Solstice[®] yf Refrigerant



User Guide

Honeywell



Honeywell Solstice® yf Refrigerant User Guide

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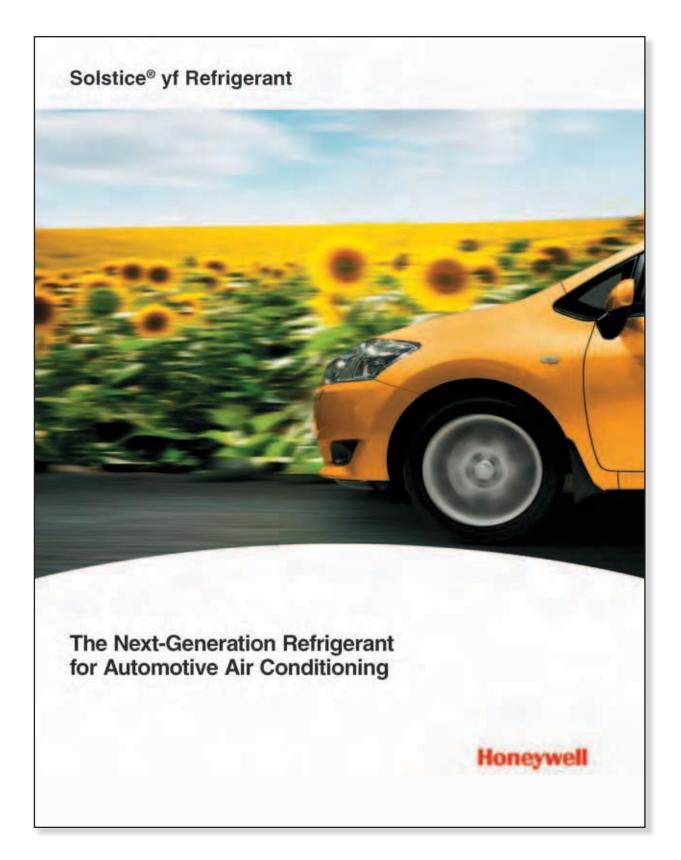




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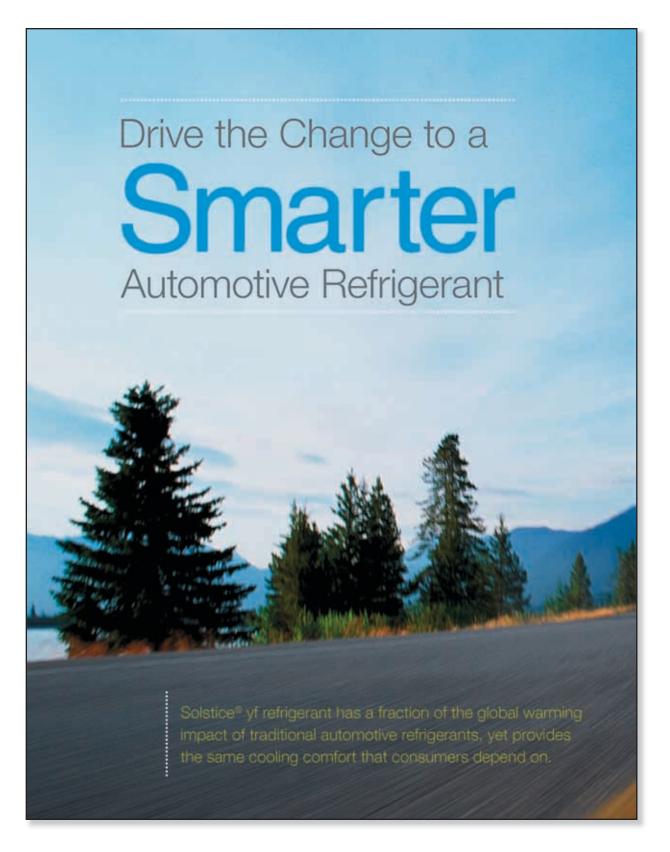


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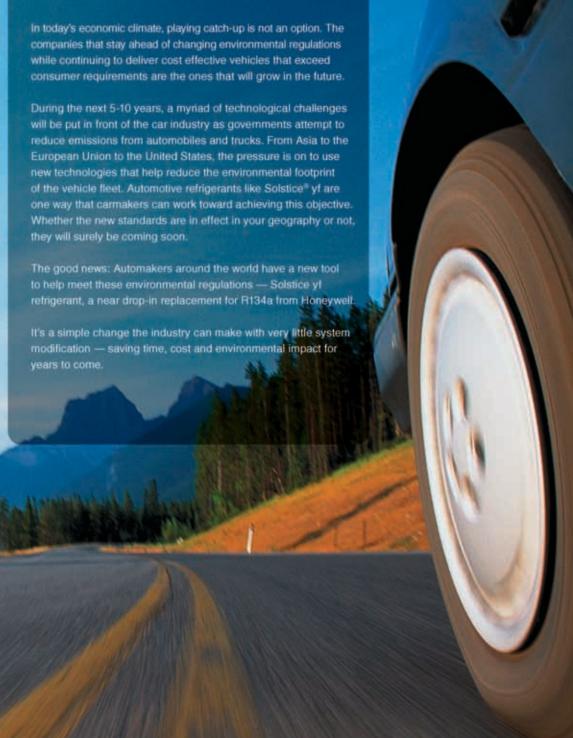
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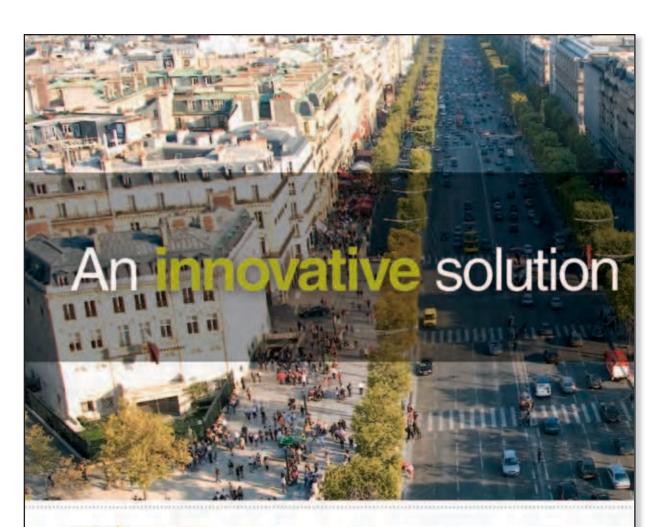


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Why Switch to Solstice® yf Refrigerant Now?

Consumers stay cool. Automakers reduce environmental impact without significant changes to vehicle designs.

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Excellent Cooling Performance

- Just as effective. Honeywall Solstice[®] yf refrigerant is as effective as HFC-134a and offers comparable cooling performance in all climates.
- More energy efficient. Air conditioning systems using Solition yf refrigerant are generally more energy efficient than competing technologies.

Lusi Environmental Impact

- Surpasses new EU standards. Honeywell Solston yf refrigerant doesn't sust meet the new standard; it significantly surpasses it. With a global warming potential (GWP) of less than 1, it's 99.3% lower than the EU's Mobile Air Conditioning (MAC) Directive requires' and 99.9% lower than R134a.
- Reduces fuel consumption and emissions. Vehicles equipped with Solitice yf refrigerant use less fuel and produce 20% to 30% fewer emissions than the CO₂ atternative, shrinking their carbon footprint even more.

99.9 percent

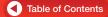
lower global warming potential than R134a

1.1.1

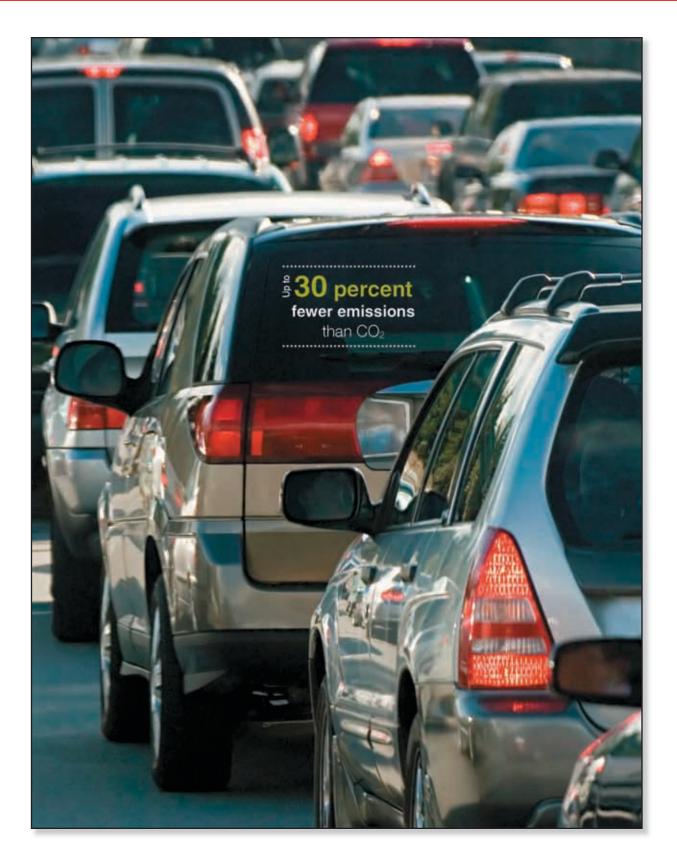
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Lower Cast In-Use

 Solstice* yf is easily integrated into vehicle systems. Little or no redesign is required. In many cases the AC system hardware costs after converting to Solstice yf are the same as they were before.

Low Inplementation Cost

- Near drop-in replacement. In most cases, Solstice yf refrigerant is a direct replacement for currently used materials.
- Single global solution. The performance characteristics of Solstice yf refrigerant make it well suited to comply with current and future regulations around the world, so automakers have the supply chain benefit of one global solution. In some regions, Solstice yf can help automakers achieve tough future fuel mileage regulations by allowing them to receive talipipe credits in return for transitioning in advance of any refrigerant-specific use regulations.

Easy Servicesbilly

 Similar components. Parts used in A/C systems running Solistice yf refrigerant are identical or similar to those used in today's HFC-134a systems.

Proven Salely

- Tested and approved. Solistice yf refrigerant has been verified as safe to use in automobiles through extensive third-party testing, including tests performed by the Society of Automotive Engineers and crash testing conducted by automakers.
- Safe and easy to use, handle and store. Unlike many of today's alternatives, Solstice yf has low flammability and toxicity, is noncorrosive and operates at pressures that repair technicians are already familiar with.

Strong Reputation

- Backed by Honeywell. Like all of our products, Honeywell Solistice yf retrigerant comes with the confidence of a brand the industry trusts to meet its requirements with quality innovations.
- Training and support. Ask about our customer support and training options to help you make a smooth transition.

"The EU's MAC Directive requires new vehicles to use refigerants with a plobal warming potential (GWP) below 150.



Ready to Learn More?

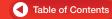
With Solution yt reingement, you swortlog nothing — wit them's a lef to gen. Volt www.1234facts.com for more information about the benefits of implementing Solettoe yf wingment now. Product Heratury, MSDS and technical specifications are also evaluate all www.honewwell.refitgements.com

Honeywell Solstice yf refrigerant. Good for auto manufacturers, great for the planet.



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Haneywell Fluorine Products 101 Columbia Road Morristown, NJ 07962-1053 Phone: 1-800-631-8138

Honeywell Belgium NV Performance Materials and Technologies Interleuvenlean 15, Building I 3001 Heverlee Belgium Tel/4 =32 (0)16 391 211 Fax# +32 (0)16 40 00 33

www.1234facts.com www.honeywell-refrigerants.com



The information provided formal to below up to be account and minimum, participation of the second properties or community, of any back response or analysis. User association of these and back to be received processing provides the determinist of the leaders is a suggestioner processing provides the determinist of the leaders is a suggestioner processing provides the determinist of the leaders is a subprocessing provides the second to be any sub-time to the second processing processing on a second to the second to be second processing processing to the second to be a second provide the second second to be any to be a second to be second provide the second second to associate to a second processing to the second processing of the second to be any processing to the second processing of the second second to be any processing to the second processing of the second to be any processing to the second processing to the second second to be and the second processing processing to the second to be a second processing to the second processing to the second to be a second to be a second processing to the second to be a second processing to the second to be a second to be a second processing to the second to be a second processing to the second to be a second to

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Solstice	yf re	efrigerant	
Solstice [®] yt refrigerant		 Developed for auto air conditioning Low global warming potential Comprehensively tested Reliable Cost-efficient 	
	HFO	Describes an organic fluorine compound called hydrofluorooletin	
	1234	Stands for a specific compound: First Number = Number of double bonds Second Number = Number of carbon atoms minus one Third Number = Number of hydrogen atoms plus one Fourth Number = Number of fluorine atoms	
	yt	Denominates the specific isomer (position of the fluorine atoms)	
MAC Directive		Starting in January 2011, all new vehicle types must have an air conditioning retrigerant with a global warming potential (GWP) below 150. From 2017 on, this will apply to all new vehicles. This is based on the MAC Directive (2006/40/EG), passed in July 2006.	
Development		Honeywell and DuPont, in a joint development agreement, have developed a new low global warming potential reingerant to replace R134a. They are commercializing the product separately. Honeywell is selling the product under the brand name Solstice TM yl retrigerant.	
Environmental	nmental Solstice of refrigerant has a GWP of <1. It significantly exceeds the mandate of the MA Directive (GWP below 150), by 99.3%.		
Approval		Solstice yl refrigerant can be used in Europe, Japan, Korea, Canada and the U.S. along with other countries.	
		Solstice yf refrigerant is registered under the EU chemical regulation REACH (Registration, Evaluation, Authorization and Restriction of Chemicals),	
		Solstice yf refrigerant is also included in the U.S. E.P.A.'s SNAP Program (Significant New Alternatives Policy), With this program, the EPA evaluates new and improved substances that replace ozone-depleting substances.	
Time of Implementation		Car manufacturers will receive the product according to their commitments.	



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Solstice® yf Refrigerant Fact Sheet

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Quantity	About 600 grams in modern air conditioning equipment; refill in automotive lifecycle, if necessary.
Scientific Studies	Honeywell ensures that all products undergo intense testing both internally and externally, especially during the development phase.
	SAE International – the international Society of Automotive Engineers with about 133,000 engineers and technicians – has tested Solstice yf refrigerant for five years in their Cooperative Research Program. Eighteen international, independent scientific institutions and 15 international car manufacturers and component suppliers have participated in this program. These industry participants include: Audi, BMW, Chrysler, Daimler, Fiat, Ford/Volvo, GM/Opel, Honda, Porsche, PSA, Renault, Jaguar/Land Rover, Toyota and VW, as well as Conti Tech, Delphi, Denso, DuPont, Freudenberg, Goodyear, Maflow, Valeo and Visteon.
	SAE has stated that Solstice yf refrigerant is safe for use in automobiles.
Crash Tests	Automotive manufacturers and component suppliers have tested Solstice yf refrigerant in detail during the SAE Cooperative Research Program. They have modern testing facilities and broad experience in conducting these tests.
	Two examples: 1. An automobile OEM performed a crash test with Solstice yf refrigerant at 65 km/h (in accordance with EuroNCAP Protocol). The result was no fire. 2. A separate OEM conducted a crash test with Solstice yf refrigerant in an automobile at 56 km/h (in accordance to ECE 94). The engine had been running for a long time and was particularly hot. Again, there was no fire.
Safety	Note: now there are two classes under 1272/2008: Category Criteria 1. Gases, which at 20 °C and a standard pressure of 101.3 kPa: (a) are ignitable when in a mixture of 13% or less by volume in air; or (b) have a flammable range with air of at least 12 percentage points regardless of the lower flammable limit. 2. Gases, other than those of Category 1, which, at 20 °C and a standard pressure of 101.3 kPa, have a flammable range while mixed in air.
	Class 1 is Extremely flammable and Class 2 is flammable.
	Tests under real-life conditions have shown that the product does not ignite on surfaces up to 800 °C. The auto ignition temperature is established using a test protocol set at 405 °C.
Additional Resources	Additional Safety information for Solstice® yf refrigerant (R-1234yf) can be found at www.honeywellmsds.com.
	www.1234facts.com has the latest industry information regarding Solstice® yf.
February 2014	

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Guidelines for Use and Handling of Solstice[®] yf

Guidelines for Use and Handling of Solstice' yf

Solstice 'yf can be described as being 'mildly flammable' as measured by standard methodology. This descriptor is used to characterize the flammability in simplistic terms; however properties such as minimum ignition energy, heat of combustion, and the burning velocity are assessed in order to arrive at such a descriptor. These measured properties, when applied to the laboratory setting, can be useful in determining if laboratory or apparatus modification should be considered. Measurement of Solstice yf flammability properties indicates that a typical static discharge will not have sufficient energy to ignite Solstice yt Available data appears below.

Upper Flammability Limit [Vol. % in air] (21°C, ASTM E681-01)	12.3
Lower Flammability Limit [Vol. % in air] (21°C, ASTM E681-01)	6.2
Minimum Ignition Energy [mJ at 20 sC and 1 atm] (In-house method, Tests conducted in 12 liter flask to minimize wall quenching effects)	5000-10000
Autoignition Temperature [°C] (EC Physico/Chemical Test A15, Measured by Chilworth Technology, UK)	405
Heat of Combustion [MJ/kg] per ASHRAE Standard 34 (Stoichiometric composition 7.73% in air)	11.8
Fundamental burning velocity [cm/s] (per ISO 817, Measured by AIST Japan)	1.5
Minimum Ignition Current (per IEC 79-3, 3rd ed., 1990; measured by UL)	No ignition*
Minimum Ignition Current Ratio (per IEC 79-3, 3rd ed., 1990; measured by UL)	≫1

"Unable to obtain ignition for any current level or test gas mixture when using calibration circuit or spirit plug box. After no ignition was obtained using the calibration circuit, attempts were made to obtain ignition range a spirit plug.

Risk assessment and risk minimization in facilities typically requires evaluation on a case-by-case basis since the outfitting of individual facilities may vary from one another in many ways. To assist the end-user in assessing and minimizing risk in association with the use of Solstice yf, a number of general guidelines can be applied.

GENERAL GUIDELINES

Read the Solstice yf Material Safety Data Sheet before beginning work with the material.

Refrigerant with Air

- Fire or explosion may result if vapor-in-air concentrations are within the flammable range and an ignition source of adequate energy level is available.
- Avoid mixing Solstice yl with air oxygen or other oxidizers at pressures above atmospheric pressure

Cylinder Storage

- Smoking should not be allowed in storage or handling areas as a general rule. Smoking should be prohibited in storage, handling and servicing areas where Solstice yl is used.
- Do not store Solstice yf cylinders near sources of open flames ignition sources or at temperatures exceeding 50°C
- Store cylinders in a cool well-ventilated area with low risk of fire and out of direct sunlight Ensure that cylinders are properly strapped into place, avoid dropping, denting or mechanically abusing containers.
- · Protect cylinders from moisture and rusting during storage

Contact with Hot-surfaces/High Energy/Ignition Sources

- Avoid contacting Solstice yl with white-hot or red-hot surfaces.
- Do not locate apparatus that produce ignition sources in proximity to air-conditioning systems, air-conditioning system test rigs, equipment or storage vessels that contains Solstice yf
- Ali-conditioning systems test rigs and service equipment should not incorporate components or devices that can generate discharges
- Devices that generate sparks may need to be isolated, purged with inert gas (to minimize the probability of attaining concentration in air that are within the flammable range), or relocated.
 - Note that DC motors that use brushes will have potential for continuous spark generation. A fan that uses such a DC motor may have to be isolated, replaced with a non-sparking one or purged with an nert gas such as nitrogen or with adequate air flow to minimize the quantity of retrigerant within the flammable range. If nitrogen nerting is used, route the exiting nitrogen gas to a local exhaust if practical, otherwise, the adjacent work environment may

Guidelines for Use and Handling of Solstice[®] vf

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also have to be monitored for oxygen level so that an acceptable breathing atmosphere is maintained.

- As spark energy data may not readily be available, electrical contactors, switches, relays, and other electrical or electronic devices capable of generating a spark that are located in proximity to probable leak sites should be subject to risk evaluation.
- Electrical equipment in and adjacent to the refrigerant charging and storage locations should be electrically classified according to applicable codes and regulations.
 - A typical 0.5 KVA 3-phase transformer with a 6-cycle breaker feeding shop utilization equipment can generate over 450,000 mJ before opening.
- In cases where NFPA 497 Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas 2008 Edition can be applied, the following guidance is available:
 - Note that Solstice yf is classified as Group D or Group I/A (per NFPA 497): the autoignition temperature of 405 °C is consistent with use of a T2 temperature class per the National Electric Code (NFPA-70).
 - Electrical equipment within 5 feet of the charging location and within 3 feet above grade and 25 ft horizontally should be Class I, Division 2, Group D (Class I, Zone 2, Group IIA).
 - In pits or other below grade servicing areas, above which the refrigerant could be charged or within 25 ft of charging locations, mechanical ventilation should be provided with a pickup no more than 12 inches above the lowest level and the electrical equipment within the pit should be Class I, Division 2, Group D (Class I, Zone 2, Group IIA).
 - In unoccupied, non-ventilated pits within 25 ft of charging locations, the electrical equipment within the pit should be Class I, Division 1, Group D (Class I, Zone 1, Group IIA).
- Due to large energy capacity and circuit amperage, there is also a potential for ignition from the electric power source for hybrid vehicles. As a matter of general safety, isolation techniques or other suitable methods should be used to prevent battery and power system sparks/arcs. In areas where processes, procedures or upset conditions such as leaks have the potential to generate flammable Solstice yf vapor-in-air concentrations in proximity to hybrid vehicle electric power sources, isolation and/or ventilation should be used.

Service Areas

- Solstice yf is a heavier-than-air gas. Depending on the quantity released in air, the material can travel a considerable distance to a low-lying ignition point.
- Solstice yf can collect in floor pits. There is potential for asphyxiation in floor pits or confined spaces. Use adequate ventilation in these areas. Monitoring/measuring oxygen levels or refrigerant vapor-in-air concentrations prior to entry into floor pits or confined spaces is recommended. Note that applicable regulations may require measurement and/or monitoring of oxygen level in confined spaces as part of dictated confined space entry procedures.
- Refrigerant charging should be performed away from open flames or high energy ignition sources.
- Provide mechanical ventilation at filling zones and storage areas or other locations where leakage is probable. It should be determined if existing local ventilation is adequate for other operating and storage areas. The ventilation rate should prevent vapor-air concentrations from exceeding 25% of the LFL. For example, NFPA 497 *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas 2008 Edition* defines adequate ventilation as a ventilation rate that affords either 6 air changes per hour, or 1 cfm per sq.ft. of floor area (0.3m³/min per m² of floor area), or other similar criteria that prevent the accumulation of significant quantities of vapor-air concentrations from exceeding 25% of the LFL.
- Refrigerant leak detection equipment that provides continuous numerical vapor-in-air measurement provides a means for personnel to respond to a leak in a timely fashion. A detection level of 25% of the lower flammability limit is acceptable. Infrared leak detection devices capable of detecting R134a at levels of 1,000 ppm in air or lower are commonly available; typically, these may also be used. Performance may vary depending on device configuration. Consult the leak detection equipment manufacturer for additional information.
- In the event of a leak, air flow will tend to disperse leaked refrigerant and may be beneficial in reducing local concentrations. Exhaust ventilation can be used to reduce vapor-in-air concentrations. The aim should be to maintain concentrations below the lower flammability limit. For example, in a calorimeter room, it may be best to leave the room air circulating (room air handler "ON") to disperse leaked refrigerant rather than shutting off room air flow. Note: This assumes that the charge is smaller than the amount needed to reach the 25% of the LFL in a well mixed room.

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Guidelines for Use and Handling of Solstice[®] yf

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- In the event of a leak, nearby electrical contactors, electric controls or other electric devices may create an undesirable spark in the affected area if the devices are shut off locally in accordance with good engineering practices, interrupt power to systems and devices at a location that is removed (remote) from the environment where the leak is. Whenever possible, create a "zero demand" signal to electrical or electronic devices, for example, adjust a zero-controlled relay serving electric resistance heaters to eliminate demand. This is preferred to opening local contacts.
- Maintenance or construction work that can produce sparks, electrical arcs, or open flames must be performed in compliance with all applicable regulations pertaining to hot work. Welding flame cutting grinding or other operations that can create an ignition source, must be carried out in compliance with applicable hot work procedures and permits.

Additional good engineering safety practices: Customer should perform their own

fire & safety review

building code review

fire alarm systems

smoke detection systems

Fire extinguishers

suppression systems

egress procedures

fire separation systems

emergency response procedures

emergency lighting

Common considerations for Solstice yf product handling & plant implementation

Tank Truck (ISO) Unloading

- 1. Is the unloading area in good condition for safe operation?
- 2 During inclement weather should any additional safety precautions be considered?
- Is grounding cable available and free of corrosion or damage for delivery trailer?
- Is the electrical receptacle properly located within 25 ft (7.5 m) by 3 ft (1 m) high radius and properly rated (Group D)?
- What ype of electrical receptacle is available (i.e. Hubbell, Four Prong, male, female, amperage, etc)?
- 6. Is the receptacle equipped with an electrical switch disconnect?
- 7 Is the bulkhead designed for impact (crash posts installed anchored) and located more than 15 feet from the bulk storage tank?
- Is the liquid line equipped with an Emergency Shutoff Valve (ESV) or Backflow Check valve?
- 9 Is the vapor line equipped with an Emergency Shutoff Valve (ESV)?
- Can the Emergency Shutoff Valves be actuated nearby and remotely?
- 11 Will Emergency Shutoff Valves be automatically activated by fite (e.g. fusible link shut off valves)?
- 12. Do fill lines and/or hoses have caps and/or plugs in place?
- 13. Are all lines identified?

