. * Vendor For similar product, 1,3,3,3-tetrafluoropropene HFO-1234ze is not likely to accumulate in the bodies of humans or animals HFO-1234ze is practically non-toxic. Short-term exposures at levels higher than 10% have not induced cardiac sensitization to adrenalin nor induced serious toxic effects. Rats and rabbits did not exhibit any serious toxic, developmental or reproductive effects even with exposures to high levels of HFO-1234ze. Based on a series of mutagenicity and genomics studies, the cancer risk for HFO-1234ze is LOW The fluoroalkenes vary widely in acute inhalation toxicity. Those, such as perfluoroisobutylene, PFIB, the most highly toxic member, attacks the pulmonary epithelium of rats eventuating in edema and death after a delay of about one day. Other fluoroalkenes, such as hexafluoropropylene (HFP) or chlorotrifluoroethylene (CTFE), also cause pulmonary injury but at lower concentrations produce concentration dependent changes in the renal concentrating mechanism of the rat. Changes in the CNS of rats and rabbits have also been reported for CTFE. Disinfection by products (DBPs) re formed when disinfectants such as chlorine, chloramine, and ozone react with organic and inorganic matter in water. The observations that some DBPs such as trihalomethanes (THMs), di-/trichloroacetic acids, and 3-chloro-4-(dichloromethyl)-5-hydroxy-2(5H)-furanone (MX) are carcinogenic in animal studies have raised public concern over the possible adverse health effects of DBPs. To date, several hundred DBPs have been identified. Numerous haloalkanes and haloalkenes have been tested for carcinogenic and mutagenic activities.
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Acute Toxicity	✗	Carcinogenicity	✗
Skin Irritation/Corrosion	✗	Reproductivity	✗
Serious Eye Damage/Irritation	✗	STOT - Single Exposure	✗
Respiratory or Skin sensitisation	✗	STOT - Repeated Exposure	✗
Mutagenicity	✗	Aspiration Hazard	✗

Legend: ✗ – Data either not available or does not fill the criteria for classification
 ✔ – Data available to make classification

SECTION 12 ECOLOGICAL INFORMATION

Toxicity

R1234yf	ENDPOINT	TEST DURATION (HR)	SPECIES	VALUE	SOURCE
	LC50	96	Fish	15.051mg/L	3
	EC50	48	Crustacea	65mg/L	2
	EC50	72	Algae or other aquatic plants	>2.5mg/L	2
	NOEC	72	Algae or other aquatic plants	>=2.5mg/L	2
Legend:	Extracted from 1. IUCLID Toxicity Data 2. Europe ECHA Registered Substances - Ecotoxicological Information - Aquatic Toxicity 3. EPIWIN Suite V3.12 (QSAR) - Aquatic Toxicity Data (Estimated) 4. US EPA, Ecotox database - Aquatic Toxicity Data 5. ECETOC Aquatic Hazard Assessment Data 6. NITE (Japan) - Bioconcentration Data 7. METI (Japan) - Bioconcentration Data 8. Vendor Data				

HFO-1234yf is the first in a new class of refrigerants acquiring a global warming potential (GWP) rating 335 times less than that of R-134a (and only 4 times higher than carbon dioxide, which can also be used as a refrigerant but has significantly different properties to R134A, especially requiring operation at around 5 times higher pressure) and an atmospheric lifetime of about 400 times shorter. It was developed to meet the European directive 2006/40/EC that went into effect in 2011 requiring that all new car platforms for sale in Europe use a refrigerant in its AC system with a GWP below 150 In the atmosphere, HFO-1234yf degrades to trifluoroacetic acid which is a mildly phytotoxic strong organic acid with no known degradation mechanism in water. GWP 1000 less than SF6 Fish LC50 (96 h): carp (Cyprinus carpio) >197 mg/l Algae NOEC (72 h): >100 mg/l Daphnia magna (EC50 (48 h): >100 mg/l Not readily biodegradable. Although practically non-biodegradable, HFO-1234ze is unlikely to impact the aquatic environment because of its high volatility and low toxicity to aquatic organisms. It will migrate almost exclusively into the atmosphere where it will have a lifetime of less than 2 weeks. Substances containing unsaturated carbons are ubiquitous in indoor environments. They result from many sources (see below). Most are reactive with environmental ozone and many produce stable products which are thought to adversely affect human health.The potential for surfaces in an enclosed space to facilitate reactions should be considered.

Source of unsaturated substances Unsaturated substances (Reactive Emissions) Major Stable Products produced following reaction with ozone.

In addition to carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O), the greenhouse gases mentioned in the Kyoto Protocol include synthetic substances that share the common feature of being highly persistent in the atmosphere and exhibiting very high specific radiative forcing (radiative forcing is the change in the balance between radiation coming into the atmosphere and radiation out; a positive radiative forcing tends on average to warm the surface of the earth). These synthetic substances include hydrocarbons that are partially fluorinated (HCFs) or totally fluorinated (PFCs) as well as sulfur hexafluoride (SF6).

The greenhouse potential of these substances, expressed as multiples of that of CO2, are within the range of 140 to 11,700 for HFCs, from 6500 to 9,200 for PFCs and 23,900 for SF6. Once emitted into the atmosphere, these substances have an impact on the environment for decades, centuries, or in certain instances, for thousands of years.

DO NOT discharge into sewer or waterways.