Bulk Storage Tank

Tank needs to be designed, installed and operated according to appropriate regulations and laws!

- 1. Is tank design pressure adequate?
- 2. Is the area free of combustibles?
- 3. Is the area fenced or protected from vandalism?
- 4. Is the tank adequately grounded?
- 5 Is the grounding Iree of corrosion?

Solstice[®] yf Refrigerant User Guide

Guidelines for Use and Handling of Solstice[®] yf

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- 6. Is the grounding checked periodically?
- 7 Are all electrical switches lighting etc rated appropriately?
- 8 Are pump motors rated appropriately?
- Are all elastomeric parts (seals, gaskets, etc.) compatible with the product?
- 10. Are the tank supports fireproofed (cement, etc.)?
- 11, is the tank properly labeled?
- 12. Is a tank label visible?
- Does instrumentation (level gauge, pressure gauge, etc.) appear to be in good condition?
- 14. Is the tank exterior free of corrosion?

Piping

- 1. Is the piping free of any signs of exterior surface corrosion?
- 2. Are all gasketing and valve internal materials compatible?
- Is piping and other equipment grounded? (Piping systems with large filter elements can develop significant static charge separation. Generally, piping systems should be grounded unless an engineering evaluation determines that it is not needed.)
- 4. Is grounding free of corrosion?
- 5. Is piping adequately supported?
- 5. Is valving designed to avoid trapping liquid between valves?
- 7. Is piping protected from impact?
- B. Is piping leak checked on a regular basis?

- 9. Is piping labeled to identify contents?
- Is piping inside the building constructed with a minimum of valves, fittings, etc.?
- Is the diameter of the piping inside the building the minimum size required?
- 12. Are block valves provided at both ends of the pipeline to isotate a leak?

Cylinder Storage Area

- Is the cylinder(s) stored on a rack or firm foundation, i.e. concrete pad?
- Is the storage area protected from excessive heat and adverse weather conditions?
- 3. Is the area fenced or protected from vandalism?
- 4. Are all electrical switches, lighting, etc. rated appropriately?
- 5. Is the area properly labeled as to contents?
- 6. Are the cylinders stored upright?

Personnel Training

- Do personnel know product hazards and have access to MSDS's?
- 2. Are personnel trained to handle flammables?
- 3. Is there a written emergency response plan?
- Does each person know his/her responsibility in case of an emergency and is properly trained?
- Does maintenance personnel know what materials of construction are compatible with Solstice yf?

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Find out more

For more information...

Honeywell Refrigerants

101 Columbia Road Morristown, NJ 07962-1053 1-800-631-8138

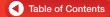
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Honeywell Solstice[®] yf Refrigerant MSDS



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Honeywell Solstice[®] yf Refrigerant MSDS:

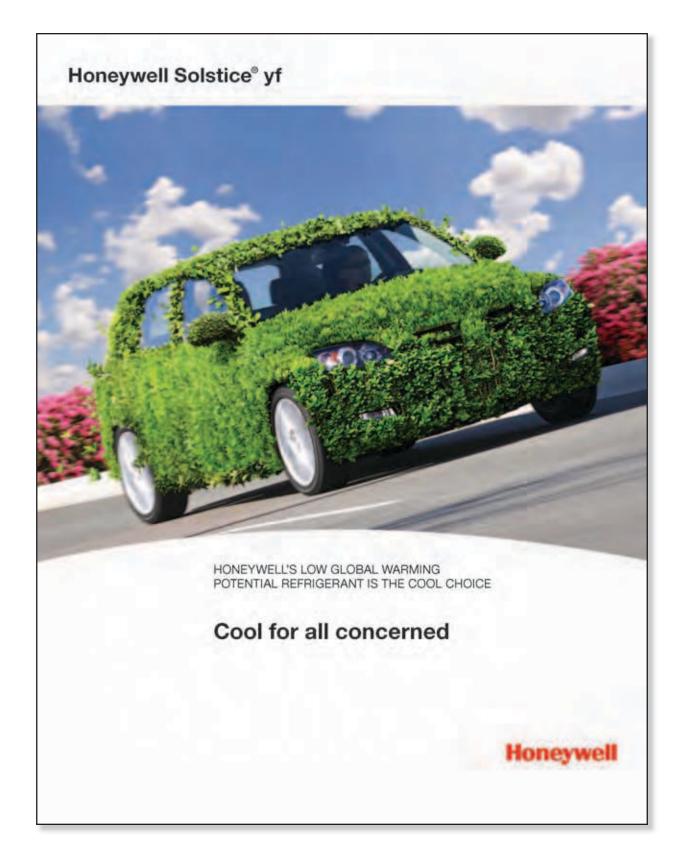


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Solstice[®] yf Refrigerant User Guide



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Cool for All Concerned



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Solstice[®] yf – A Green Solution to a Global Challenge

Introduction

Starting in 2011, automakers must meet the EU's MAC Directive, which prohibits the use of refrigerants with a global warming potential (GWP) higher than 150 in new vehicle types.

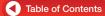
This Directive requires a globally compliant replacement for R134a refrigerant. Honeywell worked for many years and invested substantial resources to solve the challenge of finding a replacement for R134a refrigerant. Honeywell's solution, called Scieticie[®] yt is a drop-in or near drop-in replacement for R134a.

Automobile air conditioning systems using Honeyweii Solstice yf are also more energy efficient than those using CO, particularly at higher ambient temperatures, automobiles equipped with Solstice yf will use less fuel and amit fewer greenhouse gases than the CO, alternative, which further increases the environmental benefit and reduces the carbon footprint.

Solston yt is safe and easily integrated into current systems. As a near drop-in replacement, or even a drop-in replacement in certain cases, if requires virtually no alterations to current equipment. So it'll easy to use and enables automakers to meet new regulations.

Cool for the Environment

Solstice yf has an atmospheric lifetime of only 13 days - compared to 13 years for R134a and more than 500 years for carbon dioxide. Unlike HFCs and CFCs, which take decades to decompose, Solstce yf does not pensist in the atmosphere. Quite simply, automobiles using highly energy-efficient Solstce yf refrigerant will use lass fuel and produce fewer emissions than many of the existing alternatives.



Cool for All Concerned

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Verified as Safe

Sontoell yf hat been vortfod as safe to use in automobies through extensive third-party testing, including tests performed by the Society of Automotive Engineers and crash testing conducted by automotiers. Today, Solation yf is the refrigerant of choice in automotive alt-conditioning.

Highly Compatible and Easy to implement

Because the pressure and performance of Solisboe yf is so emiliar to R134a it can be used as a replacement for R134a with little of his teengineering of automotive systems. This enables automakers to comply with the new EU regulations quickly and cost-offectively.

Solstice yf Physical Properties

Dissipation	
Chemical name	2,3,3,3-Tetratiuoro prop-1-une
Molecular formula	OF305-CH2
Molecular weight (g/gmol)	114
Boiling point at 101.3 kPa (°C)	-29.45
reezing point at 101.3 kPa (°C)	150
/apour density at boiling point (kg/m3)	5.98
iquid density (kg/m3)	1092
iquid heat capacity at 25°C (kJ/kg·°K)	1.392
apour heat capacity at 25°C (kJ/kg-°K)	1.053
leat of vaporization at boiling point (kJ/kg)	180,1
apour Pressure at 25°C (kPa)	683
iquid thermal conductivity at 25°C (W/m-'K)	0.064
apour thermal conductivity at 25°C (W/m °K)	0.074
iquid viscosity at 25°C (µPa-sec)	155.4
apour viscosity at 25°C (µPa-sec)	12.3
Solubility of HFO-1234yf in water (wt.%)	0.020
iolubility of water in HFO-1234yf (wt.%)	0.026
Dzone Depletion Potential ODP-R11=1)	Q

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Pressure/T	emperature Table	Compatibility with Plastics and Elastomer	
Temperat		The table below provides a summary of materials	compatibility data derived tro
(°C)	(kPa)	performed by Honeywall and other global organiza grades and formulations of these materials, we rea	
-40	63	performed on the specific grade of materials under	
-35	70	systems. This data should be used only as a guide Solstoe yf. The rankings in the table should be us	
-30	99	judgments based on limited samplings. Customer manufacturer or conduct further independent test	
-25	123		-
-20	151	Material	Rating
-15	164	HNBR	9
-10	222	Polyester	Su
-5	266	Nylon	S
0	316	Epoxy	S
6	373	Połyimide	5
10	438	Neoprone	5
15	510	HNBR	S
20	592	EPDM	8
25	683	Silicone	5
	784	Butyl Rubber (IIR)	Su
30	895	Polyvinylidene Fluoride and copolymer of Vinylidene Fluoride and Hexafluoropropylene	U
		S: Suitable, Su: Suitable with some exception	na, Ul Unauttoble
40	1018	and the second s	
45	1154		
50	1302		
55	1464		
60	1542		
65	1634		
70	2044		

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Other Refrigeration and Air-Conditioning Applications

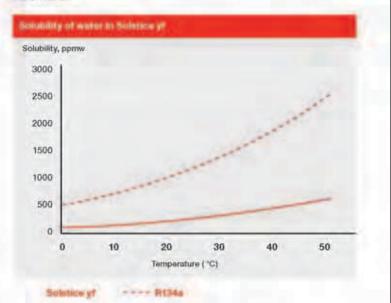
Solution" of has been developed for a number of applications beyond automotive air conditioning. These include supermarket cases, walk-in coolers, residential refrigerators and chillers. Generally, there are a few compressor design changes necessary to optimize the performance of Solutioe of in these applications, so once again it brings considerable benefit with easy implementation.

Easy Serviceability

The parts and components used in Solstoe yf systems are identical or similar to those used in R134a systems — both use flexible hoses to connect components. These parts are mass-produced in high volumes worldwide and widely available at reasonable proces. This makes systems repair and assembly easy and inexpensive.

Solubility of Water in Solstice yf

The solubility of water in Solstice y1 is shown in the graph below. It is lower than that of R134a.



Lubricants

Solstop yf performs weil when used with polyakylene glycol (PAG) and with polyol ester lubricants. Most automotive original equipment manufacturers have chosen specific PAG lubricants for their systems. For non-automotive applications, most compressor manufacturers recommend specific polyol ester lubricants. Users should check with the equipment manufacturer for the recommanded subricants for their system.

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Toxicity

Scistice⁴ y/ has undergone extensive toxicity testing, and has been found to be safe for use in its intended applications, it is also registered in the EU under REACH in the +1000 MT tonnage band. Consult the Material Safety Data Sheet (MSDS) before using Solistice vt.

Flammability

According to ASHRAE Standard 34. Solatice yt is bassified in safety group A2L. This means it is in the lower segment of the mildly flammable refrigerants. Its flammability characteristics are shown in the table below.

Finnes (Junis - ARTM ENER-OT at 21 12	Hating
LFL (Vol% in Air)	6.2
UFL (Vol% in Air)	12.3
Minimum Ignition Energy (mJ)	> 5000
Auto ignition temperature 'C	405
Heat of Combustion (kJ/g)	9.5
Burning Velocity (cm/s)	15

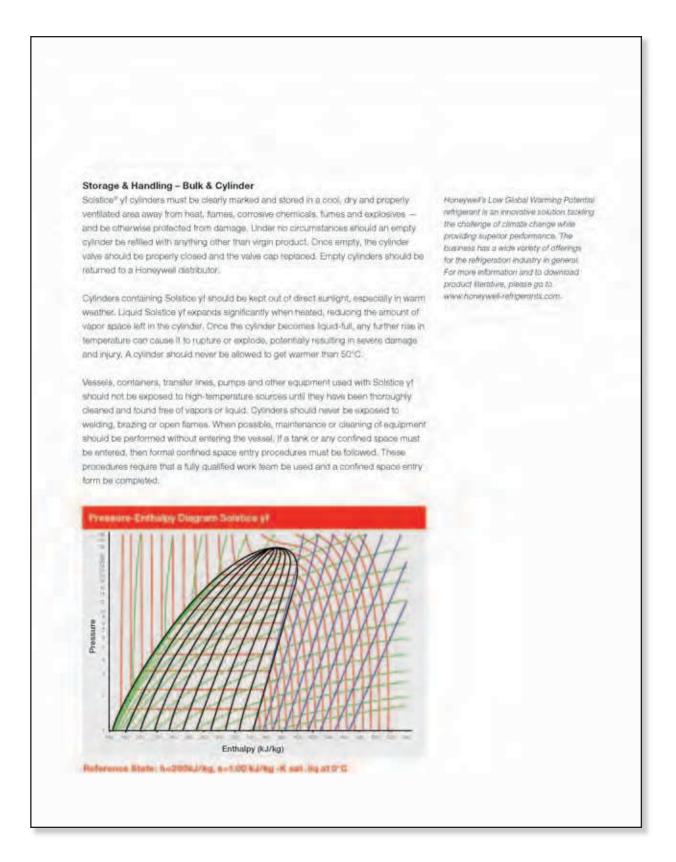
Solatice yil has undergone extensive application-specific flammability tests and risk assessment by the SAE CRP1234. Based on these results, the sponsors of the SAE CRP1234 have concluded that it can be used as a global replacement refrigerant in automobile air conditioning.

Leak Detection

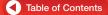
Lask detectors can be used to pinpoint leaks or to monitor an entire room on a continual basis. Leak detection is important for refrigerant conservation, equipment protection and performance, reduction of emissions, and protection of those coming into contact with the system. Customers should check with equipment manufacturers for appropriate detector equipment.

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Our commitments:

- + The safety of our employees.
- . The quality of our products
- Being responsible stewards for the protection of the environment, the communities in which we operate and our customers



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Solstice[®] yf Refrigerant User Guide

Solstice[®] yf Properties and Materials Compatibility

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Guidelines for Use and Handling of Solstice[®] yf

This brochure provides selected properties information for Solstice[®] yf including thermodynamic data, transport properties, and flammability characteristics.

Solstice yf was originally developed as a low global warming potential replacement for R134a in the automobile air-conditioning application. Because of its desirable environmental properties, along with other factors, it is being investigated in a number of stationary applications as well.

Flammability

Solstice yf can be described as being "mildly flammable" as measured by standard methodology.

This descriptor is used to characterize the flammability in simplistic terms; however, properties such as minimum ignition energy, heat of combustion, and the burning velocity are assessed in order to arrive at such a descriptor. Measurement of Solstice yt flammability properties indicates that a typical static discharge will not have sufficient energy to ignite Solstice yf. Available data appears below.

Upper Flammability Limit [Vol. % in air] (21°C: ASTM E681-01)	12.3
Lower Flammability Limit [Vol. % in air] (21°C; ASTM E681-01)	6.2
Minimum Ignition Energy [tnJ at 20 sC and 1 atm] (In-house method, Tests conducted in 12 liter flask to minimize wall quenching effects)	5000-10000
Autoignition Temperature ["C] (EC Physico/Chemical Test A15, Meas- ured by Chilworth Technology, UK)	405
Heat of Combustion [MJ/kg] per ASHRAE Standard 34 (Stolchiometric composition 7,73% in air)	11,8
Fundamental burning velocity [cm/s] per ISO 817, Measured by AIST, Japan)	1.5
Minimum Ignition Current (per IEC 79-3, 3rd ed., 1990; measured by UL)	No ignition*
Minimum Ignition Current Ratio (per IEC 79-3, 3rd ed., 1990; measured by UL)	>>1

"Unable to obtain gnition for any current level of test gas moture when using calibration circuit or spark plug box. After ne ignifica was obtained using the cellbration circuit, ettempts were made to obtain againon using a spark plug.

It is recommended that risk assessment and risk minimization for use of Solstice yf in facilities and applications should be conducted prior to use.

Selected Physical Properties

Chemical Name	2,3,3,3-Tetrafluoroprop-1-ene
Molecular Formula	CH2CFCF3
Molecular Weight	114
% Volatiles by Volume	100
Water Solubility (in Solstice yf, ppm by mass)	200
ASHRAE Safety Group Classification	A2L

Solstice[®] yf Refrigerant User Guide

Solstice[®] yf Properties and Materials Compatibility

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Boiling Point (°F) @ 1atm	-21
Freezing Point (°F)	Not available
CriticalTemperature ("F)	202.5
Critical Pressure (psia)	490.6
Critical Density (Ib/ft [®])	29.7
Vapor Density @ 20°C, 1 atm (lb/ttº)	0.303
Liquid Density (lb/ft")	68,2
Liquid Heat Capacity (Btu/lb *F)	0.33
Vapor Heat Capacity @ constant pressure, 1atm (Btu/lb °F)	0.22
Heat of Vaporization at 1 atm (Btu/lb)	77.53
Vapor Pressure at 77"F (psia)	.99
Liquid Thermal Conductivity (Btu/hr-ft *F)	0.0368
Vapor Thermal Conductivity (Btu/hr-ft "F)	0.008
Liquid Viscosity (lb/tt-hr)	0.38
Vapor Viscosity (lb/ff-hr)	0.03

Boiling Point ["C] @ 1.01 bar	-29.5
Freezing Point[°C] @1.01 bar	Not available
Critical Temperature [°C]	94.7
Critical Pressure[bar]	33.8
Critical Density [kg/m ²]	475.6
Vapor Density @ 20°C, 1 atm [kg/m³]	4,79
Liquid Density [kg/m ⁵]	1091.9
Liquid Heat Capacity [kJ/kg K]	1.39
Vapor Heat Capacity ⊚ constant pressure, 1.01 bar [kJ/kg K]	0.91
Heat of Vaporization at 1 atm [kJ/kg]	180.25
Vapor Pressure at 25°C [bar]	6.83
Liquid Thermal Conductivity [mW/m-K]	63.59
Vapor Thermal Conductivity [mW/m K]	13.97
Liquid Viscosity [µPa·s]	155.5
Vapor Viscosity [µPa-s]	12.3

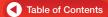
Flame Limits measured at ambient temperature and pressure using ASTM E681-85 with electrically headed match ignition, spark gritten and lased wire (phtion, ambient air, All measurements at 77°F (25°C) unless otherwise noted.

Solstice[®] yf Refrigerant User Guide

Solstice[®] yf Properties and Materials Compatibility

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Temperature °C	Pressure kPa	Density kg/m² Liquid	Density kg/m ¹ Vapor	Enthalpy kJ/kg Liquid	Enthalpy kJ/kg Vapor	Entropy kJ/kg+K Liquid	Entropy kJ/kg•K Vapor	cp kJ/kg-K Liquid	cp kJ/kg-K Vapor	cv kJ/kg-K Liquid	cv kJ/kg•K Vapor
-40	62.4	1291.9	3.7945	151,1	336.6	0.8074	6031	1.16	0.78	0.78	0.69
-38	68.7	1286.5	4.1519	153.4	337.9	0.8173	1.6020	1.16	0.78	0.79	0.70
-36	75.5	1281.0	4.5353	155.7	339,3	0.8272	1.6011	1.17	0,79	0.79	0.70
-34	82,8	1275,6	4,946	158.1	340.6	0.8370	1,6003	1.18	0,80	0,60	0.71
-32	90.6	1270,1	5.3856	160.4	342.0	0.8468	1.5996	1,18	0,80	0.80	0.71
-30	99.1	1264.5	5.8553	162.8	343.3	0.8566	1.5990	1.19	0.81	0.81	0.72
-28	108,1	1259.0	6.3566	165.2	344.7	0.8663	1.5984	1.19	0.82	0.81	0.72
-24	117.6	1253.4	6.8911 7.4602	167.6	346.0 347.4	0.8760	1.5980	1.20	0.83	0.81	0.73
-22	139.2	1242.0	8.0658	172.4	348.7	0.8954	1.5973	1.21	0.84	0.82	0.74
-20	150.9	1236.3	8.7093	174.9	350.1	0.9050	1.5970	1.22	0.85	0.83	0.75
-18	163.4	1230.5	9.3925	177.3	351.4	0.9146	1.5968	1.23	0.85	0.83	0.75
-16	176.8	1224.7	10.117	179.8	352.7	0.9242	1,5967	1.23	0.86	0.84	0.76
-14	190.9	1218.8	10.885	182.3	354.1	8666.0	1,5967	1.24	0,87	0.84	0.76
-12	205.9	1212.9	11,699	184,8	355.4	0.9433	1,5967	1.25	0.88	0.84	0,77
-10	221.8	1207.0	12,559	187,3	356,7	0.9528	1,5968	1,25	88,0	0.85	0.77
-8 -6	238.6	1200.9	13,469	189,8	358.0 359.4	0.9623	1.5969	1.26	0,89	0.85	0.78
-4	275.1	1168.7	15,446	194.9	360.7	0.9812	1.5973	1.27	0.91	0.86	0.79
.2	295.0	1182.5	16.517	197.4	362.0	0.9906	1.5975	1.28	0.92	0.86	0.80
0	315.8	1176.3	17.647	200.0	363.3	1.0000	1.5978	1.29	0.93	0.87	0.80
2	337.8	1170.0	18.837	202.6	364,6	1,0094	1,5981	1.30	0.93	0.87	0,81
4	360.9	1163.6	20.092	205.2	365.9	1,0187	1 5985	1.30	0.94	0.87	0,81
6	385.2	1157.2	21,413	207.6	367.2	1.0281	1.5989	1.31	0.95	88.0	0.82
8	410.8	1150.6	22.804	210.5	368.4	1.0374	1.5993	1,32	0,96	0.88	0.83
12	437.5 465.6	1144.0 1137.4	24.267 25.807	213.1 215.8	369.7 371.0	1.0467	1,5998	1.33	0.97	0.89	0.83
14	495.0	1130.6	27.425	218.5	372.2	1.0653	1,6008	1.34	0.99	0.89	0.84
16	625.8	1123.8	29.127	221,2	373.5	1.0746	1,6013	1,35	1.00	0.90	0.85
18	558.0	1116.9	30.916	223.9	374.7	1.0838	1.6018	1.38	1.01	0.90	0.85
20	591.7	1109.9	32.796	226.6	375.9	1.0931	1.6024	1.37	1.02	0.90	0.86
22	626.9	1102.8	34.772	229.3	377.1	1.1023	1.6029	1.38	1.04	0.91	0.87
24	663,6	1095.5	36.848	232.1	378.3	1.1115	1.6034	1.39	1.05	0.91	0.87
26 28	701.9	1088.2	39.029 41.321	234.9 237.7	379,5 380.6	1.1208	1.6040	1.40	1.06	0.91	88.0
30	783.5	1073.3	43,729	240.5	361.8	1.1392	1,6051	1.42	1.09	0.92	0.89
32	826.9	1065.7	46.26	243.4	382.9	1,1484	1,6056	1.43	1.10	0.92	0.90
34	872.0	1057.9	48.92	246.2	384.0	1.1576	1.6061	1.44	1.12	0.93	0.90
36	918.9	1050.0	51.717	249.1	385.1	1,1668	1,6066	1,45	1.13	0.93	0.91
38	967,7	1042.0	54,658	252.0	386.1	1.1759	1,6071	1.46	1.15	0.93	0.92
40	1018,4	1033.8	57.753	254,9	387.2	1.1851	1,6075	1.47	1.17	0.94	0.92
42	1071.1 1125.7	1025,5	61.01 64.44	257,8 260,8	388.2 389.2	1.1943	1.6079	1.49	1,19	0.94	0.93
46	1182.5	1005.3	68.053	263.8	390.1	1.2035	1.6087	1.50	1.23	0.94	0.94
48	1241.3	999.4	71.863	266.8	391.1	1.2220	1.6089	1.53	1.25	0.95	0.95
50	1302.3	990.4	75.884	269.9	392.0	1.2312	1.6092	1.55	1.28	0.96	0.96
52	1365.6	981.1	80.13	272.9	392.9	1.2405	1.6094	1.57	1.20	0.96	0.97
54	1431.1	971.6	84.619	276,0	393.7	1.2498	1.6095	1.59	1.33	0.96	0.97
56	1498.9	961.8	89.371	279.2	394.5	1.2592	1,6095	1,61	1,37	0.97	0.98
58	1569.2	951.7	94,407	282.3	395.2	1.2685	1.6095	1,63	1.40	0.97	0.99
60 62	1641.9	941.3	99,754	285.5	395.9	1.2779	1.6093	1,66	1.44	0.97	1.00
64	1717.1 1794.9	930.6 919.5	105.44	288.8	396.6 397.2	1.2874	1.6091	1.68	1.49	0.98	1.01
66	1875.4	907.9	117.96	295.4	397.7	1.3065	1,6082	1.75	1.59	0.98	1.02
68	1958,6	895.8	124,89	298,8	398.2	1,3162	1,6076	1.79	1.65	0.99	1.03
70	2044.5	883.2	132.33	302.2	398.6	1.3260	1.6068	1.84	1.72	0.99	1.04



Solstice[®] yf Refrigerant User Guide

Solstice[®] yf Properties and Materials Compatibility



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Temperature	Pressure	1 C C C C C C C C C C C C C C C C C C C	of Sound		onductivity		osity	Surface Tension
"C	kPa	m/s Liquid	m/s Vapor	mW/m-K Liquid	mW/m-K Vapor	uPa•s Liquid	uPa•s Vapor	mN/m Líquid
-40	62.4	735.9	133.7	85.5	8.5	358.5	9.5	15.2
-38	68.7	726.7	134.0	84.8	8.7	347.8	9.6	14.8
-36	75.5	717.5	134.2	84.1	8.8	337.6	9.7	14.5
-34	82.8	708.4	134.4	83.3	9.0	327.9	9.8	14.2
-32	90.6	699,4	134.7	82.6	9,1	318.5	9,9	13.9
-30	99,1	690.4	134.9	81.9	9.3	309.6	9.9	13,6
-28	108.1	681.4	135.0	81.2	9.4	301.0	10.0	13.3
-26	117.8	672.5	135,2	80.5	9.6	292.8	10/1	13.0
-24	128.1	663.6	135.4	79.8	9.7	284.9	10.2	12.7
-22	139,2	654,8	135.5	79,1	0.9	277.3	10.3	12.5
-20	150.9	646.0	135,6	78,4	10.0	269.9	10,3	12.2
-16	163,4	637.2	135,7	77.7	10.2	262.9	10,4	11.9 11.6
-10	176.8	628.5 619.7	135.7 135.8	77.0	10,3	249.6	10.5	11.3
-12	205.9	619.7	135.8	75.6	10.5	243.0	10.8	11.0
-10	203.8	602.4	135.8	74.9	10.8	237.1	10.7	10.7
-8	238.6	593.7	135.8	74.3	11.0	231.2	10.8	10.5
-6	256,4	585.1	135.7	73.6	11.2	225.5	10.9	10.2
-4	275.1	576.4	135.6	72.9	11,3	220.0	11.0	9.9
-2	295.0	567.8	135.5	72.3	11.5	214.6	11.1	9.6
0	315.8	559.2	135.4	71.6	11.7	209.4	11.2	9.4
2	337.8	550.6	135.2	70.9	11.8	204.4	11.2	9.1
4	360.9	542.0	135.1	70.3	12.0	199.5	11.3	8.8
8	385,2	533.4	134.8	69,6	12.2	194.7	11.4	8,6
8	410.8	524.8	134,6	69.0	12,4	190.1	11,5	8.3
10	437.5	516.2	134,3	68.3	12.5	185,6	11/6	8.0
12	465.6	507.5	134.1	67.7	12.7	181.3	11,7	7.8
14	495.0	498.9	133,7	67,1	12.9	177.0	11,8	7.5
16	525.8	490.3	133.4	66.4	13,1	172.9	11.9	7.3
18	558,0	481,6	133.0	65.8	13.3	168,8	11.9	7,0
20	591.7	472.9	132.6	65,2	13.5	164.9	12.0	6,8
22 24	626.9	464.2 455.5	132.1	64,5	13.7	161,1	12.1	6,5
26	663.6 701.9	446.8	131.7	63.9 63.3	13.9	157.3	12.2	6.3 6.0
28	741.9	438.1	130.6	62.7	14.3	150.0	12.4	5.8
30	783.5	429.3	130.0	62.0	14.5	146.5	12.6	5.6
32	826.9	420.5	129.4	81.4	14,7	143.1	12.7	5.3
34	872.0	411.7	128.8	60.5	14.9	139.7	12.8	51
36	918,9	402.9	128.1	60.2	15.1	136,4	12.9	4.9
38	967.7	394.1	127.3	59,6	15.4	133.2	13.0	4.6
40	1018.4	385.2	126.6	59.0	15.6	130.0	13.2	4.4
42	1071.1	376.4	125.7	58:4	15.8	126.9	13.3	4.2
44	1125.7	367.4	124.9	57,8	16,1	123,8	13,4	4.0
46	1182.5	358.5	124,0	57.2	16.3	120,8	13.6	3.8
48	1241.3	349,4	123.1	56.6	16,6	117.8	13,7	3,6
50	1302.3	340.3	122.1	56.1	16.9	114,9	13,9	3.4
52	1365.6	331.1	121.0	55.5	17.2	112.0	14.0	3.2
54	1431.1	321.8	120.0	54.9	17.5	109.1	14.2	3.0
56	1498.9	312.3	118.8	54.4	17.8	106.3	14.4	2.8
58	1569.2	302.6	117.6	53.8	18.1	103.5	14.6	2.6
60	1641.9	292.7	116,4	53.3	18,5	100,8	14.8	2.4
62	1717.1	282.6	115,1	52,8	18.9	0.89	15.0	2.2
64	1794.9	272.3	113.7	52,3	19,3	95.3	15.3	2.0
66 68	1875.4 1958.6	261.8	112.3	51.8 51.3	19.7	92.5 89.8	15.5 15.8	1.8
68 70	2044.5	251.0 240.0	110.8	50.9	20.2	89.8	15.8	1.7

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Solstice® yf Refrigerant User Guide

Solstice[®] yf Properties and Materials Compatibility

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$\begin{array}{cccccccccccccccccccccccccccccccccccc$	Temperature "F	Pressure psia	Density Ibm/ft ¹ Liquid	Density (b _m /ft ¹ Vapor	Enthalpy Btulbm Liquid	Enthalpy Btu/lbm Vapor	Entropy Btullbm*F Liquid	Entropy Btulbm*F Vapor	Btullbm F	Cp Btuilbm·F Vapor	Etulb _m +F	cv Btullbm*F Vapor
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	-40	9.0	80.65	0.2369	0.00	79,61	0.0000	0.1902	0.28	0.19	0.19	0.17
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$\begin{array}{cccccccccccccccccccccccccccccccccccc$	-25	13.3	79.23	0.3410	4.20	82.23	0.0098	0.1893	0.28	0,19	0.19	0,17
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	150	269.4	50.84	1.2122	61.77	106.06	0.1)88	0,1914	0.42	0.38	0.23	0.24

Solstice[®] yf Refrigerant User Guide

Solstice[®] yf Properties and Materials Compatibility

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emperature		Speed o			onductivity		osity	Surface Tension	
*C	psia	ft/s Liquid	ft/s Vapor	Btuhr:ft**F Liquid	Btu/hr;ft-*F Vapor	lbm/ft-he Liquid	Ib _m /ft-hr Vapor	dyne/cm Liquid	
-40	9.0	2414.3	438.6	0.0494	0.0049	0.87	0.0231	15.2	
-35	10.3	2372.4	439.8	0.0489	0.0050	0.83	0.0234	14.7	
-30	11.8	2330.8	440.9	0.0483	0.0052	08.0	0.0236	14,3	
-25	13.3	2289.6	441.9	0.0477	0.0053	0.77	0.0239	13.9	
-20	15.1	2248.7	442.8	0.0471	0.0054	0.74	0.0242	13.5	
-15	17.0	2208,0	443.6	0.0465	0.0055	0,71	0.0244	13.1	
-10	19,1	2167.6	444.2	0.0460	0.0056	0.68	0.0247	12.7	
-5	21,4	2127.4	444,7	0,0454	0.0058	0.66	0.0250	12.2	
0	23.9	2087.4	445.1	0.0449	0.0059	0.63	0.0252	11.8	
5	26.6	2047.5	445,4	0.0443	0.0060	0.61	0.0255	11.4	
10	29.6	2007.9	445.5	0.0438	0.0062	0.59	0.0258	11.3	
15	32.8	1968.4	445.4	0.0432	0.0063	0.57	0.0260	10.7	
20 25	36.3	1928.9	445.3	0,0427	0.0064	0.55	0.0263	10.3	
	40.1	1889.6	444.9 444.4	0.0421	0.0066	0,53	0.0266		
30 35	44.1 48.5	1850.3	443.8	0.0416	0.0067	0,51	0.0269	9.5	
40	53.1	1771.9	442.9	0.0406	0.0070	0,50	0.0274	8.8	
45	58.1	1732.7	441.9	0.0400	0.0071	0.46	0.0277	8.4	
50	63,5	1693.4	440.8	0.0395	0.0073	0,45	0.0280	8.0	
55	69.2	1654.1	439.4	0.0390	0.0074	0.43	0.0283	7.7	
60	75.3	1614 B	437.8	0.0385	0.0075	0.42	0.0286	7.3	
85	81.7	1575,3	436.1	0.0380	0.0077	0.41	0.0289	7.0	
70	88.6	1535.8	434.2	0.0375	0.0079	0.39	0.0293	6.6	
75	95.9	1496.1	432.0	0.0370	0.0080	0.38	0.0296	6.3	
80	103.7	1456,3	429.7	0.0365	0,0082	0.37	0.0299	6.0	
85	111,9	1416,4	427.1	0,0360	0,0083	0.36	0.0303	5,6	
90	120.6	1376.4	424.3	0.0355	0.0085	0.35	0.0307	5.3	
95	129.8	1336.4	421.3	0.0350	0.0087	0.33	0.0311	5.0	
100	139.6	1296.2	418.0	0.0345	0.0089	0.32	0.0315	4.7	
105	149.8	1255.8	414,5	0.0340	0.0090	0.31	0,0319	4.4	
110	160.6	1215.3	410,7	0.0335	0.0092	0.30	0.0324	4.1	
115	172.0	1174.4	406,6	0.0331	0.0094	0.29	0,0328	3,8	
120	183.9	1133.2	402.3	0.0326	0.0097	0.28	0.0334	3.5	
125	196.5	1091.4	397,7	0.0321	0.0099	0.27	0.0339	3.2	
130	209.7	1048.7	392.7	0.0317	0.0101	0.26	0.0345	2.9	
135	223.6	1005.1 960.4	387.5	0.0312 0.0308	0.0104	0.25	0.0351	2.6	
140 145	238.1 253.4	914.2	381.9 375.9	0.0304	0.0107	0.24	0.0358	2.4	
150	269,4	866.6	369.5	0,0300		0,23		1.9	
190	209.4	0,000	309,5	0,0300	0.0113	0,23	0.0375	1.9	

Solstice[®] yf Refrigerant User Guide

Solstice[®] yf Properties and Materials Compatibility

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Materials Compatibility

A number of plastics and elastomers were evaluated for compability with Solstice yf. The information below can serve as a guide to identification of compatible classes of plastics and elastomers. Performance of plastics and elastomers can vary considerably with formulation and conditions of use. Materials should be evaluated at the conditions associated with the intended application before adopting use of a particular material, especially in the case of production components.

Plastics

	Rating	24-hr Post Weight Change, %	Physical Change
Polyester	7	4,4	0
Nylon	1	-1.5	1
Epoxy	1	0.3	1
Polyethylene Terephthalate	1	2.0	0
Polyimide	0	0.2	0

Elastomers	Rating	24-hr Post Linear Swell, %	24 -hr Post Weight Change, %	24 -hr Post Change in Hardness
Neoprene WRT	0	0.0	-0.3	1.0
HNBR	0	1.6	5.5	-7.0
NBR	0	-1.2	-0.7	4.4
EPDM	0	-0.5	-0.6	4,4
Silicone	1	-0.5	2.5	-14.5
Butyl Rubber	0	-1.6	-1.9	0.5

0 - best when weight gain < 1 and physical change = 0 1 - bordenine when weight gain > 1 and < 10 and/ or

physical change up to 2

2 - incompatible when weight gain > 10 and/or physical change - 2

0 = loss than 10% weight gaur and loss than 10% lower swelt and <10 hardness u nit change 1 =>10% weight gam in >10% issuer await or >10 hardness unit change

2 = 510% wonget gain of >10% when were or >10 hordness and cronge 2 = 10% wonget gain an d >10% know word and >10 hordness o nu change

Honeywell

Other Elastomer Information

SAE Cooperative Research Program (CRP) has studied hose permeability and O-ring compatibility using samples from a number of commercial suppliers. Sample s were exposed to HFO-1234yl/modified ND-8 (PA G) lubricant. Most samples were within target parameters after exposure. Formulations of the following elastomer types having acceptable performance should be commercially available:

EPDM

HNBR Neoprene Butylrubber Chlorobutyl rubber Polyamide elastomer

Honeywell Refrigerants

101 Columbia Road Morristown, NJ 07962-1053 1-800-631-8138

www.honeywell.com



Patroary 2014 20014 Hassader Exercising Sec. N. Conta

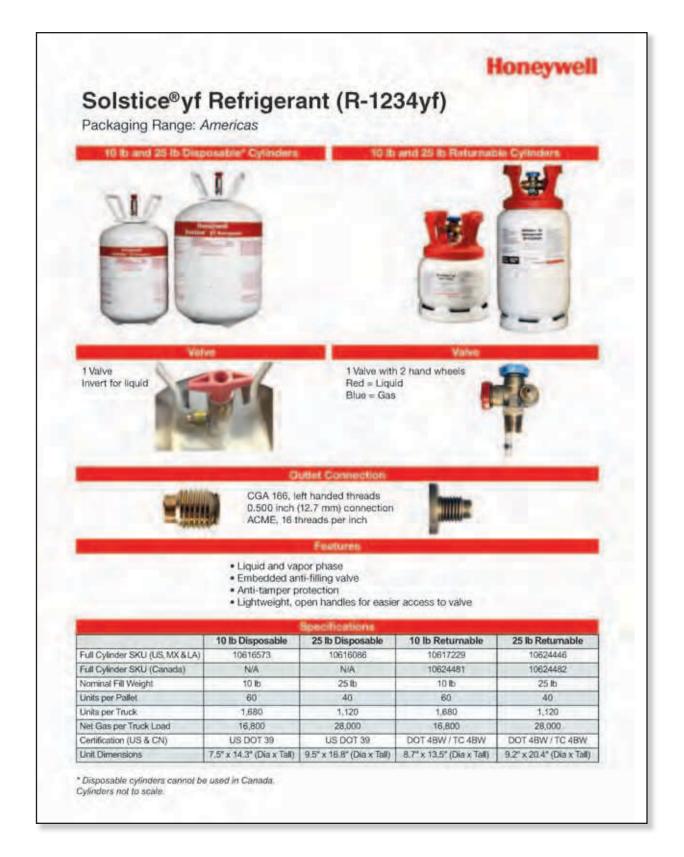


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Part 2 Customer Process and Procedures



2

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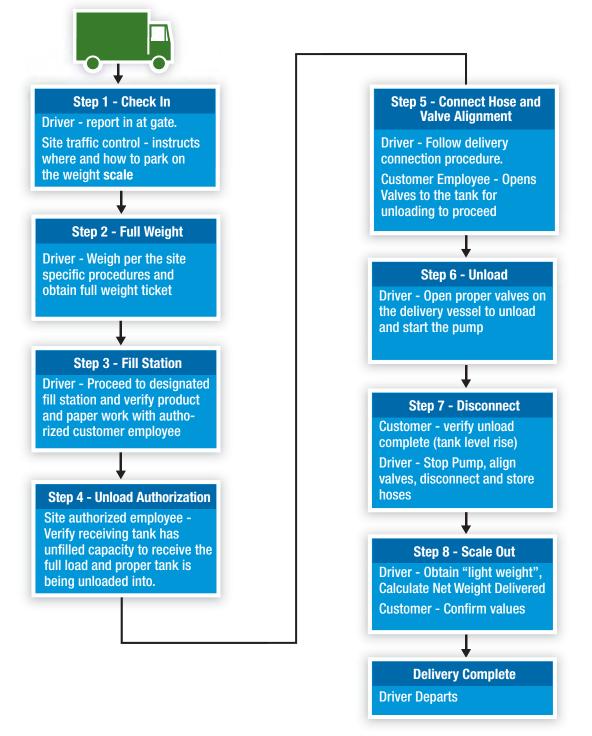


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Flow Chart

Driver arrives at facility





Receiving Loaded ISO Tanks

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1. RECEIVING LOADED ISO TANKS

- 1.1 Reception
 - a. Truck arrives at gate and is admitted by traffic control
- 1.2 ISO Weight (Full)
 - a. Receiving facility performs daily scale procedures prior to weighing ISO
 - b. Park ISO chassis and tractor on the scale per receiving facilities direction
 - c. Weigh ISO and receive the "full weight" value from the customer's facility
- 1.3 Product and Documentation Verification
 - a. Receiving facility will verify all shipping documents such as:
 - Bill of Lading (BOL)
 - Certificate of Analysis (COA)
 - Consignment Note (CMR)
 - Facility contact checks the scale weight verses the BOL weight and notifies Honeywell of any discrepancies > +/- 5%.

Immediately notify Honeywell of any abnormalities using the STOP procedure as outlined in procedure Honeywell STOP Procedure and provide supporting documentation such as digital photos.

2. VERIFICATION AND HANDOVER OF DOCUMENTATION

- 2.1 Driver parks the ISO tank at the unloading spot/station per site personnel instructions
- 2.2 Driver presents the shipping paperwork to the sites authorized unloading contact
- 2.3 Facility contact verifies the product paperwork ensuring that the product listed matches product entered into the scale and what was scheduled for delivery

Immediately notify Honeywell of any abnormalities using the STOP procedure as outlined in procedure Honeywell STOP Procedure and provide supporting documentation such as digital photos.

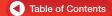
3. UNLOADING AND SCALE OUT

- 3.1 Facility primary contact instructs driver where to hook up to unload
- 3.2 Driver connects the appropriate liquid and vapor hoses to the unload station
- 3.3 Driver unloads the contents of the ISO
- 3.4 Driver safely disconnects and stores the hoses at the facilities location or on the delivery vessel.
- 3.5 Driver proceeds to the facility scale for "light weight" scale reading

4. HEEL WEIGHT CHECK

- 4.1 ISO Weight (Light)
 - a. Park ISO chassis and tractor on the scale per receiving facilities direction
 - b. Weigh ISO and receive the "light weight" value from the customer's facility
 - c. Driver shares light weight with the receiving, tank farm or traffic department contact (should be the same contact that received the full weight for comparison to the Bill Of Lading).
- 4.2 "Complete" offload verification
 - a. Utilizing the following math, ensure a "normal" heel is all that remains in the ISO.
 - Full Weight Light Weight = Net Weight Delivered
 - (Light Weight / Full Weight) x 100 = % Heel Remaining
 - b. Driver shares the Net Weight Delivered and the % Heel Remaining with the receiving tank farm or traffic department contact.
 - c. The % Heel Remaining should be less than 5%
 - d. If more than 5% remains, use the STOP process





Receiving Loaded ISO Tanks

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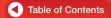
Immediately notify Honeywell of any abnormalities using the STOP procedure as outlined in procedure Honeywell STOP Procedure and provide supporting documentation such as scale tickets or digital photos.

EXAMPLE:

Full Weight		Light Weight		Net Weight Delivered
30,000 lbs	minus	1,500 lbs	equals	28,500 lbs
Light Weight		Full Weight		% Heel Remaining
1,500 lbs	divide	30,000 lbs	multiply 100 equals	5%



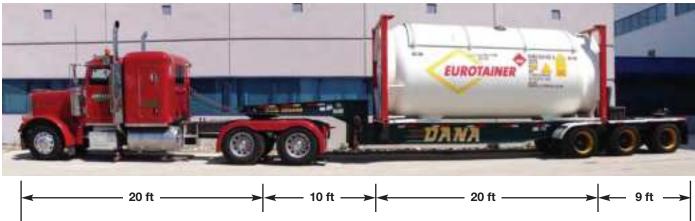
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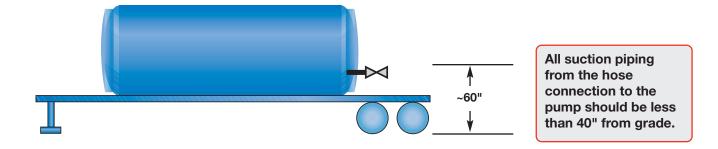
Prepare Tank and Equipment For Initial Offload

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Approximate ISO Dimensions







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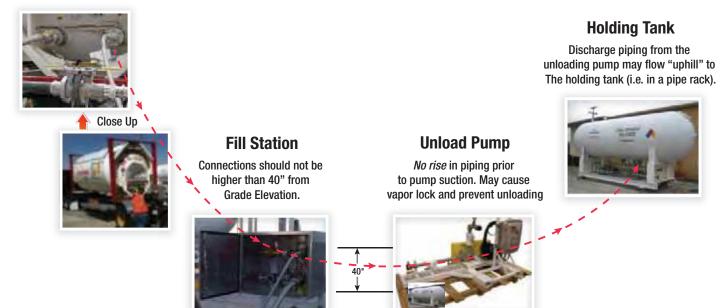
Prepare Tank and Equipment For Initial Offload Table of Contents

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Typical R-1234yf Pump and Unloading Configuration

ISO Tank

Sits at grade + 60 Inches. Hoses should flow "downhill" toward the Fill Station box.





Prepare Tank and Equipment For Initial Offload



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PRIOR TO THE FIRST LOAD BEING DELIVERED TAKE THE FOLLOWING STEPS TO PREPARE THE TANK:

- 1. Pressure test
 - a. Pressure up with Nitrogen to 90% of the lowest pressure rated piece of equipment in the system. (Note: This could change with each system so no specific pressure is recommended)
 - b. Monitor the system for a minimum of 24 hours to ensure no pressure loss has occurred on the system.
 - c. If loss of pressure occurs, leak check joints, flanges, fittings etc with soap and water

Note: fluctuations in ambient temperature change may cause pressure increase/decrease. A steady decrease is the sign of a leak. Open all Valves and connections to get a true SYSTEM tightness.

2. Nitrogen Purge (this could be accomplished by releasing the nitrogen used to pressure test through <u>all</u> the "bleed" valves on the tank and associated piping).

Note: It is recommended that Step 1 and this step occur two to three times. This will help to "drive" a lot of the moisture out of the low lying points and joints and make the next step easier to accomplish.

- 3. Pull vacuum down to 2,000 microns (measured at the tank, not at the pump)
 - a. When the vacuum pump is shut down or valved off, the vacuum at the tank should hold for a minimum of 60 minutes.
 - b. In good conditions (warm days and nights) this process could take 1 to 2 days. This is vacuum pump size dependant, must use a 12 cfm or larger vacuum pump.

Caution: If a total of a liter of water is present in the system, this time could go as long as 3 days and up to a week (depending on ambient temperature), step 2 will help prevent this from occurring

Caution: If water is present, or during winter, it may be necessary to use a heater with insulating blankets and a tent tarp to elevate the tank temperature and drive off water and/or frost. The fittings and pipes also need to be heated or the water will just move to the coldest portions.

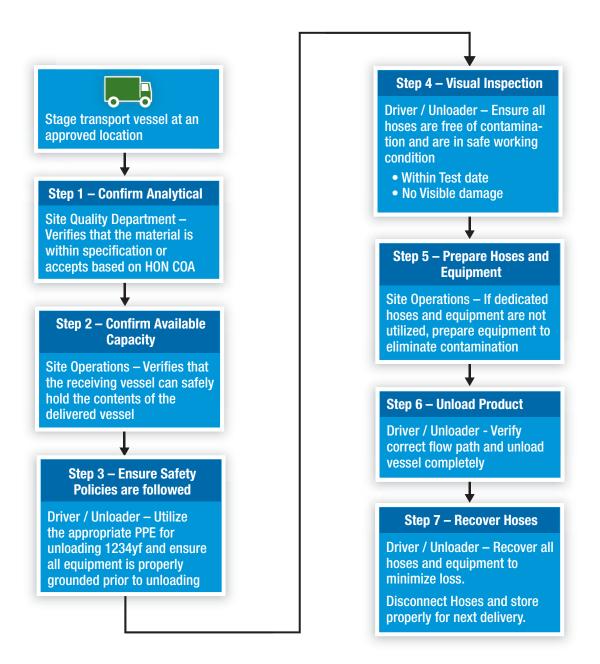
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Offloading into a Fixed Bulk Storage Asset

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Flow Chart





Offloading into a Fixed Bulk Storage Asset

OFFLOADING INTO A FIXED BULK STORAGE ASSET

- 1. Verify that a COA is included in the shipping paperwork. The COA certification date may not be greater than 90 days old.
- 2. Verify that the fixed bulk storage asset has sufficient available space to receive the full contents of the ISO. Fixed bulk storage assets should not be filled above 85% of their total capacity
- 3. Ensure site personnel are informed/trained in the handling of refrigerants are wearing all required PPE
- 4. Position the ISO in the designated area for 1234yf transfers. If this area is not marked appropriately, STOP and seek guidance from the responsible Health and Safety professional on site.
- 5. Check grounding equipment is in good working order, free of abrasions, gouges, kinks or any line breaks
- 6. Ground the ISO tank, transfer pump and fixed bulk storage asset
- 7. Under ideal conditions the hoses used will be as short as possible to minimize the opportunity for introduction of non condensable gases and moisture into the transfer lines and tanks.
- 8. Visually inspect hoses to ensure they are safe for use, check for:
 - a. Fraying
 - b. Gouges
 - c. Kinks
 - d. Any other defects
- 9. Hoses and pumps should be stored indoors or in a covered area to prevent accumulation of moisture; pump should have caps applied over hose connection points
- 10. Visually inspect each connection to ensure moisture is not present. If present, manually remove with a clean, dry cloth
- 11. Connect the couplings to the liquid line of the ISO tank
- 12. Connect the hose from the coupling to the pump
- 13. Ideally the hoses and pump should be dedicated for specific product usage. To prepare the hose:
 - a. Connect all hoses, valve, couplings etc.
 - b. Ensure the valves going into the bulk storage tank are closed
 - c. Leave the internal valves and the manual valves for the ISO closed
 - d. Connect to a vacuum source to the point shown below and pull to 2 mbar, holding for 1 minute
 - e. hoses have been completely evacuated, close valves and disconnect vacuum source
- 14. Close (ensure that) the bleed valve used to pull the vacuum is closed
- 15. Open the valve(s) from the ISO tank vapor line to the fill box
- 16. Open the valve(s) from the ISO tank liquid line to the fill box
- 17. Open the valve(s) for the vapor line to the bulk tank starting inside the fill box
- 18. Open the valve(s) for the liquid line through the pump to the bulk tank starting inside the fill box
- 19. Turn on the pump
- 20. Using a hand held gas leak detector, frequently monitor the pump, bulk tank, all lines and connections for leaks
- 21. Offload the appropriate contents of the ISO tank. A partial offload may be requested only when the bulk tank is installed on a scale or other means of estimating offload amount are present
- 22. Stop the pump
- 23. Close the bulk storage liquid fill valves do not disconnect the hoses (leave the vapor line to the storage open)
- 24. Close the internal valve and valves "B" and "C" shown below
- 25. Begin hose recovery procedures to minimize and/or prevent product loss:
 - a. Connect the suction of recovery pump to the liquid sample valve, pictured below as a vacuum connection valve, on the liquid discharge line of the ISO
 - b. Connect the discharge of the recover pump to the vapor sample valve, pictured below as a vacuum connection valve, on the vapor equalization line of the ISO
 - c. Open both sample valves

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Offloading into a Fixed Bulk Storage Asset

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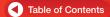
Vacuum can be pulled at these connection ports for the liquid and the vapor hoses.