Persistence and degradability

Ingredient	Persistence: Water/Soil	Persistence: Air
R1234yf	HIGH	HIGH

Bioaccumulative potential

Ingredient	Bioaccumulation
R1234yf	LOW (LogKOW = 2.1485)

Mobility in soil

Ingredient	Mobility
R1234yf	LOW (KOC = 154.4)

SECTION 13 DISPOSAL CONSIDERATIONS

Waste treatment methods

Product / Packaging disposal	▶ Evaporate or incinerate residue at an approved site. ▶ Return empty containers to supplier. ▶ Ensure damaged or non-returnable cylinders are gas-free before disposal.
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SECTION 14 TRANSPORT INFORMATION

Labels Required

	
Marine Pollutant	NO
HAZCHEM	2YE

Land transport (ADG)

UN number	3161				
UN proper shipping name	LIQUEFIED GAS, FLAMMABLE, N.O.S. (contains R1234yf)				
Transport hazard class(es)	<table><tr><td>Class</td><td>2.1</td></tr><tr><td>Subrisk</td><td>Not Applicable</td></tr></table>	Class	2.1	Subrisk	Not Applicable
Class	2.1				
Subrisk	Not Applicable				
Packing group	Not Applicable				
Environmental hazard	Not Applicable				
Special precautions for user	<table><tr><td>Special provisions</td><td>274</td></tr><tr><td>Limited quantity</td><td>0</td></tr></table>	Special provisions	274	Limited quantity	0
Special provisions	274				
Limited quantity	0				

Air transport (ICAO-IATA / DGR)

UN number	3161						
UN proper shipping name	Liquefied gas, flammable, n.o.s. * (contains R1234yf)						
Transport hazard class(es)	<table><tr><td>ICAO/IATA Class</td><td>2.1</td></tr><tr><td>ICAO / IATA Subrisk</td><td>Not Applicable</td></tr><tr><td>ERG Code</td><td>10L</td></tr></table>	ICAO/IATA Class	2.1	ICAO / IATA Subrisk	Not Applicable	ERG Code	10L
ICAO/IATA Class	2.1						
ICAO / IATA Subrisk	Not Applicable						
ERG Code	10L						
Packing group	Not Applicable						
Environmental hazard	Not Applicable						

Special precautions for user	Special provisions	A1 A807
	Cargo Only Packing Instructions	200
	Cargo Only Maximum Qty / Pack	150 kg
	Passenger and Cargo Packing Instructions	Forbidden
	Passenger and Cargo Maximum Qty / Pack	Forbidden
	Passenger and Cargo Limited Quantity Packing Instructions	Forbidden
	Passenger and Cargo Limited Maximum Qty / Pack	Forbidden

Sea transport (IMDG-Code / GGVSee)

UN number	3161
UN proper shipping name	LIQUEFIED GAS, FLAMMABLE, N.O.S. (contains R1234yf)
Transport hazard class(es)	IMDG Class2.1
	IMDG SubriskNot Applicable
Packing group	Not Applicable
Environmental hazard	Not Applicable
Special precautions for user	EMS NumberF-D , S-U
	Special provisions274
	Limited Quantities0

Transport in bulk according to Annex II of MARPOL and the IBC code

Not Applicable

SECTION 15 REGULATORY INFORMATION

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

R1234YF IS FOUND ON THE FOLLOWING REGULATORY LISTS	
Australia Dangerous Goods Code (ADG Code) - Dangerous Goods List	International Air Transport Association (IATA) Dangerous Goods Regulations
Australia Dangerous Goods Code (ADG Code) - List of Emergency Action Codes	International Maritime Dangerous Goods Requirements (IMDG Code)
Australia Dangerous Goods Code (ADG Code) - Packing Instruction - Liquefied and Dissolved Gases	United Nations Recommendations on the Transport of Dangerous Goods Model Regulations

National Inventory Status

National Inventory	Status
Australia - AICS	No (R1234yf)
Canada - DSL	Yes
Canada - NDSL	No (R1234yf)
China - IECSC	No (R1234yf)
Europe - EINEC / ELINCS / NLP	No (R1234yf)
Japan - ENCS	Yes
Korea - KECI	Yes
New Zealand - NZIoC	Yes
Philippines - PICCS	No (R1234yf)
USA - TSCA	Yes
Taiwan - TCSI	Yes
Mexico - INSQ	No (R1234yf)
Vietnam - NCI	Yes
Russia - ARIPS	No (R1234yf)
Legend:	Yes = All CAS declared ingredients are on the inventory No = One or more of the CAS listed ingredients are not on the inventory and are not exempt from listing(see specific ingredients in brackets)

SECTION 16 OTHER INFORMATION

Revision Date	27/08/2019
Initial Date	16/02/2015

SDS Version Summary

Version	Issue Date	Sections Updated
3.1.1.1	27/08/2019	Expiration. Review and Update

Other information

Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.

The SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings. Risks may be determined by reference to Exposures Scenarios. Scale of use, frequency of use and current or available engineering controls must be considered.

Definitions and abbreviations

PC—TWA: Permissible Concentration-Time Weighted Average

PC—STEL: Permissible Concentration-Short Term Exposure Limit

IARC: International Agency for Research on Cancer

ACGIH: American Conference of Governmental Industrial Hygienists

STEL: Short Term Exposure Limit

TEEL: Temporary Emergency Exposure Limit.

IDLH: Immediately Dangerous to Life or Health Concentrations

OSF: Odour Safety Factor

NOAEL :No Observed Adverse Effect Level

LOAEL: Lowest Observed Adverse Effect Level

TLV: Threshold Limit Value

LOD: Limit Of Detection

OTV: Odour Threshold Value

BCF: BioConcentration Factors

BEI: Biological Exposure Index

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