- d. Verify flow of product, should be pulling product out of the liquid hoses from the liquid fill line on the storage, through the pump and back into the vapor side of the ISO. See diagram below for the proper valve arrangement.
 - Valve C is Closed
 - Valve D is Open
 - Valve B is Closed
 - Valve A is Open
- e. Open the valves for the recovery pump
- f. Engage the pump to recover the product
- g. Recover product to 3mbar of total pressure on the recovery pump
- h. Close all valves
- i. Disconnect all piping and equipment
- j. Close all valves, Disconnect all piping and equipment

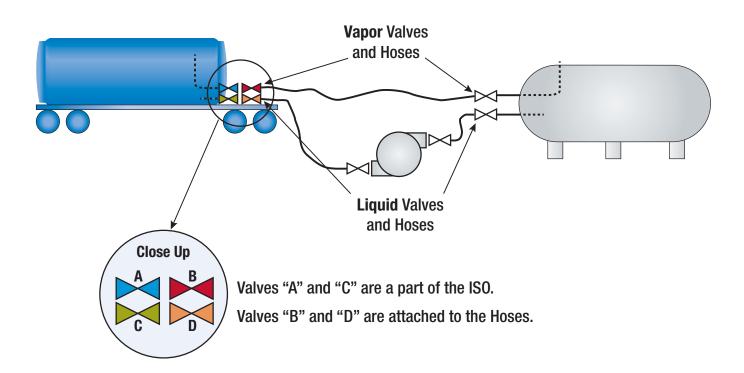


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Offloading into a Fixed Bulk Storage Asset



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Unloading Procedure and Operation/Maintenance Manual

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10522 SUCCESS LANE DAYTON, OHIO 45458 937 245 1915 937 748 5249 FAX www.questengineering.net



"Committed to the Quest for Higher Performance"

Refrigerant R1234yf ISO Container Unloading Pump Station

- MACHINE DESIGN/BUILD
- MACHINE VISION
- SYSTEMS INTEGRATION
- DATA ACQUISITION
- TURNKEY PROJECTS

UNLOADING PROCEDURE AND OPERATION/MAINTENANCE MANUAL



February 2013

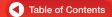
SERIAL NUMBER's: 12043-1 thru 12043-5

Manufactured for: Honeywell Specialty Materials 101 Columbia Road



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Unloading Procedure and Operation/Maintenance Manual



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7.	Component InformationPage 55 Pump (attached as PDF) Motor (attached as PDF)	

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QUEST ENGINEERING

Refrigerant R1234yf ISO Container Unloading Pump Station

1. SYSTEM OVERVIEW

The Refrigerant R1234yf ISO Container Unloading Pump Station described in this document is intended for use to transfer refrigerant R1234yf from an ISO container to a customer's bulk tank.

2. SYSTEM SPECIFICATIONS

Pump:	sliding vane
Flow rate:	45 GPM at 50 psi differential
Motor:	5hp, 480/3/60, 6.83 amps, 215T farme
	1150 rpm
Pressure:	400 psig max, 125 psi max differential
Hoses:	(2) 2" hoses, 15 feet long, stainless steel braid, PTFE lined
	(1) 1-1/2" hose, 15 feet long, stainless steel braid, PTFE lined

3. R1234YF ISO UNLOADING PROCEDURE

Proper PPE consisting of face shields and gloves are required.

- 3.1 Position the ISO container chassis close enough to the unloading station to attach the hoses. The hoses should not be under tension or undue strain at the connections. The hoses are approximately 15 feet long.
- 3.2 Attach static ground cable on unloading station to static ground point on truck chassis.
- 3.3 Remove hoses as needed from hose storage tubes. Always use caution to avoid kinks in the hoses.
- 3.4 Remove any safety plugs or caps on the hose ends.
- 3.5 Connect 2" liquid hose from the customer's existing truck unload station to the liquid port on the ISO container.
- 3.6 Connect the 1-1/2" vapor hose from the customer's existing truck unload station to thevapor port on the ISO container.





Unloading Procedure and Operation/Maintenance Manual

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3.7 Open vapor valve (slowly) at the truck unload station.

- 3.8 Open vapor valve (slowly) on ISO container to allow pressure to equalize between the tanks. If the tank pressures are unequal (pressure difference greater the 10 psi), you should hear vapor traveling in the line. If not, the ISO container internal excess flow valve may have closed due to excess vapor flow. In this case, close the vapor valve on ISO container. Wait 5-10 minutes for the excess flow valve to open. Again slowly open the vapor valve to allow tank pressures to equalize. When the pressures are equalized between the two vessels proceed to the next step.
- 3.9 Open the liquid valve (slowly) on the ISO container. Check for any leaks at connections.
- 3.10 Open the liquid valve (slowly) at the truck unload station and the valves on the liquid lines to and from the pump. Check for any leaks at connections a second time.
- 3.11 Make sure electrical disconnect switch on electrical enclosure at pumping station is in OFF position.
- 3.12 Connect power cord of pumping station to power source.
- 3.13 Turn electrical disconnect switch on unloading position to ON position.
- 3.14 Select FWD or REV on electrical enclosure.
- 3.15 Quickly start and stop the pump motor to check pump rotation. An arrow indicating correct rotation is located on the pump casing. If rotation is correct, proceed with unloading, checking for leaks at all times. If rotation is not correct, switch pump rotation at the enclosure and check rotation again. When rotation is correct, proceed with unloading.
- 3.16 Verify the flow indicator on the unloading station indicates flow is going to bulk tank. The flow indicator can also be used to indicate when liquid flow has stopped and the ISO container is empty.
- 3.17 When the flow stops the hose may jump or vibrate. This is a signal the ISO container is empty.
- 3.18 Stop the pump at this point, turn disconnect switch to OFF position and unplug the power cable from the power source.
- 3.19 Close the liquid valves on the ISO container and the truck unload station.
- 3.20 Close the vapor valves on the ISO container and the truck unload station.
- 3.21 Disconnect the vapor line hose and return to hose storage tube. Do not drop the hoses. The fittings are very expensive and can be damaged. Replace any safety plugs or caps that were on the hoses originally.
- 3.22 Disconnect the 2" liquid line hose and return to the hose storage tube.
- 3.23 Detach static ground cable from chassis and allow it to retract to unloading station.

4. MAINTENANCE

Item	Maintenance Required	Frequency
Hoses	Check for leaks/wear	Each use
Strainer	Remove and clean	Annually, or as needed
Pump	Lubricate bearings(refer to mfr's manual) Check for leaks	Six month Each use
Motor	Lubricate bearings(refer to mfr's manual)	Annually, or as needed
Drive belt	Check wear, alignment, tension	Six months



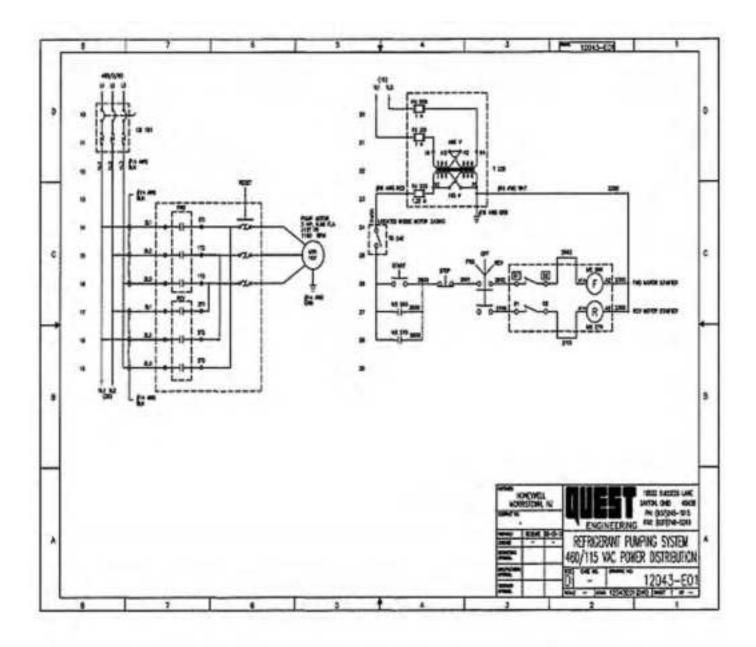
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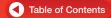
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5. DRAWINGS

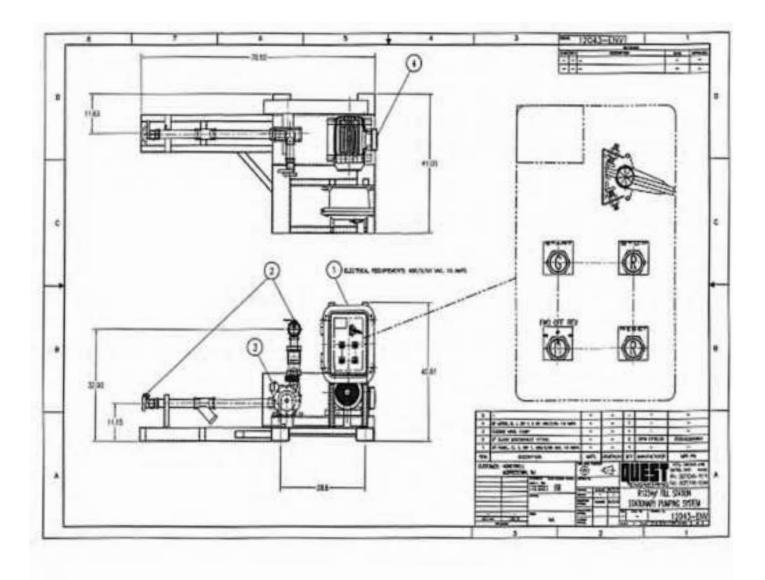




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6. PARTS LIST

Pump - Corken part number ZX2000HGBFFU Motor – WEG part number 00512XT3E215T Flow Indicator – Corken part number FC200AF Pressure Gauge – Ashcroft 25 1009AW02L Drive Belt – Gates part number BX70 Pump Station Connection – OPW Epsilon part number ZE32AS32A01101 2" Hose Connection – OPW Epsilon part number ZE32DS32A05301-Q 1" Hose Connection – OPW Epsilon part number ZE16HS16A01301

7. COMPONENT INFORMATION

PUMP

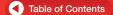
(PDF Document attached, separate file)

MOTOR

(PDF Document attached, separate file)

8. RECOMMENDED SPARE PARTS

Item	MFR Part Number	Quantity
Pump	Corken ZX2000HGBFFU	1
Pump, repair kit	Corken 3193-XB1	1
Pump, mech seal	Corken 4431-XB2	2
2" Epsilon coupler	OPW ZE32DS32A05301-Q	1
2" Epsilon coupler, seal kit	OPW ZK32HM002002	2
2" Epsilon adaptor	OPW ZE32AS32A01101	1
2" Epsilon adaptor, seal kit	OPW ZK32AM001	2
2" Epsilon adaptor, face seal	OPW ZE100397-040	2
1" Epsilon coupler	OPW ZE16HS16A01301	1
1" Epsilon coupler, seal kit	OPW ZK16HM001	1
Drive Belt	Gates BX70	2



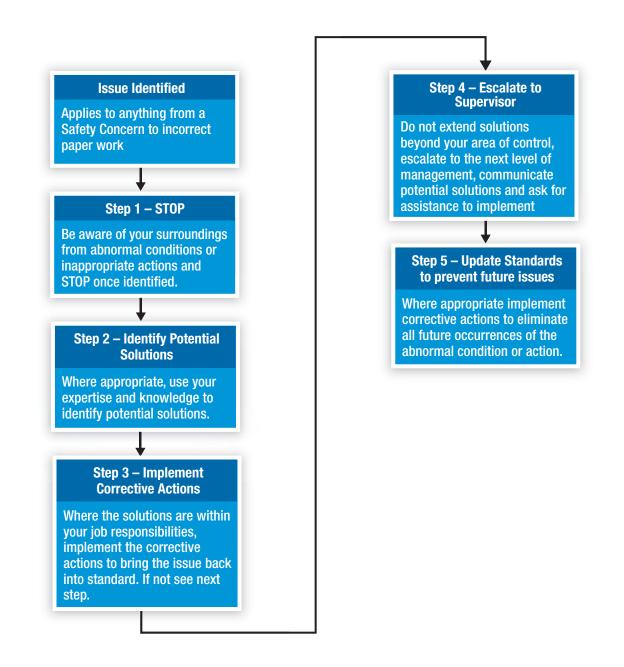




Honeywell STOP process

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Flow Chart



Honeywell STOP process

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Safety Bulletin - STOP

USING THE "STOP" PROCESS IS AN EXPECTATION OF EMPLOYEES, TOLLERS AND DISTRIBUTORS

Response Time Standards

Step	Total		
11 12 7 9 5 8 7 6 5 5	$\begin{array}{c} 1000000000000000000000000000000000000$	Person Escalating the Question	Person Providing the Response
30 min	30 min	Staff: Identify the root cause and apply the solution. If a solution is not available within 30 minutes or support required, inform next level support.	Not applicable
60 min	90 min	Maintenance: Production Manager: Plant Manager: Safety Manager: Identify the root cause. If cause not identifiable in 60 minutes or support needed, escalate.	Present the root cause preferably along with the solution to the person originally escalating the question within 60 minutes.
2 hr	3.5 hr	Honeywell Supply Chain: Identify the root cause. If cause not identifiable in 60 minutes or support needed, escalate.	Present the root cause preferably along with the solution to the person originally escalating the question within 2 hours.
	>3.5 hr	Honeywell Leadership: Identify the root cause utilizing all available assets until identified and a solution created.	Not applicable



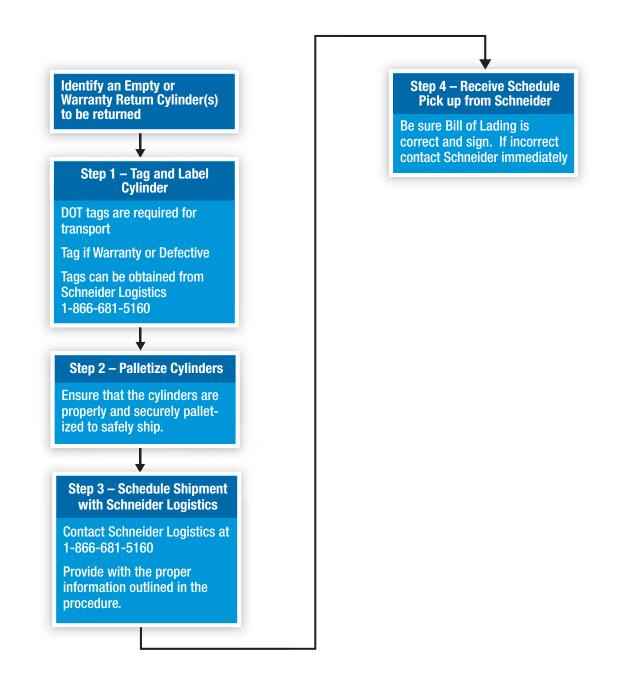
TRUE EMERGENCIES should be handled using local emergency response, not the STOP Process



Cylinder Return Process

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Flow Chart



Cylinder Return Process

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EMPTY AND WARRANTY

- 1. Freight paid by Honeywell on the following:
 - a. All Warranty returns
 - b. Empty ton, half ton,100lb, 25lb, and 10lb cylinders
- 2. Estimated Credit Processing Time:
 - a. Cylinder Deposit (for Empty, and/or Warranty) 30 days
 - b. Credit for Product (Warranty) 60 days
- 3. Shipment Requirements:
 - a. Make sure DOT tags are attached. DOT tags are required for shipment (if missing please contact Schneider Logistics @ 1-866-681-5160)
 - b. For warranty/defective returns Warranty Return Cylinder Tag must be attached (please contact Schneider Logistics @ 1-866-681-5160)
 - c. Palletize properly, 8 to 12 100lbs cylinders per pallet. Cylinders must be standing up, and insure red arrows are facing up.
 - d. 10lb & 25lb cylinders must be returned palletized and standing upright.
 - e. Empty cylinders are sent to the Honeywell Danville plant*
 - f. Warranty/Defective cylinders are sent to Honeywell Danville plant*

*Schneider Logistics will arrange for shipment and will determine where the cylinders should be sent.

- 4. Instructions for scheduling a cylinder return
 - a. Contact Schneider Logistics at 1-866-681-5160 and have the following information available when placing your call:
 - Customer name, address, telephone number, fax number, and, e-mail address
 - Type of return: Warranty and/or empty cylinders
 - Did you purchase cylinders from Honeywell?
 - Do you have the proper DOT tags, and Warranty return cylinder tags?
 - Number of empty cylinders being returned
 - Size of cylinder (ton, half ton,100lb, 25lb, or 10lb cylinder)
 - Provide product last contained in each cylinder
 - Ton cylinder serial number (optional)
 - Customer's internal reference number (optional).
 - b. Schneider Logistics will provide the following:
 - Pickup time, date, and name of carrier.
 - Please allow 48 hours for full-truck loads
 - Next day before 3:00pm for LTL shipments (request must be made by 3:00 pm CST the previous day to insure pick up)
 - Fax or e-mail you copy of the Bill of Lading
 - Please review, verify accuracy, and sign Bill of Lading.
 - Please contact Schneider Logistics for any corrections or changes to the B/L, and retain a copy for your files

Please note that material returned without proper tags may delay credit

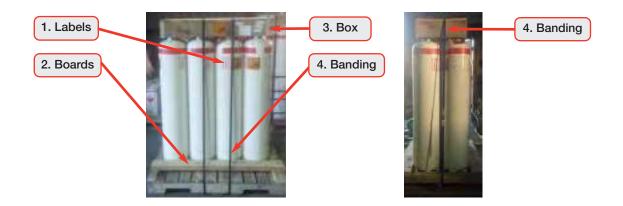


Cylinder Return Process

- 5. Guidance for Palletizing Cylinders: Due to the flammability classification of this product, cylinders must be palletized in a way to prevent accidental release and the possibility of creating a flammable atmosphere.
 - a. Cylinders must be palletized with the valve facing the upright position.
 - b. The number of cylinders that may be palletized varies, please follow the recommended guidelines.

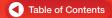
Type of Cylinder	Maximum Cylinders per Pallet	
100 lb (45.3 kg)	11 (4 on each side x 3 in the middle)	
25 lb (10 kg)	40	
10 lb (5 kg)	60	

- c. Since the 100 lb Cylinders are not stackable, this is one suggestion for securely palletizing the cylinders (visual aids follow)
 - 1. Ensure all the cylinders are labeled correctly
 - 2. Once cylinders are placed on the pallet in the upright position, surround the base of the cylinders with boards and nail them to the pallet.
 - 3. Fabricate a box to entirely cover the valve caps of the group of cylinders and place the box on top of and fully covering the cylinder caps.
 - 4. Place steel banding surrounding the boards and cylinders in both directions of the pallet



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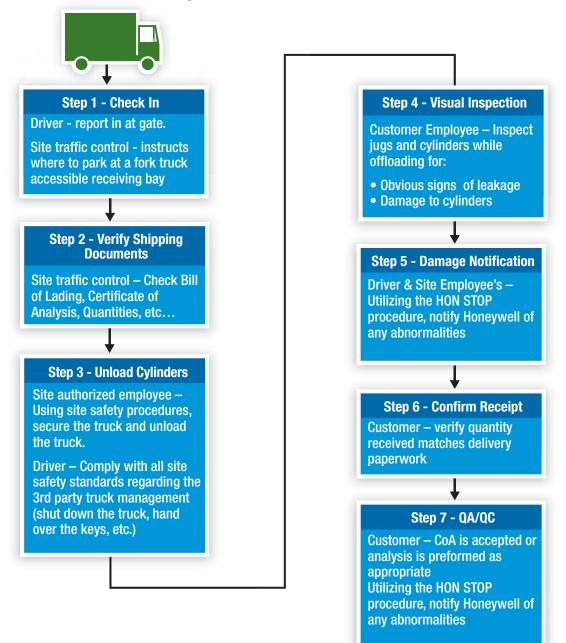
Receiving Full Cylinders



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Flow Chart

Driver arrives at facility





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Receiving Full Cylinders

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RECEIVING FULL CYLINDERS

2.

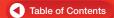
- 1. Truck arrives on site and reports to traffic control
 - Product and Documentation Verification
 - a. Customer employee begins filling out the proper site receiving documentation
 - b. Customer employee physically verifies the following:
 - The presence of all required paperwork:
 - Bill of Lading (BOL)
 - Consignment Note (CMR)
 - Certificate of Analysis (COA)
 - A two way product match:
 - The labels and tags located on the cylinders
 - The product on the paper work match
- 3. Offload truck and store tanks in designated areas. While offloading, watch for obvious signs of leaking or tank damage

Immediately notify Honeywell of any abnormalities using the STOP procedure as outlined in procedure Honeywell STOP Procedure and provide supporting documentation such as digital photos.

- 4. Net weight is received by the warehouse
- 5. CoA review or analysis is performed by the quality department as appropriate

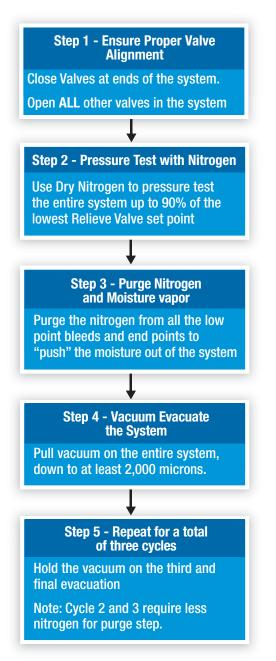
Immediately notify Honeywell of any abnormalities using the STOP procedure as outlined in procedure Honeywell STOP Procedure and provide supporting documentation such as digital photos.

Commission Tank for Initial Offloading



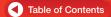
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Flow Chart





Commission Tank for Initial Offloading



1. PRESSURE TEST AND EVACUATION PROCESS

Perform pressure tests and evacuation procedures on all lines and equipment that will contain R1234yf.

For all steps ensure that all auxiliary equipment utilized in this procedure, including connections and hoses, are rated for greater than 500 psig and certified to hold a 500 micron Hg vacuum.

- 1.1 Pressure test
 - a. Ensure that you have enough nitrogen on site to pressure up the entire system, this could take at least 4 "cylinder banks" of nitrogen per testing cycle
 - b. Make certain ALL valves are open to the lines and equipment to be tested.

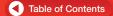


Some valves may be air operated and may even need a signal from a panel to open the valve. It is important to ensure all valves are in the open position.



There are a lot of valves on the bottom of the tank to open, be sure to get them all. You can use the pressure gauges to monitor pressures. There should also be bleed points to relieve the pressure during the purge step(s).

Commission Tank for Initial Offloading



c. Pressure test the entire system to 10% less than the lowest rated relief valve setting in the system with dry nitrogen.



Primary Tank RV will typically be located on top of the tank. There may be other RV's in the system.



The fill box, pictured here, is a good place to connect the nitrogen bank and the recommend location for pulling vacuum. Use the hose provided and connect to the 1" vapor Epsilon fitting. The other hose end can be fitted with a connection for the nitrogen bank or vacuum pump.

NOTE: Do not use the 2" liquid connection for vacuum, the flow check will prevent the vacuum flow path.

- d. Perform leak test on lines and equipment using leak detection solution (Cal Blu is recommended).
- e. If necessary, repair leaking lines and equipment.
- f. Repeat steps 2-4 until no leaks are detected.
- g. Hold N2 pressure for one hour. Residual moisture contained in the system will evaporate into the nitrogen during this period. Compressed air should not be used for leak checking, you will adding moisture to the vessel and will significantly extend evacuation time. Honeywell does not recommend using compressed air.
- h. Once the lines and equipment are deemed to be leak free continue to the next step.

Purge Nitrogen through the low point bleeds and ends of the system

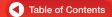
- a. Open the valves at the ends of the system (Fill Box and Assembly Line) and under the holding tank. Pay particular attention to open the low points in the system, especially under the holding tank.
 - This could be a loud process

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1.2



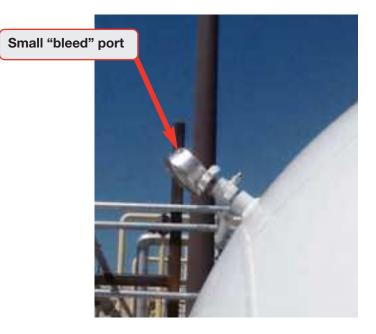
Commission Tank for Initial Offloading



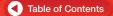
- b. Monitor a pressure gauge on the system once the gauges read 50 to 100 PSIG, begin to close the valves at the end of the lines working toward the holding tank.
- c. Continue to bleed the nitrogen in the system down to a slight positive pressure on the system, 5 to 10 psig.
- 1.3 Evacuate lines and equipment to less than 2,000 microns
 - a. Utilize an adequately sized vacuum pump to evacuate the system. Remember the tank is typically 6,500 gallon capacity and the systems normally have a lot of piping to be evacuated.

While a smaller vacuum pump(s) can be used , we recommend at least one 80 SCFM vacuum pump to pull down the system (shown below). This size pump should pull down the entire system in 4-6 hours. If it takes longer than 6 hours, you probably have a leak in the system (a valve open to atmosphere, loose hose connections and small bleeds like the one behind this pressure gauge are likely leak sources) or residual water in the tank.





Commission Tank for Initial Offloading



b. Hook up the vacuum pump to the vapor line at the fill box and pull vacuum on the entire system.



- c. Ensure that the entire system is open from the fill box to the end of the line inside the assembly plant.
- d. Pull vacuum until 2,000 microns vacuum is attained and continue evacuating for two hours. Residual water will vaporize during evacuation to below 2000 microns.



We recommend a digital Micrometer that should be connected to a bleed port under the tank, not at the vacuum pump. The micrometer pictured is capable of reading high readings approx. 75,000 microns. Most meters will not start reading until the system is less than 12,000 microns.





- e. Shut down the vacuum pump and close off the valve at the fill box "locking in" the vacuum
- f. The system should hold less than 2,000 microns for one to two hours.
 - If the lines and equipment do not pass the vacuum check (step F), look for possible sources of leaks at all connections, including welds, hoses, valves, etc. Likely sources of leak points are hoses and connections, ensure the vacuum pump(s) and hose(s) are isolated from the system being tested.
 - If the evacuation pressure plateaus or slows significantly you may have free water in the tank. Add insulating blankets and start heating the tank to drive off water or frost. Once the tank and lines are above freezing, break the vacuum with dry nitrogen and start evacuation over.
- 1.4 Repeat all steps above **two** (2) more times to ensure the system is ready to charge.
- 1.5 On the third and final evacuation, keep the system under vacuum until the unloading of the 1234yf product takes place. Vapor form the 1234yf ISO will be used to break the vacuum during the initial unloading.
- 1.6 If the tank initial fill is to be postponed/delayed, Honeywell recommends filling with +30 psig of dry nitrogen (NOT compressed air) until Commissioning takes place.
 - a. Vacuum will have to be pulled down to 2,000 microns and held for one to two hours prior to filling with Solstice 1234yf.

The entire process could take 3-6 days to complete

Disclaimer

Although all statements and information contained herein are believed to be accurate and reliable, they are presented without guarantee or warranty of any kind, expressed or implied. Information provided herein does not relieve the user from the responsibility of carrying out its own tests and experiments, and the user assumes all risks and liability for use of the information and results obtained. Statements or suggestions concerning the use of materials and processes are made without representation or warranty that any such use is free of patent infringement and are not recommendations to infringe on any patents. The user should not assume that all toxicity data and safety measures are indicated herein or that other measures may not be required.

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Checklist for Commissioning Tank for Initial Unloading

Doc Number: NA-1234-2.9

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	Yes	No	Initial
Piping installed completely from the Fill Box to the Fill Station inside the			
Assembly Plant (Ensure Scope of Work was completed)			
Ensure tank is properly marked with Chemical Name, HMIS ratings, etc.			
Valve Closed at filling station cabinet inside Assembly Plant			
All Valves Open "walking back" to 1234yf Holding Tank discharge pump			
All Valves Open under the 1234yf Holding Tank			

- Pay careful attention to air accuted valves
- Pay careful attention to any control valves
- You may have to activate the control pannel
- You may have to activate the Emergency Shut Down system

Ensure one Relief Valves (RV's) is in the open position			
Document the Set Pressure on the RV			
All Valves Open "walking back" to the skid pump (the liquid unload line)			
All Valves Open " walking back" to the fill box (the vapor equalize line)			
ISO Delivery Scheduled, Please indicate the date for the ISO delivery			
Complete Pressure Test and Evacuation Procedure (SOP NA-1234yf-2.8)			

• Purchase or ensure the site has Nitrogen for pressure testing

- Rent or ensure that you have the proper vacuum pump to evacuate
- Rent or ensure that you have hoses and connections
- This proces may take 3 to 6 days (Initial when cycle step is complete)

Pressure test preformed (at 10% less than RV set points)		
Pressure test held for 1 hour minimum		
Nitrogen Purged through low points and ends of the piping system		
Vacuum (measured at the 1234yf holding tank) reached 2000 microns		
Vacuum (measured at the 1234yf holding tank) held 2000 microns for 2 hours		

Contractor Preforming work Signature:

Customer Accepting work Signature:

Hold vacuum (and equipment) until ISO arrives for unloading		
Vacuum (measured at the 1234yf holding tank) held 2000 microns for 2 hours		

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Part 3 Quality and Analytical Information



3

Certificate of Analysis

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Master Lot Number: Packaged Lot Number: Customer: <i>if applicable</i>		Delivery Date: Packaged Date: Order Number: <i>if applicable</i>
2,3,3	Honeywell stice™ yf Refrigerant ,3-Tetrafluoroprop-1-ene (Automotive Grade) rtificate Of Analysis	
	Specification	Results
Purity 1225yeZ 1234zeE Other unsaturates (total)	99.5 wt.% min 150 ppm by wt. max 500 ppm by wt. max 40 ppm by wt. max	Pass Pass Pass Pass
Moisture Acidity Residue Non Condensible Gases	20 ppm by wt. max 1 ppm by wt. max 100 ppm by v/v max 1.5 Vol. % max	Pass Pass Pass Pass
Appearance Particles or Solids	Clear, Colorless Visually Clean	Pass Pass
	Certified by Laborato	ry Analyst
The test results herein reported represent the		



Customer Specification

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Solstice TM 1234yf	
Limit ¹	Test Method
99.5% (w/w), min.	RDAM-618 Rev. 7
20 ppm (w/w), max.	Solstice-1234yf-5
1 ppm (w/w) as HCI, max.	Solstice-1234yf-2
100 ppm (v/v), max.	Solstice-1234yf-6
Visually clean to pass	Visual Inspection
1.08 to 1.10 Kg/L	Solstice-1234yf-5
1.5% (v/v) max.	Solstice-1234yf-8
Visual to pass test	Visual Inspection
1,000 ppm (w/w), max.	RDAM-618 Rev 1
150 ppm (w/w), max.	RDAM-618 Rev.
40 ppm (w/w), max.	RDAM-618 Rev.
5,000 ppm (w/w), max.	RDAM-618 Rev.
ample, unless noted otherwise Date:08/22/*	12
neter for (E) 1,3,3,3-Tetrafluoroprop-1-er c due to Name Change from HFO-1234) thod. The method RDAM-618T has bee ides parameter. Removed limit for Acidit	/f to Solstice [™] 1234yf. In revised and is now RDAI
	99.5% (w/w), min. 20 ppm (w/w), max. 1 ppm (w/w) as HCl, max. 100 ppm (v/v), max. Visually clean to pass 1.08 to 1.10 Kg/L 1.5% (v/v) max. Visual to pass test 1,000 ppm (w/w), max. 150 ppm (w/w), max. 40 ppm (w/w), max. 5,000 ppm (w/w), max. ample, unless noted otherwise. Date: <u>08/22/</u> neter for (E) 1,3,3,3-Tetrafluoroprop-1-er c due to Name Change from HFO-1234; thod. The method RDAM-618T has bee

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Laboratory Equipment Recommendation for HFO Refrigerants QA/QC Analyses

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Laboratory Equipment Recommendation for HFO Refrigerants QA/QC Analyses

This document describes the recommended equipment needed for HFO Refrigerants QA/QC analyses procedures. The details of the laboratory layout, wiring and plumbing designs as well as gas supply and chemical reagents are not included in this document.

1. SAMPLING CYLINDERS , QTY: VARY

- 1.1 Stainless steel, carbon steel or Aluminum cylinders, which are certified for refrigerant service and have pressure rating greater than 15 bar with relief valve, should be used.
- 1.2 The internal volume should be more than 300 mL but less than 1 L (300 mL < Volume < 1000 mL). for gas and vapor sampling cylinders. Qty: 4-6
- 1.3 The internal volume should be 1L for ISO sample retaining cylinders. QTY:12-14

2. LARGE DRYING OVEN, QTY:1

- 2.1 Internal depth should be larger than sampling cylinder length and diameter.
- 2.2 Temperature control range: room temperature to 200 °C

3. VACUUM PUMP, QTY:1

- 3.1 The maximum vacuum should be 29.5 inches of Hg (10 torr) or better.
- 3.2 Free air displacement at 1 aatmosphere should be greater than 2 CFM or 60 L/min.

4. CYLINDER PREPARATION MANIFOLD, QTY: 1

- 4.1 The manifold should have two or more sampling cylinder inlet connections.
- 4.2 The manifold should have a minimum of one Helium supply port, and one vacuum port.
- 4.3 The manifold should have one Pressure-Vacuum gauge, 30" Hg vacuum to 30 PSIG (-100 to 200 kPa gauge), this gauge may be dial or electronic.

5. GC SYSTEM, QTY: 1

- 5.1 Assay determination using traditional GC system
 - a. Equipped with a flame ionization detector (FID)
 - b. Chromatography data system: Capable of electronic integration and processing the chromatographic data.
 - c. Gas chromatographic column: 1% SP-1000, 60/80 Carbopack B column. 24 ft, 1/8" Stainless steel column or equivalent.
 - d. Gas inject syringe (2 mL) or auto injection valve with sampling loop (1mL)
- 5.2 Non- condensable gas analysis using traditional GC system
 - a. Equipped with a thermal conductivity detector (TCD), and capable of oven temperature programming.
 - b. Chromatography data system: Capable of electronic integration and processing the chromatographic data.
 - c. Gas chromatographic column (Packed): Poropak QS, 80-100 mesh 6ft, 1/8" Stainless steel column, or equivalent.
 - d. Gas inject syringe (2 mL) or auto gas injection valve with sampling loop (1mL)

6. KARL FISCHER ANALYZER, QTY:1

- 6.1 KF coulometric titration system (contains a removable drying tube for venting refrigerant, anode and cathode solutions, septum, and water vaporizer)
- 6.2 Drierite, 20-40 mesh
- 6.3 Desiccator, containing Drierite
- 6.4 Needle attachment assembly for cylinder sampling. Please refer to AHRI standard 700-2006, 2008 appendix C, Part 2





Laboratory Equipment Recommendation for HFO Refrigerants QA/QC Analyses

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7. SCALES, QTY: VARY

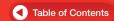
- 7.1 op loading scale 4000g with 0.1g resolution, Qty:1
- 7.2 Analytical scale, 320g with 0.1mg resolution, Qty:1

8. GENERAL LAB GLASSWARE AND SUPPLIES, QTY: VARY

- 8.1 Gas Dispersion tube, polyethylene, Qty:1
- 8.2 Hot plate with stir, Qty:1
- 8.3 Amber-glass bottle, 300 mL, for Silver Nitrate solution, Qty:1
- 8.4 Assorted graduated cylinders
- 8.5 Assorted beakers
- 8.6 Assorted volumetric flasks
- 8.7 Deionized water supply system

Revised: v101, Jim Tu, 10/16/2012 - modify required GC equipments to matching current method.

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Sampling Cylinder Preparation for HFO Refrigerants QA/QC Analyses

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Honeywell International, Inc. Performance Materials and Technologies Buffalo Research Laboratory Buffalo, New York 14210 716-827-6245

Sampling Cylinder Preparation for HFO Refrigerants QA/QC Analyses

HFO-Refrigerants-1

Material:	HFO Refrigerants
Analyte:	Sampling Cylinder Preparation for HFO Refrigerants QA/QC Analyses
Technique:	Vacuum and Purge
Specific Method:	HFO-Refrigerants-1
Supersedes:	None
Also Required:	None

PURPOSE

To describe sampling cylinder preparation procedure for HFO Refrigerants QA/QC analyses.

SCOPE

All cylinders used for sampling HFO Refrigerants analyses should be prepared per this procedure. Procedure written for 50 c.c. to 1 liter sampling cylinders.

SAFETY

- 1. HFO Refrigerants is a compressed liquefied gas which becomes very cold as it volatilizes. See MSDS.
- 2. Please review the all materials' MSDS. Wear safety glasses and safety shoes at all time.

This method may involve the use of hazardous materials, operations and equipment. This method does not purport to address all of the safety problems associated with its use. It is the responsibility of whomever uses this method to establish appropriate safety practices and to determine the applicability of regulatory limitations prior to use.

EQUIPMENT

- 1. Large drying oven controlled at 50°C
- 2. Vacuum pump, capable of achieving 29.5 in Hg of vacuum (1600 Pa abs. or 12 Torr)
- 3. Helium, industrial grade, feeding pressure 35 PSIA (240 kPa abs.)
- 4. Preparation manifold with pressure (0-30 PSIA, 0-200 kPa abs.) and vacuum gauge
- 5. Preferred solvent: Solstice™ 1233zd
- 6. Alternative Solvents: methylene chloride, acetone or hexane, reagent grade
- 7. Graduated cylinder, 100mL
- 8. Balance

PROCEDURE

Preparation of new sampling cylinders for HFO Refrigerants service

- 1. Inspect new sampling cylinder for any rust, water and/or oil residue. Clean any visible contaminations.
- 2. Place sample cylinder in the oven at 50°C, with valves completely open, for no less than one hour.
- 3. Remove cylinder from the oven and connect cylinder to the preparation manifold.





Sampling Cylinder Preparation for HFO Refrigerants QA/QC Analyses

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- 4. Evacuate cylinder to at least 29.5 in.Hg of vacuum (1600 Pa abs. or 12 Torr) for 20 minutes.
- 5. Shut off vacuum, fill the cylinder with helium to 25 PSIA (175 kPa abs.), and then close the cylinder valve for 5 minutes.
- 6. Open cylinder valve and evacuate cylinder to at least 29.5 in.Hg of vacuum (1600 Pa abs. or 12 Torr) for 10 minutes.
- 7. Repeat steps 5 and 6 two more times.
- 8. Close cylinder valves, and the cylinder is ready for sampling.

Preparation of used sampling cylinders for HFO Refrigerants service

- 1. Connect cylinder to the preparation manifold.
- 2. Vent residual HFO Refrigerants from the cylinder to ambient pressure.
- 3. Evacuate cylinder to at least 29.5 in.Hg of vacuum (1600 Pa abs. or 12 Torr) for 3 minutes.
- 4. Shut off vacuum, fill the cylinder with Helium to 25 PSIA (175 kPa abs.), and then close the cylinder valve for 30 seconds.
- 5. Open cylinder valve and evacuate cylinder to at least 29.5 in.Hg of vacuum (1600 Pa abs. or 12 Torr) for 1 minute.
- 6. Repeat steps 4 and 5 two more times.
- 7. Close cylinder valves, and the cylinder is ready for sampling.

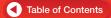
Contaminated sampling cylinders cleaning procedures

* This section is for the contaminated new sampling cylinders and for used sampling cylinders are contaminated with oil residues during the service.

[Use Solstice[™] Performance Fluid (1233zd) – preferred solvent]

**The following steps are the cleaning procedures for using Solstice™ Performance Fluid (1233zd) (preferred).

- 1. Connect the sampling cylinder valve to 1233zd container with clean fittings and tubings.
- 2. Open the sampling cylinder valve, and then fill the cylinder with about 32 grams of 1233zd solvent (~25 mL of 1233zd).
- 3. Close sampling cylinder valve, and detach the cylinder from 1233zd container.
- 4. Carefully swirl the cylinder to rinse the cylinder interior wall for 30-60 seconds.
- 5. Carefully empty the 1233zd from the sampling cylinder to a waste container.
 - a. The cylinder will have built up vapor pressure. Open the cylinder valve carefully.
 - b. Position the sampling cylinder upside-down to help 1233zd liquid flow out from the cylinder.
- 6. Repeat steps 1 5 three more times so total of approximately 100 mL of 1233zd solvent is used for rinsing the cylinder.
- Disassemble the cylinder valve, and then inspect the cylinder for any visible oil residue. If any oil residue is still visible, reinstall the cylinder valve, and then repeat steps 1 5 one more time. If the oil residue is still visible, discard the cylinder.
- 8. Reassemble the cylinder valve per cylinder/valve manufacturer procedures.
- 9. Evacuate cylinder to at least 29.5 in.Hg of vacuum (1600 Pa abs. or 12 Torr) for 5 minutes.
- 10. Shut off vacuum, fill the cylinder with helium to 25 PSIA (175 kPa abs.), and then close the cylinder valve. Check for leak around the cylinder valve.
- 11. Open cylinder valve and evacuate cylinder to at least -29.5 in.Hg of vacuum (1600 Pa abs. or 12 Torr) for 5 minutes.
- 12. Fill the cylinder with helium to ambient pressure.
- 13. Disconnect the cylinder from the manifold with cylinder valve completely opened. Place the cylinder in the 50°C oven for no less than one hour.
- 14. Prepare the cleaned cylinder as NEW sampling cylinder for service.



Sampling Cylinder Preparation for HFO Refrigerants QA/QC Analyses

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[Use Alternative Solvents]

*** The following steps are the cleaning procedures for using alternative solvents, such as methylene chloride, acetone or hexane.

- 1. Disassemble the cylinder value from the contaminated cylinder per cylinder/valve manufacturer procedures.
- 2. Fill the cylinder with 25 mL of solvent.
- 3. Carefully swirl the cylinder to rinse the cylinder interior wall for 30-60 seconds.
- 4. Pour alternative solvents from the cylinder to a waste container.
- 5. Repeat steps 2 4 three more times so total of ~100 mL of solvent is used for rinsing the cylinder.
- 6. Inspect the cylinder for any visible oil residue. If any oil residue is still visible, repeat steps 2 4 three more times. If the oil residue is still visible, discard the cylinder.
- 7. Reassemble the cylinder valve per cylinder/valve manufacturer procedures.
- 8. Evacuate cylinder to at least 29.5 in.Hg of vacuum (1600 Pa abs. or 12 Torr) for 5 minutes.
- 9. Shut off vacuum, fill the cylinder with helium to 25 PSIA (175 kPa abs.), and then close the cylinder valve. Check for leak around the cylinder valve.
- 10. Open cylinder valve and evacuate cylinder to at least 29.5 in.Hg of vacuum (1600 Pa abs. or 12 Torr) for 5 minutes.
- 11. Fill the cylinder with helium to ambient pressure.
- 12. Disconnect the cylinder from the manifold with cylinder valve completely opened. Place the cylinder in the 50°C oven for no less than one hour.
- 13. Prepare the cleaned cylinder as NEW sampling cylinder for service.

Written by; Jim Tu

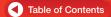
Date: April 17, 2012

Date: Sep. 21, 2012, Revised by: Jim Tu, Revision on changing 1234yf to HFO Refrigerants and added cleaning procedures for contaminated cylinders. Date: Nov. 12, 2012, Revised by: Jim Tu, Revision on adding 1233zd as preferred solvent. Added Acetone and Hexane as alternative solvents. Date: Nov 14, 2012, Revised by: Jim Tu, Added metric units and modified procedure description texts for clarification. Corrected the oven temperature in equipment section. Approved by: John L. Welch

Date: April 17, 2012

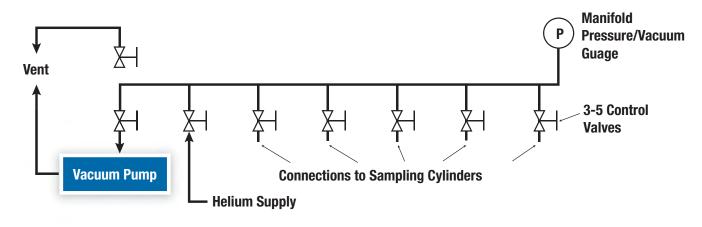


Sampling Cylinder Preparation Rack Schematic



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Sampling Cylinder Preparation Rack Schematic



1. VACUUM PUMP

- 1.2 Capable of achieving 29.5 in Hg of vacuum (1600 Pa abs. or 12 Torr) or better
- 1.1 Free air displacement at 1 atmosphere should be greater than 2 CFM or 60 L/min

2. HELIUM, INDUSTRIAL GRADE, FEEDING PRESSURE 35 PSIA (240 KPA ABS.)

3. PRESSURE/VACUUM (0-30 PSIA, 0-200 KPA ABS.) GAUGE

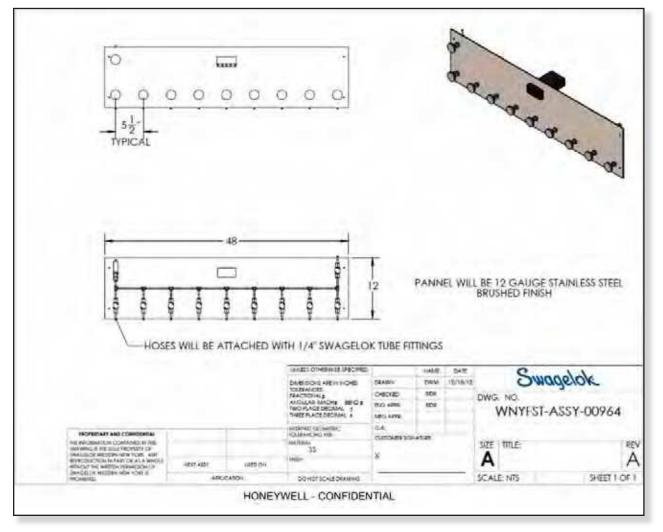
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Sampling Manifold Design from Swagelok

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Sampling Manifold Design from Swagelok



Sampling manifold design from Swagelok

- 1. VACUUM PUMP IS NOT INCLUDED IN THE DESIGN.
- 2. SIX CYLINDER CONNECTIONS, ONE HELIUM, ONE NITROGEN AND ONE VACUUM PORT.
- 3. WELDED MANIFOLD WITH VCR FITTINGS.
- 4. PARTS NUMBER

4.3

- 4.1 Valves: SS-4BK-VCR (Swaglok)
- 4.2 Pressure transducer: PX309-200Al (OMEGA ENGINEERING, Inc.) - 0-200 PSIA
 - 4-20 mA output
 - 2 wire cable internal excitation pressure transducer
 - Digital meter : DP25B-E ((OMEGA ENGINEERING, Inc.)
 - 4 digits meter
 - Resolution: 0.1 PSIA

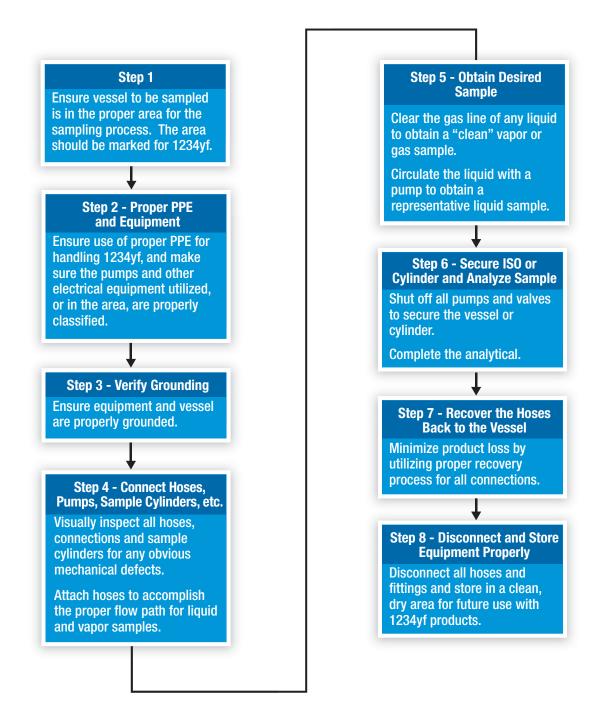
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Collecting Samples from ISOs and Cylinders

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Flow Chart



Collecting Samples from ISOs and Cylinders

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1. EQUIPMENT REQUIRED

- 1.1 Sample bottles must meet the following specifications:
 - a. Valves: All materials must be compatible with 1234yf per the compatibility matrix
 - b. Pressure Rating: The bottle must have a minimum pressure rating of 18 bar or 260 PSI
 - c. Acceptable Bottle Composition:
 - Stainless Steel
 - Aluminum
 - Carbon Steel
- 1.2 Gas Leak Detectors are needed for this procedure:
 - a. Should be portable, hand held devices
 - b. Must be calibrated for 1234yf

2. ISO TANKS

- 2.1 Vapor Sample
 - a. Ensure site personnel are wearing all PPE required for handling 1234yf.
 - b. Inspect the area to ensure the presence of only properly certified equipment. Remove any spark generating device from the immediate sampling area.
 - c. Position the ISO in the designated area for safely handling R1234yf. If the area is not marked to handle 1234yf, STOP immediately and consult the onsite HS&E professional.
 - d. Visually inspect hoses to ensure that they are safe for use. Check for
 - Fraying
 - Gouges
 - Kinks
 - Any other defects
 - e. Pump preparation: Ideally the pump should be dedicated for specific product usage.
 - Connect all hoses, valve, couplings etc., except the connection, to the liquid phase
 - Open the valves from the gas phase to the liquid phase to purge the pump
 - Connect the hose of the pump to the liquid phase
 - Open all valves
 - "Bump" start and immediately stop the pump until all liquid is out of the gas phase
 - Stop the pump
 - Close all valves and disconnect the pump
 - f. Take a sample from the gas phase by using a flow-through cylinder.
 - · Connect the sample hose to the vapor line
 - Connect the other end of the hose to a flow through cylinder
 - Open the valves to the flow through cylinder and purge for 10 seconds
 - Close the valves of the flow-through cylinder, farthest away from the ISO first and then moving toward the ISO.
- 2.2 Liquid phase samples
 - a. Connect the gas phase line to the discharge of the properly certified pump.
 - b. Connect the liquid phase line to the suction of the pump.
 - c. Leaving the valves to the ISO closed, pull a slight vacuum on the hoses and the pump to remove any air introduced to the system during the hose connections.
 - d. Open the valve to the liquid line, through the pump and into the vapor side of the ISO.
 - e. Continue to vent air until the gas monitor detects the presence of gas.
 - f. Turn on the pump.





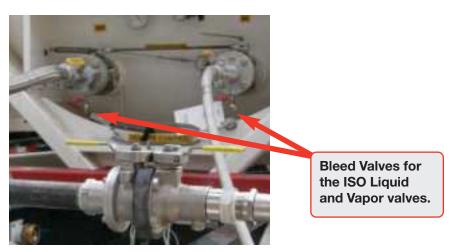
Collecting Samples from ISOs and Cylinders

• Circulate using the following guidance:

Pump Capacity	
1,700 kg/hr	

Quantity in ISO Tank	Duration
≥ 10 MT	30 minutes
< 10 MT	15 minutes

- Note that the above circulation times will have to be adjusted based on the capacity of available pumps.
- g. Stop the pump.
- h. Connect the sample cylinder, prepared per the procedure in Section 3, on the discharge side of the pump, but prior to the ISO.
 - Start the pump
 - Open the sample cylinder valve
 - Fill with a minimum of 1,000 g
 - · Close the valve to the sample cylinder and the sample valve on the pump
 - Stop the pump
 - Disconnect the sample bottle

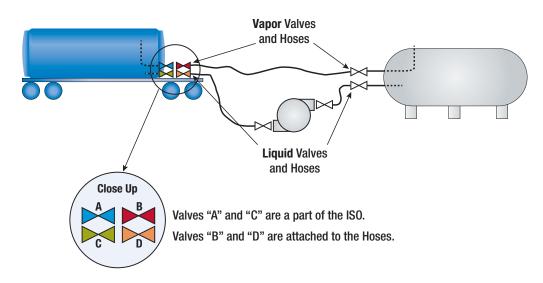


- i. Begin hose recovery procedures to minimize and/or prevent product loss.
 - Connect the suction of recovery pump to the liquid sample valve, pictured above as a bleed valve connection, on the liquid discharge line of the ISO
 - Connect the discharge of the recover pump to the vapor sample valve, picture above as a bleed connection valve, on the vapor equalization line of the ISO

Collecting Samples from ISOs and Cylinders

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- Open both sample valves
- Verify flow of product, should be pulling product out of the liquid hoses from the liquid fill line on the storage, through the pump and back into the vapor side of the ISO. See diagram below for the proper valve arrangement
 - Valve C is Closed
 - Valve D is Open
 - Valve B is Closed
 - Valve A is Open
- Open the valves for the recovery pump
- Engage the pump to recover the product
- Recover product to 3mbar of total pressure on the recovery pump
- Close all valves
- Disconnect all piping and equipment
- Close all valves. Disconnect all piping and equipment



3. CYLINDERS

- 3.1 Cylinders returned from end customer whose valves exhibit no evidence of tamper (i.e. the pilot plate of the CGA670 has not been damaged or removed) do not require analysis.
- 3.2 Tanks returned from Distributor no analysis required.
- 3.3 Tanks returned whose valves exhibit evidence of tamper (i.e. the pilot plate of the CGA670 has been damaged or removed) recover the 1234yf to a bulk tank and pull the cylinder pressure to less than 0.5 bar.

If sampling is required

- a. Ensure site personnel are wearing all PPE required for handling 1234yf.
- b. Inspect the area to ensure the presence of only properly certified equipment. Remove any spark generating device from the immediate sampling area.
- c. Position the ISO in the designated area for safely handling R1234yf. If the area is not marked to handle 1234yf, STOP immediately and consult the onsite HS&E professional.
- d. Evacuate a clean sample cylinder; ensure to use proper sample cylinder preparation.
- e. Attach an adapter to the cylinder valve for the appropriate sample you are attempting to collect.

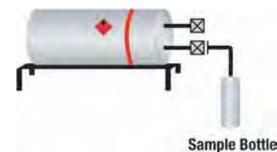


Collecting Samples from ISOs and Cylinders



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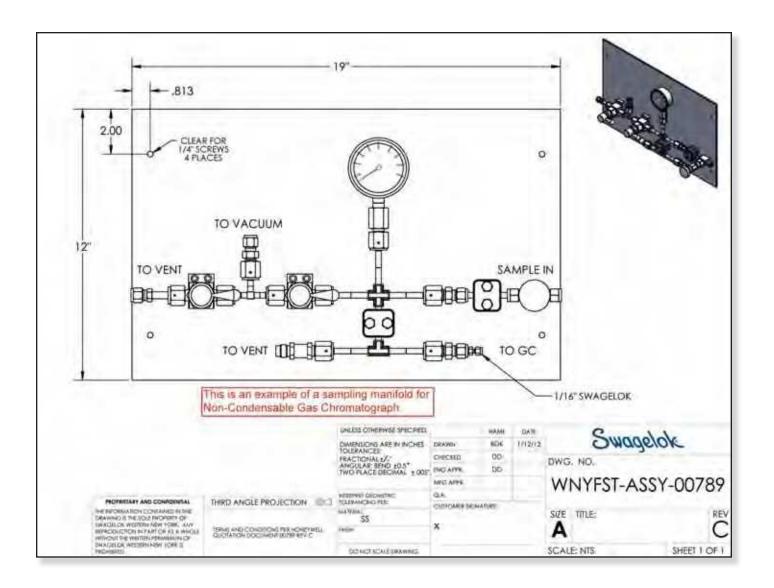
- For Ton Cylinders the valve closest to the 12 o'clock position for vapor sample and closest to the 6 o'clock position for the liquid sample.
- For all other cylinders, use the valve marked "vapor and liquid" for the proper sample.
- f. Under ideal conditions, the sampling hose used will be as short as possible to minimize the opportunity for introduction of Non-Condensable Gases and moisture into the line.
- g. Visually inspect sample cylinder hose to ensure that it is safe for use. Check for
 - Fraying
 - Gouges
 - Kinks
 - Any other defects
- h. Connect a sample cylinder to the adapter.
- i. Position a gas detector near the sample cylinder.
- j. Open the corresponding tank valve.
- k. Slightly open the hose connection at the sample cylinder to vent the hose. Vent until gas detector detects gas.
- I. Tighten the connection.
- m. Open the sample bottle valve to fill.
- n. Draw 30g vapor sample/600g liquid sample.
- o. Close the cylinder valve and the tank valve.
- p. Disconnect the sample hose and the sample adapter.

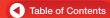


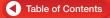
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Connection of Sample Cylinder to Gas Chromatograph

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Visual Inspection for Appearance, Particulates and Solids in HFO Refrigerants

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Honeywell International, Inc. Performance Materials and Technologies Buffalo Research Laboratory Buffalo, New York 14210 716-827-6245

Visual Inspection for Appearance, Particulates and Solids in HFO Refrigerants

HFO-Refrigerants-10

Material:	HFO Refrigerants
Analyte:	Appearance Particulates and Solids
Technique:	Visual Inspection
Specific Method:	HFO-Refrigerants-10
Supersedes:	None
Also Required:	None

PURPOSE

This method describes the visual inspection of HFO Refrigerants.

SCOPE

This method is for use with virgin HFO Refrigerants.

PRINCIPLE

The HFO Refrigerant is inspected visually for any abnormal appearance, particulates and solids.

SAFETY PRECAUTIONS

1. Consult the MSDS for each chemical used in this method prior to using the method for analysis. Follow the guidelines specified by the MSDS.

This method may involve the use of hazardous materials, operations and equipment. This method does not purport to address all of the safety problems associated with its use. It is the responsibility of whomever uses this method to establish appropriate safety practices and to determine the applicability of regulatory limitations prior to use.

SPECIAL APPARATUS AND REAGENTS

Note: EQUIVALENTS MAY BE SUBSTITUTED.

1. 500 mL Pyrex Erlenmeyer Flask

PROCEDURE

- 1. Fill flask with at least 100 mL of product directly from the bulk container, filled cylinder or storage tank of the lot that is being tested.
- 2. Visually check sample in flask for any foreign products in the material. This includes rust, dirt, oil, discoloration, etc.
- 3. Any amount of foreign material in the product will result in the lot/cylinder failing visual inspection.
- 4. The failing cylinder will need to be filtered and retested prior to approval.

Written: Jim Tu Date: 04/25/2012 Revised: Jim Tu Date: 07/12/2012 Approved: John L. Welch

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Determination of Moisture in HFO Refrigerants

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Honeywell International, Inc. Performance Materials and Technologies Buffalo Research Laboratory Buffalo, New York 14210 716-827-6245

Determination of Moisture in HFO Refrigerants

HFO-Refrigerants-52

Material:	HFO Refrigerants
Analyte:	Moisture (Water vapor)
Technique:	Coulometric Karl Fisher Titrimetry
Specific Method:	HFO-Refrigerants-52
Supersedes:	None
Also Required:	None

PURPOSE

The purpose of this method is to determine the water in virgin HFO Refrigerants

SCOPE

This test method is for use with virgin HFO Refrigerants

PRINCIPLE

The moisture of HFO Refrigerants is determined by taking a known quantity of sample and titrating it with Karl Fisher reagent in a coulometric titrator to an electronic endpoint.

APPLICABILITY

This method is applicable to the determination of moisture as ug/g (ppm) in virgin HFO Refrigerants

SAFETY PRECAUTIONS

- 1. HFO Refrigerants see MSDS.
- 2. HYDRANAL[®] COULOMAT A and HYDRANAL[®] -COULAMAT C are proprietary, pyridine free, methanolic solutions for coulometric Karl Fisher titrators. See MSDS.

This method may involve the use of hazardous materials, operations and equipment. This method does not purport to address all of the safety problems associated with its use. It is the responsibility of whomever uses this method to establish appropriate safety practices and to determine the applicability of regulatory limitations prior to use.

SPECIAL APPARATUS AND REAGENTS

Note: EQUIVALENTS MAY BE SUBSTITUTED.

- 1. Mitsubishi CA-06 Karl Fisher Titrator.
- 2. Sample cylinder, stainless steel, 125mL (Optional- Only used if sample has to be taken from a larger cylinder).
- 3. 1/8 inch stainless steel needle valve.
- 4. 1-1/4 inch to 1/8 inch reducing fitting.
- 5. 1/8 inch stainless steel tubing, approximately 9 inches.



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Determination of Moisture in HFO Refrigerants

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- 6. ¹/₄ inch refrigeration fitting.
- 7. Heat gun.
- 8. HYDRANAL® -COULOMAT A #34807 anode solution, 500mL. Available from Fisher Scientific.
- 9. HYDRANAL® -COULOMAT CG #34840 cathode solution, 5ml. Available from Fisher Scientific.
- 10. HYDRANAL® Water Standard 0.10.

PROCEDURE

- Prepare the instrument according to the manufacturer's instructions. If the Mitsubishi CA-06 Karl Fisher titrator is used, add 5 mL of Coulomat CG to cathode's inner compartment. Add 100 mL of Coulomot A to the anode compartment of the cell. Turn instrument on. Press <Titr Current> and allow instrument to stabilize (< 0.05 ug/sec reading on the display). Set Titration parameters:
 - Delay-5 min.
 - Sens: 0.1
- 2. Check the instrument using PROCEDURE LQA1-18 and HYDRANAL® Water Standard 0.10.
- 3. Weigh the cylinder to the nearest 0.1 grams and record the weight as #1.
- 4. Attach needle assembly to cylinder. Make sure needle valve is in the closed position. Open main sample valve.
- 5. Install the needle into the titration cell solution making sure it does not touch either the anode or the cathode.
- 6. Heat the needle section of the needle assembly with the heat gun for a least 1 minute to remove water vapor.
- 7. Titrate away any water that came from the needle assembly by pressing the titration button.
- 8. When the display reads, "Stable," and the ug/sec reading is less than 0.1, press <START>. Continue applying heat to the needle and immediately introduce sample into the Karl Fisher vessel. Bubble sample at a rate of 1.5 to 1.8 liters per minute. As soon as sample starts entering the vessel, remove drying tube from the titration vessel to keep pressure from building up in the vessel.
- 9. Close sample valve after 4.0 minutes. Let the sample that is left in the needle assembly bubble into the vessel. Twenty to 30 grams of sample should be introduced. Replace the drying tube after the entire sample is in the vessel.
- 10. Remove the needle assembly by closing the needle valve and disconnecting it from the cylinder. Reweigh the sample cylinder to the nearest 0.1 grams and record as weight #2.
- 11. Record the Micrograms (ug) of moisture present in the sample. Calculate result.
- 12. Repeat steps 3 9 until three results agree within ± 10 percent of each other. Report the average of these three results.

CALCULATION

Moisture (ug/g) = $\frac{\text{Titration data (ug)}^*}{\text{Wt.#1-Wt.#2}}$

Report results to the nearest 0.1 ug/g. The minimum report is 2.5 ug/g

* Titration data from instrument (Step 10).

PRECISION AND ACCURACY

A study conducted at the Buffalo Research Lab on a sample of HFC-134a with an average water content of 9.0 ug/g showed the standard deviation to be 1.48 ug/g with a relative standard deviation of 16.5 percent. A spiking recovery conduct with the above mentioned sample showed the recovery to be 97.2 percent when conducted around the samples at 20 ppm.

Written: John L. Welch Date: 10/07/2008 Revision: Jim Tu Date: 07/122/2012 Approved: John L. Welch

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Determination of Acidity in HFO Refrigerants

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Honeywell International, Inc. Performance Materials and Technologies Buffalo Research Laboratory Buffalo, New York 14210 716-827-6245

Determination of Acidity in HFO Refrigerants

HFO-Refrigerants-2

Material:	HFO Refrigerants
Analyte:	Acidity
Technique:	Alkalimetric Titration
Specific Method:	HFO-Refrigerants-2
Supersedes:	None
Also Required:	None

PURPOSE

This method describes the determination of acidity in HFO Refrigerants.

SCOPE

This test method is for use with virgin HFO Refrigerants.

PRINCIPAL

The acidity of HFO Refrigerants is determined by bubbling a known quantity of sample through water. Any acidity imparted to the water is titrated with standardized sodium hydroxide.

SAFETY PRECAUTIONS

1. Consult the MSDS for each chemical used in this method prior to using the method for analysis. Follow the guidelines specified by the MSDS.

This method may involve the use of hazardous materials, operations and equipment. This method does not purport to address all of the safety problems associated with its use. It is the responsibility of whomever uses this method to establish appropriate safety practices and to determine the applicability of regulatory limitations prior to use.

SPECIAL APPARATUS AND REAGENTS

Note: EQUIVALENTS MAY BE SUBSTITUTED.

- 1. Buret, Micro, 5 mL with 0.01 mL graduations and a PTFE stopcock.
- 2. Gas dispersion tube, polyethylene. Bel-Art Products No.F 13691 or equivalent.
- 3. Evaporating dish, porcelain, 525 mL capacity or equivalent.
- 4. Water. All water used in the preparation of reagents and in the procedure is either distilled or deionized.
- 5. Sodium hydroxide, 0.1 N solution standardized. Prepare and standardize as directed in ASTM E200-91or obtain from Fisher, Cat. No. SS276-1 and standardize as directed in ASTM E200-91.
- 6. Sodium hydroxide 0.01 N solution. Pipet 100.0 mL of 0.1 N sodium hydroxide solution (Reagent from step 6) into a 1000-mL volumetric flask, dilute to the mark with water and mix. The final solution will have a normality 1/10 the normality of the step 6 reagent, or obtain from Fisher, Cat. No. SS284-1 and standardize as directed in ASTM E200-91.



Determination of Acidity in HFO Refrigerants

- 7. Hydrochloric acid, approximately 0.1 N solution. Prepare and standardize as directed in ASTM E200-91or obtain from Fisher, Cat. No. SA54-4 and standardize as directed in ASTM E200-91.
- 8. **Hydrochloric acid, approximately 0.01 N solution.** Transfer 100.0 mL of the 1.0 N hydrochloric acid (Reagent from step 8) into a 1000-mL volumetric flask and dilute to the mark with water and mix. The final solution will have a normality 1/10 the normality of the step 8 reagent. An alternative is to obtain from Fisher, Cat. No. SA62-1.
- 9. **Bromothymol blue indicator,** 1.0 g/L solution. Dissolve 0.1 g of bromothymol blue, sodium salt, in 100mL of water. Store solution in a dropping bottle.

PROCEDURE

- 1. Place approximately 150 mL of water in the gas dispersion tube or other suitable vessel. Add 6-8 drops of bromothymol blue indicator.
- 2. Weigh the sample cylinder to the nearest 0.1 gram and record the weight as A. Support the cylinder so that the sample will be drawn from the liquid phase.
- 3. Connect the sample cylinder and the outlet to the gas dispersion tube. Keep the connections as short as possible.
- 4. Adjust the water solution to the green endpoint with 0.01 N sodium hydroxide or 0.01 N Hydrochloric Acid as required (Note 1).
- 5. Bubble sample through the dispersion tube at a rate of 1-2 liters per minute until at least 100 grams of sample has been added.
- 6. A positive result for acidity will result in conversion of the indicator from blue-green to yellow (pH <7.6). A negative result for acidity will result in no change in the indicator color or a change to blue. (Note 2)
- 7. If positive result is detected, pour the contents of the dispersion tube into a 525-mL porcelain dish and titrate the solution to the green endpoint with 0.01 N sodium hydroxide from a 5-mL micro buret.
- 8. Reweigh the sample cylinder to the nearest 0.1 gram and record this weight as B.

CALCULATION

Acidity as ug/g HCl = $\frac{\text{mL NaOH x normality NaOH x 36,460}}{\text{A-B}}$

Report results to the nearest 0.1 ug/g. The minimum reportable result shall be 0.5 ug/g

NOTES

- 1. The volume of NaOH or HCl used for this adjustment should not be included in the titration in procedure Step 4.
- 2. If the solution remains green or turns blue after sample introduction, no acidity is present in the sample and the minimum reportable amount must be reported.

PRECISION AND ACCURACY

Studies are planned.

Written: John L. Welch Date: 10/07/2008 Revision: Jim Tu Date: 07/12/2012 Approved: John L. Welch

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Determination of Non-Volatile Residue in HFO Refrigerants

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Honeywell International, Inc. Performance Materials and Technologies Buffalo Research Laboratory Buffalo, New York 14210 716-827-6245

Determination of Non-Volatile Residue in HFO Refrigerants

HFO-Refrigerants-6

Material:	HFO Refrigerants
Analyte:	Total Non-Volatile Residue
Technique:	Gravimetric
Specific Method:	HFO-Refrigerants-6
Supersedes:	None
Also Required:	None

PURPOSE

The purpose of this method is to determine the total residue in HFO Refrigerants.

SCOPE

This test method is for use with HFO Refrigerants.

PRINCIPLE

The total residue of HFO Refrigerants is determined by taking a known quantity of sample and evaporating it in a tared weighing dish, the residue is dried at 105°C, and reweighed. The increase in weight of the dish is the weight of total residue.

APPLICABILITY

This method is applicable to the determination of total residue as ug/g (ppm) in HFO Refrigerants.

SAFETY PRECAUTIONS

1. HFO Refrigerants are compressed liquefied gas which becomes very cold as it volatilizes. See MSDS.

This method may involve the use of hazardous materials, operations and equipment. This method does not purport to address all of the safety problems associated with its use. It is the responsibility of whomever uses this method to establish appropriate safety practices and to determine the applicability of regulatory limitations prior to use.

SPECIAL APPARATUS AND REAGENTS

Note: EQUIVALENTS MAY BE SUBSTITUTED.

- Sample cylinder with cylinder valve, 300-500 mL capacity. Aluminum, steel or stainless steel with adaptor to 1/8" Swagelok fitting.
- b. Needle valve, 1/8" Swagelok fitting, SS-SS2 or equivalents.
- c. 6" (15 cm) 1/8" Stainless steel tubing.
- d. Aluminum dishes, 110 mm diameter, Fisher Catalog 08-732-108, or equivalent.
- e. Heat gun.

Determination of Non-Volatile Residue in HFO Refrigerants

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PROCEDURE

- 1. Collect about 100-150 grams of HFO Refrigerant in the clean, dry sample cylinder assembly from the liquid phase of a sample container. Weigh the assembly to 0.1g and record as (A).
- 2. Attach assembly needle valve to sampling cylinder and connect the valve outlet to the 1/8" tubing.
- 3. Weigh one clean and dry aluminum dish to 0.0001g and record the tare weight of sample as (B).
- 4. Place the aluminum dish and sampling cylinder in a fume hood. Reverse the cylinder so the HFO Refrigerant is flowing out as liquid. Position the 1/8" tubing outlet pointing to the center of the aluminum dish. Make sure the needle valve is set at minimum flow position. Open the cylinder valve slowly and allow the HFO Refrigerant flow into the aluminum dish. Adjust the needle valve so the liquid flow rate is about 20-50 mL/minute. Adjust flow rate carefully so HFO Refrigerant does not splash out from the aluminum dish and the 1/8" tubing is not touching the HFO Refrigerant in the dish. Allow about 100 mL of HFO Refrigerant flow into aluminum dish. Close the cylinder valve.
- 5. Gently heat the needle valve and 1/8" tubing with heat gun to make sure no residual HFO Refrigerant is between the needle valve and cylinder valve nor in the tubing.
- 6. Allow HFO Refrigerant to be evaporated from aluminum dish and place the dish in a 105°C oven for 30 minutes.
- 7. Allow the sampling to cool to room temperature and the moisture to evaporate from the cylinder surface. Disassemble the needle valve and 1/8" tubing. Reweigh the sampling cylinder to 0.1g and record as (C).
- 8. Remove the dish from the oven, cool in a desiccator, reweigh the dishes to 0.0001g and record the final weights as (D).

CALCULATION

ug/g (ppm) Total Residue = $\frac{[D-B] \times 1,000,000}{[C-A]}$

Report result to the nearest 0.1 ug/g The minimum report is 1 ug/g

- Where: A = Gross weight of the sampling cylinder with liquid HFO Refrigerant, in grams
 - B = Tare weight of the aluminum dish, in grams
 - C = Final weight of the sampling cylinder, in grams
 - D = Final weight of the aluminum dish, in grams

PRECISION AND ACCURACY

Studies are planned.

Written: John L. Welch Date: 10/07/2008 Revision: Jim Tu Date: 07/12/2012 Date: 9/24/2012: Revised the procedure so the methylene chloride is not needed for this analysis. Date:11/15/2012: Correct Fisher catalog part number for aluminum dishes

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Determination of Chloride in HFO Refrigerants

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Honeywell International, Inc. Performance Materials and Technologies Buffalo Research Laboratory Buffalo, New York 14210 716-827-6245

Determination of Chloride in HFO Refrigerants

HFO-Refrigerants-4

Material:	HFO Refrigerants
Analyte:	Chloride
Technique:	Silver Nitrate Precipitation
Specific Method:	HFO-Refrigerants-4
Supersedes:	None
Also Required:	None

PURPOSE

This method describes the determination of chloride in HFO Refrigerants.

SCOPE

This test method is for use with virgin HFO Refrigerants.

PRINCIPLE

The chloride of HFO Refrigerants is determined by bubbling a known quantity of sample through silver nitrate/methanol solution. Any chloride will be precipitation as silver chloride where visual turbidity could be observed.

SAFETY PRECAUTIONS

1. Consult the MSDS for each chemical used in this method prior to using the method for analysis. Follow the guidelines specified by the MSDS.

This method may involve the use of hazardous materials, operations and equipment. This method does not purport to address all of the safety problems associated with its use. It is the responsibility of whomever uses this method to establish appropriate safety practices and to determine the applicability of regulatory limitations prior to use.

SPECIAL APPARATUS AND REAGENTS

Note: EQUIVALENTS MAY BE SUBSTITUTED.

- 1. Amber-glass bottle, 300 mL
- 2. Research grade silver nitrate (AgNO₃)
- 3. Research grade anhydrous methanol (CH₃OH)
- 4. Concentrated nitric acid (HNO₃)

PROCEDURE

Prepare alcoholic silver nitrate solution as follows

- 1. Add 8 grams of silver nitrate to 200 mL of anhydrous methanol in an amber-glass bottle.
- 2. Place stopper in bottle and mix contents until no more of the silver nitrate dissolves.
- 3. Allow remaining solids to settle and use the clear, supernatant liquid, filtered, if necessary.



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Determination of Chloride in HFO Refrigerants

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Sample analysis

- 1. Weigh a clean evacuated sample cylinder to the nearest 0.1 grams and record the weight as (A).
- 2. Collect about 10 to 30 g of HFO Refrigerants liquid in the sample cylinder. Weigh the sample cylinder and record the weight as (B).
- 3. Calculated the volume of HFO Refrigerants in the sample cylinder using following equation.

Volumne = $\frac{(B - A)}{Density of 1234yf@ambient T}$

- 4. Add the same volume of anhydrous methanol to a 100-mL test tube.
- 5. For every 5 mL of anhydrous methanol add 3 drops of alcoholic silver nitrate solution to the test tube. Add one drop of nitric acid. Swirl until mixed.
- 6. Bubble all HFO Refrigerants sample into the test tube slowly. At the end, swirl until well mixed.
- 7. Observe results.
 - a. If solution is clear, test is NEGATIVE for inorganic chlorides. Report as passes test.
 - b. If solution is cloudy, test is POSITIVE for inorganic chlorides. Report as fails test.

PRECISION AND ACCURACY

The sensitivity of the chloride turbidity test using 5 mL of HFO Refrigerants in 5 mL of methanol containing three drops of saturated AgNO₃ is approximately 3 ppm¹.

1. AHRI Standard 700-95, appendix C.

Written: Jim Tu, 04/25/2012 Revised: Jim Tu, 07/12/2012 Approved: John L. Welch

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Determination of HFO Refrigerants Assay

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Honeywell International, Inc. Performance Materials and Technologies Buffalo Research Laboratory Buffalo, New York 14210 716-827-6245

Determination of HFO Refrigerants Assay

HFO-Refrigerants-7

APPLICATION

This method describes the determination of purity and impurity profile for HFO refrigerants production samples by gas chromatography.

PRINCIPLE

A representative sample is injected into a gas chromatograph using a 2.0 mL gas tight syringe. The components present are detected with a flame ionization detector, identified by retention times, then quantified using peak area.

SAFETY PRECAUTIONS

1. HFO Refrigerants are a compressed liquefied gas which becomes very cold as it volatilizes. See MSDS.

This method may involve the use of hazardous materials, operations and equipment. This method does not purport to address all of the safety problems associated with its use. It is the responsibility of whomever uses this method to establish appropriate safety practices and to determine the applicability of regulatory limitations prior to use.

APPARATUS:

Note: EQUIVALENTS MAY BE SUBSTITUTED

- 1. Gas chromatograph equipped with a flame ionization detector (FID), Perkin-Elmer 9000, or equivalent.
- 2. Electronic interface, Perkin-Elmer 900 or equivalent. Totalchrom software version 6 and a personal computer for data reduction and output.
- 3. 2.0 mL Gas tight syringe (sample size 1.0mL).
- 4. Column: 1percent SP™-1000, 60/80 Carbopack B column, 24 ft, 1/8", stainless steel column. (available through SUPELCO)

INSTRUMENT CONDITIONS:

Carrier Flow (helium)	20 mL/minute (approx. 60 psi)
FID Hydrogen Flow	45 mL/minute
FID Air Flow 450 mL/minute	
Injector Temperature	200°C
Injection Volume	1.0mL
Detector Temperature	250°C
Sensitivity 20, -3	
Oven Temperature Program:	
Initial Temperature	35°C
Initial time	5 minutes
Temperature Ramp	10°C/minute
Temperature 2	200°C
Hold	10 minutes
Equilibration Time:	not less than 0.5 minute



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Determination of HFO Refrigerants Assay

STANDARDIZATION - VOLUME %

The volume percent gas standards will be provided by Honeywell.

SAMPLE PREPARATION

A 1.0 mL gas sample of the vaporized liquid HFO Refrigerants from a tedlar bag is injected into a GC using a 2-mL gas tight syringe.

PROCEDURE

- 1. After GC has stabilized, inject the HFO Refrigerants sample and collect chromatographic data using above conditions.
- 2. Calculate Volume percent based upon the data from the known standard

Written by: Jim Tu 7/9/2012

Solstice® yf Refrigerant User Guide



Determination of Non-Condensable Gases in HFO Refrigerants

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Honeywell International, Inc. Performance Materials and Technologies Buffalo Research Laboratory Buffalo, New York 14210 716-827-6245

Determination of Non-Condensable Gases in HFO Refrigerants

HFO-Refrigerants-8

Material:	HFO Refrigerants
Analyte:	Non-Condensable gases
Technique:	Gas Chromatography
Specific Method:	HFO-Refrigerants-8
Supersedes:	None
Also Required:	None

PURPOSE

The purpose of this method is to determine the non-condensable gases in virgin HFO Refrigerants as air.

SCOPE

This test method is for use with virgin HFO Refrigerants

PRINCIPLE

A measured volume of sample from the vapor phase of a sample cylinder is chromatographed with the area counts of the air peak being compared to those of standards similarly chromatographed.

LIMITATIONS AND INTERFERENCES

Care must be taken to inject only sample vapor. Injections of liquid phase will yield significantly lower results (non-condensable gases are only marginally soluble in HFO Refrigerants liquid, can damage the test gauge and overload the column. All compound identities are based on retention time and interfering compounds can be misidentified.

APPLICABILITY

This method is applicable to the gas chromatographic determination of non-condensable gases in virgin HFO Refrigerants.

SAFETY PRECAUTIONS

1. HFO Refrigerants are a compressed liquefied gas which becomes very cold as it volatilizes. See MSDS.

This method may involve the use of hazardous materials, operations and equipment. This method does not purport to address all of the safety problems associated with its use. It is the responsibility of whomever uses this method to establish appropriate safety practices and to determine the applicability of regulatory limitations prior to use.

SPECIAL APPARATUS AND REAGENTS

Note: EQUIVALENTS MAY BE SUBSTITUTED.

- a. Gas chromatography: Hewlett-Packard 5890, equipped with a thermal conductivity detector.
- b. Electronic integrator or data station: Perkin-Elmer Turbochrom.





Determination of Non-Condensable Gases in HFO Refrigerants

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- c. Gas chromatographic column: stainless steel 6 foot x 1/8 inch containing Porapak QS, 80-100 mesh. available from Supelco.
- d. Flow meter.
- e. Six-port gas sample valve port and loop, 1-mL from Valco.
- f. Gas handling manifold with vacuum test gauge (0-760mmHg), Ashcroft (302084SD02L15#A).
- g. Helium, chromatographic grade.
- h. Precision vacuum pump, Model DD-90 (0.1mmHg). Fisher Scientific Cat. No. 01-182-13.
- i. Certified gas mixture standard 1.5 volume percent air balanced helium. Available from specialty gas supply company.

PROCEDURE

Operating Conditions.

Gas Chromatographic conditions

Detector	TCD
Carrier gas	helium 20 mL/min.
Injection Port Temp	175°C
Detector Temp.	220°C
Column Temp.	35°C for 8 minutes, ramp temperature 20°C/minute to 200°C
Max. Column Temp.	250°C
Sample Size	1 mL loop containing 600mmHg of sample
Detector sensitivity	High

Totalchrom conditions

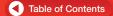
0.00 min.
14.5 min.
1.25 points/ second
0
OFF
1 points
1 uV
5.00 uV
0.100
0.100
5.000
4.000
3.000

COMPONENT INFORMATION

Components retention time can be acquired by certified gas mixture standard.

PROCEDURE

- 1. Using the appropriate regulator, connectors and tubing, attach the standard cylinder to the sample manifold in an upright position.
- 2. With the standard cylinder valve closed, evacuate the sampling manifold, loop and lines.
- 3. Close the vacuum valve, open the cylinder valve, and then purge the sample loop and lines with standard gas.
- 4. Close cylinder valve, and then open vacuum valve.
- 5. Repeat steps 2 4 two more times then evacuate.





Determination of Non-Condensable Gases in HFO Refrigerants

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- 6. Turn off vacuum valve. Open the cylinder valve and charge 600 mm Hg of standard to the sample loop. Allow the pressure to stabilize, and then inject the standard.
- 7. Determine and record the area counts of the air peak.
- 8. Analyze the standard three times and determine the average area counts.
- 9. Remove standard cylinder and repeat steps 1–8 for the HFO Refrigerants sample cylinder. Analyze the sample in duplicate.

CALCULATIONS

1. Calculate the Volume percent of air in the sample using the following equation

Vol.% Air = Vol % Air Standard x Average Area counts Air in Sample Average Area counts of Air peak of the standard

Total non-condensable = Vol. % Air

Report results to the nearest 0.1%. Minimum reportable result is 0.1%

Written: John L. Welch Date: 10/07/2008 Revision: Jim Tu Date: 07/12/2012 – revise the column length to match AHRI Standard 700-2006, Appendix C and revise the total non-condensable as Air vol.% Date 9/24/2012 – remove figure 1 which is no longer applicable. Approved: John L. Welch

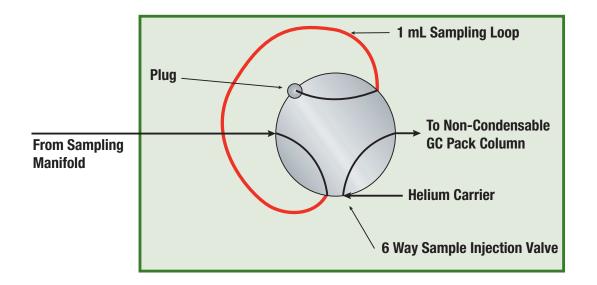


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Scheme for Non-Condensable GC Injection Valve

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Scheme for Non-Condensable GC Injection Valve

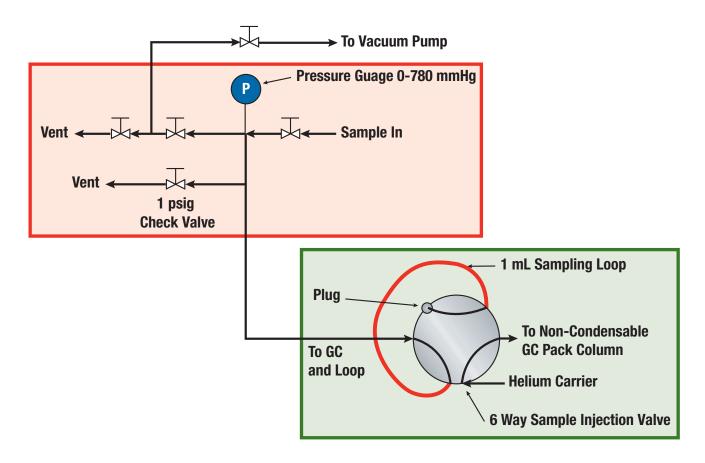


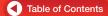


Scheme for Non-Condensable GC Sampling Manifold Table of Contents

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Scheme for Non-Condensable GC Sampling Manifold

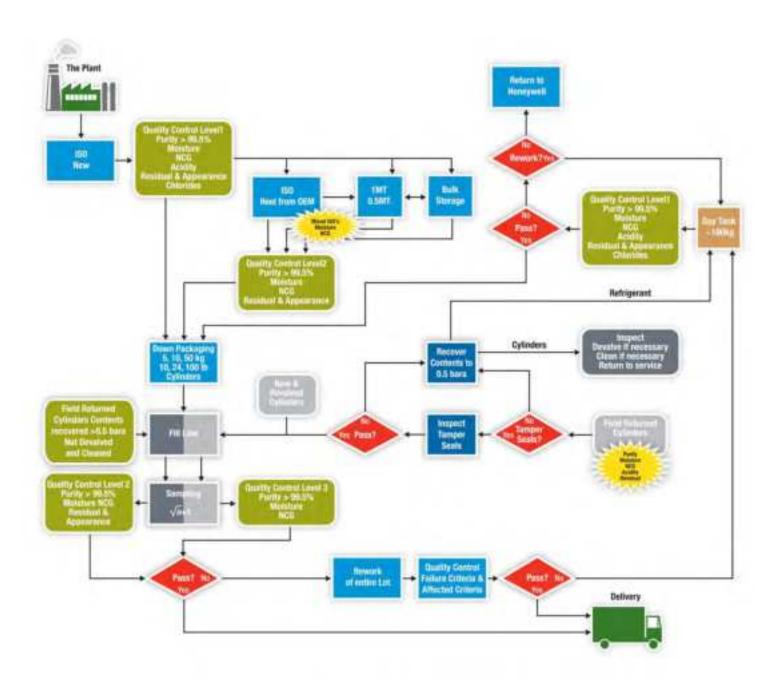




Solstice[®] yf Refrigerant User Guide

Process Map – Distribution and QC

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Sample Size Summary Chart

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Analyses Level Summary

Sample type	Required Analyses	Frequency/ When	Retain Sample?	Cylinder size	Analysis	1234yf sampling amount
Incoming virgin bulk materials	Level 1	Every container at receiving	Yes	1L / liquid (Also the retained sample)	Assay, Moisture, Non-Volatile Residue, Acidity, Chlorides	1000g
(ISO container)				300ml-1L / gas	Non Condensable Gas	~20g
Bulk storage and intermediate	Level 2	One per lot or new materials	Ne	300ml-1L / liquid	Assay, Moisture, Non-Volatile Residue	250-280g
material cylinders	Level 2	are added	No	300ml-1L / gas	Non Condensable Gas	~20g
ISO heel from	Level 2	One per lot	No	300ml-1L / liquid	Assay, Moisture, Non-Volatile Residue	250-280g
OEL filling	Level 2	One per lot	NO	300ml-1L / gas	Non Condensable Gas	~20g
Day tank	Level 1	As needed	No	500ml-1L / liquid	Assay, Moisture, Non-Volatile Residue, Acidity, Chlorides	350-380g
				300ml-1L / gas	Non Condensable Gas	~20g
Down Packaged containers less than 450 kg, 1000 lb but greater than 100 kg only						
Returned cvlinders from	Level 3	√η +1 per lot	No	300ml-1L / liquid	Assay, Moisture,	100-130g
OEM producers	Level 3		No	300ml-1L / gas	Non Condensable Gas	~20g
Returned cylinders from aftermarket	Level 3	√η +1 per lot	No	300ml-1L / liquid	Assay, Moisture,	100-130g
customers with tamper evident seals	Level 3	vij +i periot	NO	300ml-1L / gas	Non Condensable Gas	~20g
HFO Refrigerants cylinders without tamper evident	Level 2	$\sqrt{\eta}$ +1 per lot	No	300ml-1L / liquid	Assay, Moisture, Non-Volatile Residue	250-280g
seals or cylinders with the tamper seal broken	Level 2	vij + i periot	NO	300ml-1L / gas	Non Condensable Gas	~20g
For down package	ed container	s smaller than 10	0 kg. Perform	analyses from the	containers directly	
	Laural O	On a man lat	NIa	300ml-1L / liquid	Assay, Moisture, Non-Volatile Residue	250-280g
Down packaged	Level 2	One per lot	No	300ml-1L / gas	Non Condensable Gas	~20g
containers 450 kg, 1000 lb or greater		The rest of	NL	300ml-1L / liquid	Assay, Moisture	100-130g
	Level 3	the lot	No	300ml-1L / gas	Non Condensable Gas	~20g
Bulk ISO	Level 1	Every ISO	Yes	1L / liquid (Also the retained sample)	Assay, Moisture, Non-Volatile Residue, Acidity, Chlorides	1000g
shipment		before shipment		300ml-1L / gas	Non Condensable Gas	~20g
Reworked material	As needed	Every container	No			
Bulk heel for return of the ISO to Honeywell	As F	lequested by Hone	eywell	N/A		

Notes: 1) For ISO, bulk tanks and down packaged containers greater than 100 kg, use sampling cylinders for QA/QC analysis.

2) For down packaged containers smaller than 100 kg., perform analyses from the containers directly.

3) For ISO retain sample, the QA/QC analyses will be performed from the sampling cylinder and then the sampling cylinder becomes retained sample cylinder.

Created by: Jim Tu 10/23/2012

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Part 4 Cylinder Specifications and Drawings



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Solstice[®] yf Refrigerant User Guide

10 lb (4.5 kg) Non Returnable Cylinder Specification

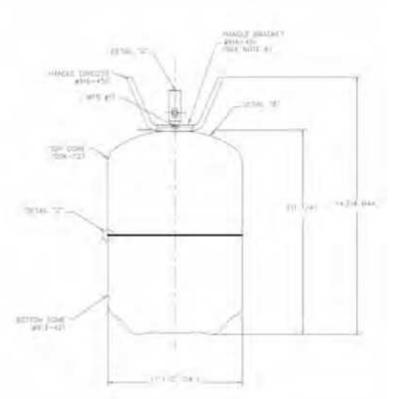
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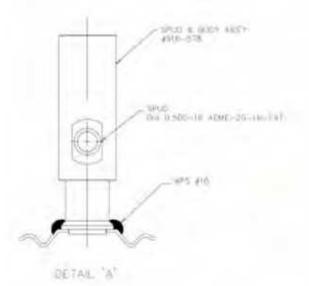
Document S-7863-YF Part 4 - Page 109



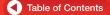
Regions: North America (ex Canada) Water Capacity: 15 lbs / 6 Liters Features: DOT39 Compliant CG-7 with a Pressure Relief Device for flammables Valve Outlet: CGA 166

Thread Pattern: 0.500 – 16 ACME – 2G – LH – EXT (Left Handed Threads)









10 lb (4.5 kg) Non Returnable Cylinder Specification

Honeywell Fluorine Products P.O. Box 1053 Morristown, NJ 07962-1053

Container Purchase Specifications

Specino	S-7863-YF	Page	I	of	3	Ĺ
Date:	2/18/13					ĺ
Supersedes Spec. No.:	New					ĺ
Change:	J color	Rev 3				Ĺ
Product:	1234yf					Ĺ
Location:	Danville					
E S F	Jate: Supersedes Spec. No.: Change: Product:	Date: 2/18/13 Supersedes Spec. No.: New Change: J color Product: 1234yf	Date: 2/18/13 Supersedes Spec. No.: New Change: J color Rev 3 Product: 1234yf	Date: 2/18/13 Supersedes Spec. No.: New Change: J color Rev 3 Product: 1234yf	Date: 2/18/13 Gupersedes Spec. No.: New Change: J color Rev 3 Product: 1234yf	Date: 2/18/13 Gupersedes Spec. No.: New Change: J color Rev 3 Product: 1234yf

2. Detail Requirements:

a. Capacity:	415 cu. in. (15.4 lbs. w.c.) minimum.
b. Material:	ASTM 620, Class I, drawing quality aluminum killed low carbon steel.
c. Construction:	Two drawn steel shells, circumferentially welded or brazed, with welded foot ring or extruded feet and steel valve body with welded carrying handle.
	Service Pressure: 260 psig Test Pressure: 325 psig
	All cylinders are to be designed, constructed, inspected, leak checked, burst-tested and date coded in accordance with DOT-39 /TC-39M specifications and CGA "Recommended Safe Practices for DOT-39 Fluorocarbon Steel Cylinders." Deviations from these DOT/TC specifications and CGA recommendations are not authorized.
	No modifications in the design of the cylinder, valve, relief device or unit carton may be made without prior authorization from Honeywell.

- d. Valve and Pressure Relief Device: Each cylinder to be equipped with a refillable valve and relief device as follows:
 - **Valve:** Steel valve body with 0.500-16 ACME-2G-LH-EXT. (CGA 166) threaded outlet, welded into top center of cylinder. A solid stem of glass-filled nylon to be crimped into the valve body. Design of this valve is such that once the stem has been torqued closed, the non-refillable mechanism is activated, thereby preventing refill and allowing only discharge of contents

10 lb (4.5 kg) Non Returnable Cylinder Specification

Honeywell Fluorine Products P.O. Box 1053 Morristown, NJ 07962-1053

Container Purchase Specifications

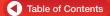
oontainer i urchase opecifications	Spec No.:	S-7863-YF	Page	2	of	3	
	Date:	2/18/13					
	Supersedes Spec. No.:	New					
1. Type:	Change:	J color	Rev 3				
Steel Cylinder, 15 lbs. water capacity, DOT-39/TC-39M	Product:	1234yf					
JUG, Non-Returnable	Location:	Danville					

2. Detail Requirements:

Pressure Relief Device: CGA CG-7 reseating relief device to be welded into upper shoulder of cylinder. Relief device operating range: 340-520 psig.

Cylinders to be shipped with valves open and outlets sealed with push-on plastic caps.

e. Tare Weight (approximate):	3 1/2 lbs.
f. Dimensions (approximate):	7 1/2" O.D. x 14 1/2" O.H.
g. Interior:	Must be dry, clean and free of rust, oil, water and other foreign matter.
h. Markings:	Cylinders and unit cartons to be legibly date coded in accordance with CGA "Recommendations". Cylinder to bear required DOT-39/TC-39M markings.
i. Painting & Printing:	Cylinders to be thoroughly dried in preparation for painting. Paint to be uniformly applied to exterior surface, relief disc cup and handle. Paint color and silk screen decoration are as follows:
	Solstice 1234yf - Cylinder to be painted white, valve opening to be protected from overspray.
	A contrasting 2" wide red [Pantone 485C] band is to be painted around the circumference of the cylinder positioned just below the cylinder shoulder radius at the top of the cylinder, per SAE J2844, AHRI Guideline N-2008: 4.8.
	Silk screen to be centered with valve outlet.
	Silk screen and paint must be thoroughly dried before cylinder is packed into shipper



10 lb (4.5 kg) Non Returnable Cylinder Specification

Honeywell Fluorine Products P.O. Box 1053 Morristown, NJ 07962-1053

Container Purchase Specifications	Spec No.:	S-7863-YF	Page	3	of	3
	Date:	2/18/13				
	Supersedes Spec. No.:	New				
1. Type:	Change:	J color	Rev 3			
Steel Cylinder, 15 lbs. water capacity, DOT-39/TC-39M	Product:	1234yf				
JUG, Non-Returnable	Location:	Danville				

j. Carton: Each cylinder to be packed into a single unit carton, positioned so that the valve outlet points toward the die cut circular hole. Top flaps to be folded shut; bottom flaps to be stapled or glued.

Cylinders/cartons to be unitized for shipment on four-way entry wooden pallets, measuring 36" x 48".

Cartons, to be unprinted natural kraft and constructed to Honeywell's specification no. S-6805-8.

Solstice® yf Refrigerant User Guide

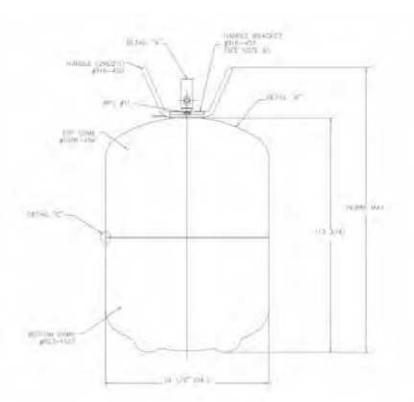
25 lb (11.3 kg) Non Returnable Cylinder Specification

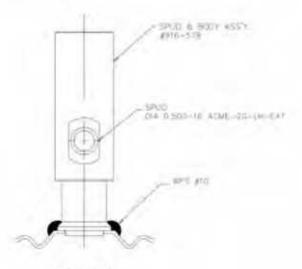
Doc Number: S-1234-YF Part 4 - Page 113

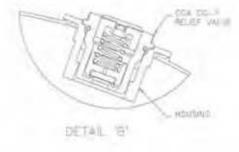
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Regions: North America (ex Canada) Water Capacity: 29.7 lbs / 13.6 Liters Features: DOT39 Compliant CG-7 with a Pressure Relief Device for flammables Valve Outlet: CGA 166 Thread Pattern: 0.500 – 16 ACME – 2G – LH – EXT (Left Handed Threads)

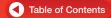






DETAIL 'A'

Solstice[®] yf Refrigerant User Guide



25 lb (11.3 kg) Non Returnable Cylinder Specification

Honeywell Fluorine Products P.O. Box 1053 Morristown, NJ 07962-1053

Container Purchase Specifications

oontainer i urchase opecifications	Spec No.:	S-1234-YF	Page	1	of	2	
	Date:	2/18/13					
	Supersedes Spec. No.:						
1. Type:	Change:	J color	Rev 3				
30 lb. Non-Returnable, Non-Refillable, Steel Cylinder	Product:	1234yf					
(JUG) (9½ inch)	Location:						
							ŕ.

2. Detail Requirements:

a. Capacity: 840 cu. in. (30.4 lbs

b. Material: ASTM 620, Class I, drawing quality aluminum killed low carbon steel.

c. **Construction:** Two drawn steel shells, circumferentially welded or brazed, with welded foot ring or extruded feet and steel valve body with welded carrying handle.

Service Pressure: 260 psig Test Pressure: 325 psig

All cylinders are to be designed, constructed, inspected, leak checked, burst-tested and date coded in accordance with DOT-39 specifications and CGA "Recommended Safe Practices for DOT-39 Fluorocarbon Steel Cylinders."

Deviations from these DOT specifications and CGA recommendations are not authorized.

No modifications in the design of the cylinder, valve, pressure relief device or unit carton may be made without prior authorization from Honeywell.

d. Valve and Pressure Relief Device:

Each cylinder to be equipped with a non-refillable valve and pressure relief device as follows:

Valve: Steel valve body with .500-16 ACME-2G-LH-EXT. (CGA 166) threaded outlet, welded into top center of cylinder. A solid stem of glass-filled nylon to be crimped into the valve body. Stem must be in the open position to allow for evacuation and filling of the cylinder. Design of this valve is such that once the stem has been torqued closed, the non-refillable mechanism is activated, thereby preventing refill and allowing only discharge of contents from the cylinder.

25 lb (11.3 kg) Non Returnable Cylinder Specification

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Honeywell Fluorine Products P.O. Box 1053 Morristown, NJ 07962-1053

Container Purchase Specifications Spec No.: Date:

	Date:	2/18/13	
	Supersedes Spec. No.:		
1. Type: 30 lb. Non-Returnable, Non-Refillable, Steel Cylinder (JUG) (9½ inch)	Change: Product: Location:	J color 1234yf	Rev 3

2. Detail Requirements:

Pressure Relief Device:	CGA CG-7 reseating relief device to be welded into upper shoulder of cylinder. Relief device operating range: 340-520 psig.
Cylinders to be shipped with	n valves open and outlets sealed with push-on plastic caps.
e. Tare Weight (approximate):	6 lbs.
f. Dimensions (approximate):	9½"O.D. x 16 ½" O.H.
g. Interior:	Must be dry, clean and free of rust, oil, water and other foreign matter.
h. Markings:	Cylinders and unit cartons to be legibly date coded in accordance with CGA "Recommendations". Silk screen to bear required DOT-39 markings
i. Painting & Printing:	Cylinders to be thoroughly dried in preparation for painting. Paint to be uniformly applied to exterior surface, relief disc cup and handle. Paint color and silk screen decoration are as follows:
	Solstice 1234YF- Cylinder to be painted white, valve opening to be protected from overspray. A contrasting 2" wide red [Pantone 485C] band is to be painted around the circumference of the cylinder positioned just below the cylinder shoulder radius at the top of the cylinder, per SAE J2844, AHRI Guideline N-2008: 4.8 Silk screen to be centered with valve outlet
	Silk screen and paint must be thoroughly dried before cylinder is packed into shipper carton.
j. Carton:	Each cylinder to be packed into a single unit carton, positioned so that the valve outlet points toward the die cut circular hole. Scored top flaps to be folded inward, securing the handles. Top flaps to be stapled twice or glued. Bottom flaps may be stapled or glued. Cylinders/cartons to be unitized for shipment on four-way entry wooden pallets, measuring 36" x 48", or 38" x 48", in accordance with instructions from receiving location.

Cartons are to be constructed to Honeywell specification no. S-6807-13.

Solstice[®] yf Refrigerant User Guide

10 lb (4.5 kg) Returnable Cylinder Specification

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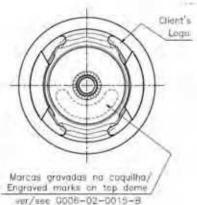
Regions: North America

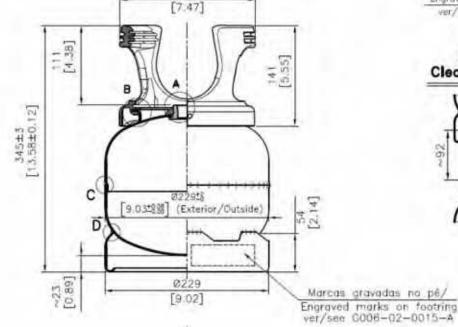
Water Capacity: 15 lbs / 6 Liters

Features: Light weight and plastic handles for easy transport, dual phase valve for gas or liquid discharge

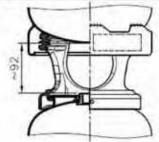
Valve Outlet: CGA 166

Thread Pattern: 0.500 – 16 ACME – 2G – LH – EXT (Left Handed Threads)





Emplihamento/ Clearance for stacking



10 lb (4.5 kg) Returnable **Cylinder Specification**

Honeywell **Fluorine Products** P.O. Box 1053 Morristown, NJ 07962-1053

Container Purchase Specifications

Container Purchase Specifications	Spec No.:	M-8110-YF	Page	1	of	2	
	Date:	2/18/13					
	Supersedes Spec. No.:	8110-YF	Rev 1				
1. Type:	Change:	J color					
Returnable Steel Cylinder 15.5 lbs. Water Capacity DOT 4BA400/TC/EN	Product: Location:	Solstice [®] 12	234yf				

2. Detail Requirements:

- 15.5 lbs. water, minimum. a. Capacity:
- b. Material: Open hearth or electric steel of with minimum wall thickness of .082". Compositions of steel to be in accordance with DOT 4BA/TC/EN specifications.
- c. Construction: Two drawn steel shells circumferentially welded, with welded foot ring and collar. Construction to comply with DOT 4BA specifications for a service pressure of 400 psig. and Transport Canada (TC) 4BA specifications for a service pressure of 400 psig
- d. Opening: Top head to have 3/4"-14 NGT opening.
- e. Valve and Pressure Relief Device:
 - **Option A:** Neriki air-activated liquid/vapor valve #DCU-2-018-1A with .500-16ACME-LH-EXT (CGA 166) outlet and replaceable pressure relief valve #3EA-003-2 installed.

Valve inlet CGA ¾-14NGT Taper 1/16

The start-to-discharge pressure of the relief valve must be between 600 and 800 psig; the flow rating pressure shall not exceed 800 psig.

Each valve to be assembled with a securely clamped polyethylene dip tube extending to the base of the cylinder. Valve to be installed such that the outlet faces the handle opening.

- f. Tare Weight: 11. lbs. (approximate) with valve.
- g. Dimensions: (Approximately) 7 1/2" O.D. x 14 3/4" from bottom of foot ring to top of collar.
- h. Interior: Must not contain in excess of 1.5 grams of particulate matter (rust, slag, scale and other solids) and must show no evidence of moisture or oil

10 lb (4.5 kg) Returnable Cylinder Specification

Honeywell **Fluorine Products** P.O. Box 1053 Morristown, NJ 07962-1053

Container Purchase Specifications

Container Purchase Specifications	Spec No.: Date: Supersedes Spec. No.:	M-8110-YF Page 2 of 2 2/18/13 8110-YF Rev 1
1. Type: Returnable Steel Cylinder 15.5 lbs. Water Capacity DOT 4BA400/TC/EN	Change: Product: Location:	J color Solstice [®] Refrigerants 1234yf

2. Detail Requirements:

i. Markings:	Collar to bear required DOT 4BA 400 markings and the following: - "Honeywell"
	- Tare weight including valve
	- Water capacity
j. Painting:	Solstice 1234YF - Cylinder to be painted white, valve opening to be protected from overspray. A contrasting 2" wide red [Pantone 485C] band is to be painted around the circumference of the cylinder positioned just below the cylinder shoulder radius at the top of the cylinder, per SAE J2844, AHRI Guideline N-2008: 4.8.
k. Test Reports:	Copies of complete cylinder test reports are to be supplied to
	Honeywell Fluorine Products 101 Columbia Turnpike Morristown, NJ. 07962 Attn: Insert the Name of the buyer from the PO

Cylinder manufacturer will also maintain copies of these reports.

Solstice® yf Refrigerant User Guide

25 lb (11.3 kg) Returnable Cylinder Specification

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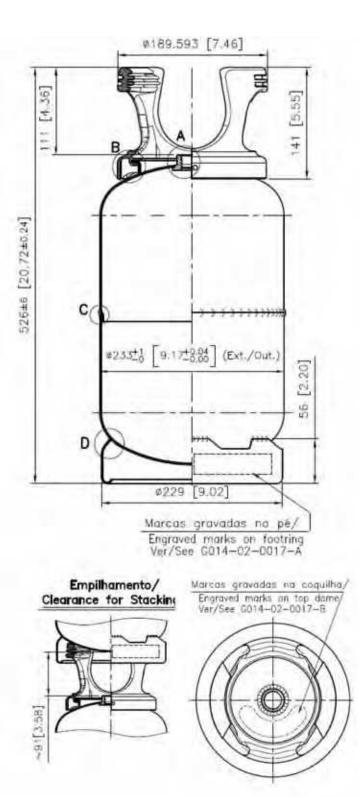


Regions: North America

Water Capacity: 29.7 lbs / 13.6 Liters

Features: Light weight and plastic handles for easy transport, dual phase valve for gas or liquid discharge Valve Outlet: CGA 166

Thread Pattern: 0.500 – 16 ACME – 2G – LH – EXT (Left Handed Threads)



25 lb (11.3 kg) Returnable Cylinder Specification

Honeywell Fluorine Products P.O. Box 1053 Morristown, NJ 07962-1053

Container Purchase Specifications

Container i drendse opeenieddons	Spec No.:	M-8100yf	Page 1	of	2	
	Date:	2/18/13				
	Supersedes Spec. No.:	New	Rev 1			
1. Type:	Change:	J color				
Returnable Steel Cylinder 30.0 lbs. water capacity	Product:	1234yf				
DOT 4BA400/TC4BAM28/EN	Location:	Danville				
Returnable Steel Cylinder 30.0 lbs. water capacity	Product:	1234yf				

2. Detail Requirements:

a. Capacity:	30.0 lbs. water
--------------	-----------------

- b. Material: Open hearth or electric steel with minimum wall thickness of 0.090 in.
- c. **Construction:** To comply with DOT/TC 4BA/EN specifications for a service pressure of 400 psig. Collar to be heavy gauge 270 degree style with a 1/4" hole drilled opposite the opening; foot ring to be heavy gauge. Foot rings and collars to be nestable for stacking.
- d. **Opening:** Top spud to have 3/4 in.-14NGT opening.

e. Valve and Pressure Relief Device:

Option A: Neriki air-activated liquid/vapor valve #DCU-2-018-1A with .500-16ACME-LH-EXT (CGA 166) outlet and replaceable pressure relief valve #3EA-003-2 installed. Valve inlet CGA ¾-14NGT Taper 1/16

The start-to-discharge pressure of the relief valve must be between 600 and 800 psig; the flow rating pressure shall not exceed 800 psig. Each valve to be assembled with a securely clamped polyethylene dip tube extending to the base of the cylinder. Valve to be installed such that the outlet faces the handle opening.

- f. Tare Weight: Approximately 18.8 lbs.
- g. Dimensions: 9 in. diameter x 20 in. height.
- h. Interior: Must be dry, clean, and free of rust, oil, water and other foreign matter.

25 lb (11.3 kg) Returnable Cylinder Specification

Honeywell Fluorine Products P.O. Box 1053 Morristown, NJ 07962-1053

Container Purchase Specifications

Container Furchase Specifications	Spec No.:	M-8100yf	Page	2	of	2	
	Date:	2/18/13					
	Supersedes Spec. No.:	New	Rev 1				
1. Type:	Change:	J color					
Returnable Steel Cylinder 30.0 lbs. water capacity	Product:	1234yf					
DOT 4BA400/TC4BAM28/EN	Location:	Danville					

2. Detail Requirements:

> Morristown, NJ. 07962 ATTN: The Buyers Name associated with the PO

Solstice[®] yf Refrigerant User Guide

100 lb (45.3 kg) Returnable Cylinder Specification

Doc Number: M-8120-yf Part 4 - Page 122

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Regions: North America

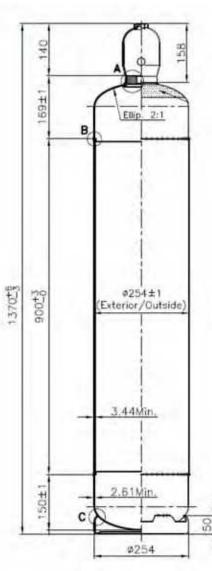
Water Capacity: 123 lbs / 55.8 Liters

Features:

Manageable size cylinders in tight spaces and good capacity for lower production environments Valve Outlet: CGA 670 Dual Phase

Thread Pattern:

1.030 – 14 NGO –LH – EXT (Left Handed Threads)





100 lb (45.3 kg) Returnable **Cylinder Specification**

Honeywell **Fluorine Products** P.O. Box 1053 Morristown, NJ 07962-1053

Container Purchase Specifications

Container Purchase Specifications	Spec No.:	M-8120-YF	Page	1	of	2
	Date:	2/18/13				
	Supersedes Spec. No.:	New	Rev 1			
1. Type:	Change:	J color				
Returnable Steel Cylinder 123 lbs. Water Capacity	Product:	1234yf				
DOT 4BW400/TC4BWM27/EN	Location:					

2. Detail Requirements:

- a. Capacity: 123 lbs. water, minimum.
- b. Material: Open hearth or electric steel of prescribed analysis.
- c. Construction: Longitudinally welded shell with ellipsoidal head welded to each end, with welded foot ring and 3 1/8"-11 TPI spud welded on top for valve cover. Construction to comply with U.S. Department of Transportation (DOT) and Transport Canada (TC) 4BW specifications for a service pressure of 260 psig.
- d. Opening: Top spud to have 3/4"-14 NGT opening. Cylinders to be equipped either with a specified valve and dip tube or a steel plug, installed wrench tight to prevent accumulation of moisture and contamination. Cylinders to be supplied with valve covers.
- e. Valve and Pressure Relief Device:

Option A:	
·	Neriki air-activated liquid/vapor valve #D-7CU-502-2 with.1.030-14NGOLH-EXT (CGA 670) outlet and replaceable pressure relief valve #3EA-003-2 installed.
	Valve inlet CGA ¾-14NGT Taper 1/16
	The start-to-discharge pressure of the relief valve must be between 600 and 800 psig; the flow rating pressure shall not exceed 800 psig.
	Each valve to be assembled with a securely clamped polyethylene dip tube extending to the base of the cylinder. Valve to be installed such that the outlet faces the handle opening.
f. Tare Weight:	65 lbs. (approximate) with valve and cap.
g. Dimensions:	(Approximate) 10" O.D. x 48" from bottom of foot ring to top face of threaded opening.
h. Interior:	Must not contain in excess of 1.5 grams of particulate matter (rust, slag, scale and other solids) and must show no evidence of moisture or oil.

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100 lb (45.3 kg) Returnable Cylinder Specification

Honeywell Fluorine Products P.O. Box 1053 Morristown, NJ 07962-1053

Container Purchase Specifications

	Spec No.:	M-8120-YF	Page	2	of	2	
	Date:	2/18/13					
	Supersedes Spec. No.:	New	Rev 1				
1. Type:	Change:	J color					
Returnable Steel Cylinder 123 lbs. Water Capacity	Product:	1234yf					
DOT 4BW400/TC4BWM27/EN	Location:						
	1						

2. Detail Requirements:

i. Markings:	Shoulder to bear required DOT/TC 4BW/EN markings and manufacturer's registered symbol and serial number. Owner's registered symbol to be stamped on shoulder, opposite the DOT/TC markings, as follows:
	"Honeywell"
	Tare weight of cylinder (include 1 ³ /4 lbs. for valve) to be stamped on shoulder.
j. Painting:	Solstice [®] 1234YF- Cylinder to be painted white, valve opening to be protected from overspray. A contrasting 2" wide red [Pantone 485C] band is to be painted around the circumference of the cylinder positioned just below the cylinder shoulder radius at the top of the cylinder, per SAE J2844, AHRI Guideline N-2008: 4.8.
k. Test Reports:	Cylinder test reports are to be sent to:
	Honeywell Fluorine Products 101 Columbia Road Morristown, NJ. 07962 Attn: The purchasing contact indicated on the PO

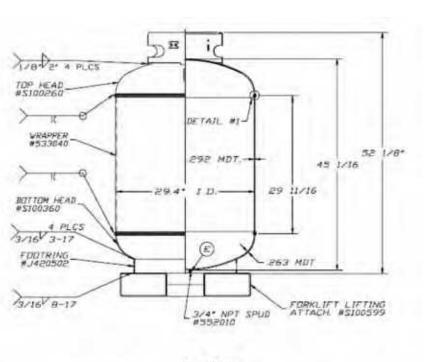
Solstice[®] yf Refrigerant User Guide

950 lb (430 kg) Returnable Cylinder Specification

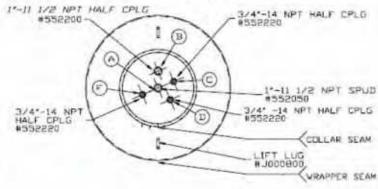
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Doc Number: M-7863-yf Part 4 - Page 125





Top View



Valve Outlet: CGA 670 Single Outlet (x2)

Features:

Thread Pattern: 1.030 – 14 NGO –LH – EXT (Left Handed Threads)

Water Capacity: 1000 lbs

production environments

Easy to maneuver with a fort truck

contains enough capacity for higher



950 lb (430 kg) Returnable Cylinder Specification

Honeywell Fluorine Products P.O. Box 1053 Morristown, NJ 07962-1053

Container Purchase Specifications

Container Furchase Specifications	Spec No.:	M-7863yf	Page	1	of	2	
	Date:	2/18/13					
	Supersedes Spec. No.:	New	Rev 1				
1. Type:	Change:	J color					
Returnable Steel Cylinder 1000 lbs. Water Capacity	Product:	1234yf					
DOT 4BW400/TC4BWM27	Location:	Danville					

2. Detail Requirements:

a. Capacity:	1000 lbs. water, nominal
b. Material:	Open hearth or electric steel of prescribed analysis.
c. Construction:	Longitudinally welded shell with ellipsoidal head welded to each end, mounted on 4-way entry pallet skid. Construction to comply with U.S. Department of Transportation (DOT) and Transport Canada (TC) 4BW specifications for a service pressure of 400 psig.
d. Openings:	Top head to have three (3) $3/4$ " x 14 NPT openings and two (2) 1" x $11\frac{1}{2}$ NPT openings. Bottom head to have one (1) $3/4$ " x 14 NPT opening.
e. Pressure Relief I	 Device & Valves: To be equipped with two (2) spring loaded relief valve(s), sized in accordance with CGA Pamphlet S-1.1 for use in refrigerant 1234yf and assembled with refrigerant grade neoprene seat. Two (2) Neriki valves, one (with red handle) to be assembled with polyethylene dip tube, to be installed in 3/4" openings in top head. The valves should have a CGA670 outlet connection with a thread pattern of 1.030-14 NGO-LH-EXT (Left Handed Threads). Unused holes to be plugged.
f. Tare Weight:	500 lbs. (approximate)
g. Dimensions:	30" O.D. x 60" H (approximate)
h. Interior:	Must be dry, clean, and free of rust, oil, water and other foreign matter.

950 lb (430 kg) Returnable Cylinder Specification

Honeywell Fluorine Products P.O. Box 1053 Morristown, NJ 07962-1053

Container Purchase Specifications

Container Furchase Specifications	Spec No.:	M-7863yf	Page	2	of	2	
	Date:	2/18/13					
	Supersedes Spec. No.:	New	Rev 1				
1. Type:	Change:	J color					
Returnable Steel Cylinder 1000 lbs. Water Capacity	Product:	1234yf					
DOT 4BW400/TC4BWM27	Location:	Danville					

2. Detail Requirements:

i. **Markings:** Collar to bear required DOT-4BW/ TC markings and manufacturer's registered symbol and serial number. Purchaser identification to be included as follows:

"Honeywell"

Tare weight of cylinder including valves to be included on collar.

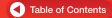
- j. Painting: Solstice 1234YF- Cylinder to be painted white, valve opening to be protected from overspray. A contrasting 2" wide red [Pantone 485C] band is to be painted around the circumference of the cylinder positioned just below the cylinder shoulder radius at the top of the cylinder, per SAE J2844, AHRI Guideline N-2008: 4.8.
- k. Test Reports: Copies of cylinder test reports to be supplied to:

Honeywell Fluorine Products P.O. Box 1053 Morristown, NJ 07962. Attention: To the buyer issuing the PO

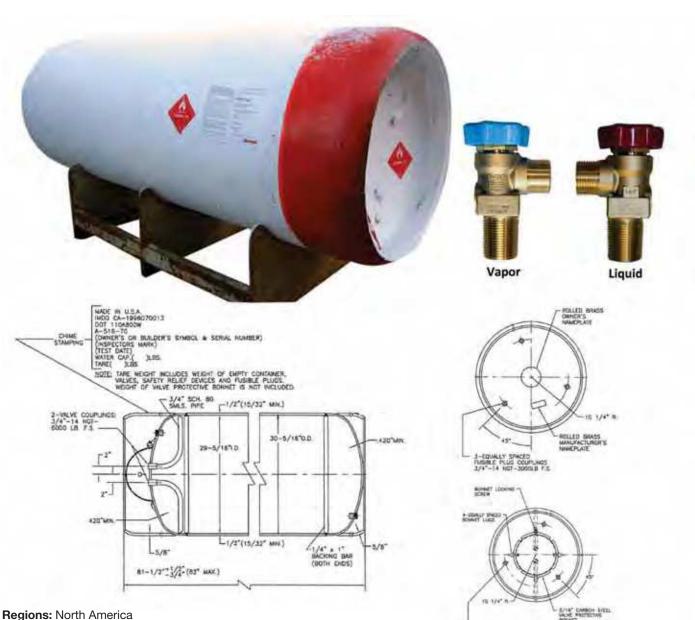
Cylinder manufacturer will also maintain copies of these reports.

Solstice[®] yf Refrigerant User Guide

1750 lbs (794 kg) Returnable **Cylinder Specification**



Doc Number: S-7816-yf Part 4 - Page 128



1-EDUBLIT SPACED FUSBLE PUBLICE SWEET VALVE COX 2/47-14 ADI-3000LB FX

Regions: North America

Water Capacity: 1600 lbs

Features:

Utilized as a mini-Bulk tank, enough capacity for high production, requires special equipment to maneuver

Valve Outlet: CGA 670, Single Outlet (x2)

Thread Pattern: 1.030-14NGO-LH-EX

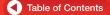
1750 lbs (794 kg) Returnable Cylinder Specification

Honeywell **Fluorine Products** P.O. Box 1053 Morristown, NJ 07962-1053

Container Purchase Specifications

Container Purchase Specifications	Spec No.: Date: Supersedes Spec. No.:	S-7816yf 2/18/13 New	Page	1	of	2
1. Type: "Ton Cylinder" Multi Unit Tank Car Tank DOT-110A800W	Change: Product: Location:	J color 1234yf Danville				
2. Detail Requirements:	1					

a. Capacity:	1600 lbs. water, minimum 1674 lbs. water, average
b. Material:	Carbon steel plate. Composition and thickness of steel to be in accordance with DOT-110A800W specification.
c. Construction:	Cylindrical steel shell with fusion-welded heads formed concave to pressure. Construction to comply with DOT-110A800W specification.
d. Openings:	Each head to have three equally spaced $\frac{3}{4}$ "-14 NGT couplings (for pressure relief devices). One head to have two $\frac{3}{4}$ "-14 NGT valve couplings spaced 4" apart on center line. Each valve coupling to be connected to a $\frac{3}{4}$ " schedule 80 eduction pipe. Two valves, Neriki # D-7CU-602-1A, to be installed.
e. Pressure Relief De	evice & Valves: Tank to be equipped with five fusible plugs. Neriki # S-1-010-1, with two installed on valve end and three on opposite end. One relief valve, Neriki # S-1-009-1, to be installed on valve end.
f. Tare Weight:	(average) 1425 lbs. (complete with fittings and bonnet)
g. Dimensions:	30 5/16" O. D. x 81 ½" + ½" – ¾" L.
h. Interior:	Must be dry, clean, and free of rust, oil, water and other foreign matter.



1750 lbs (794 kg) Returnable Cylinder Specification

Honeywell Fluorine Products P.O. Box 1053 Morristown, NJ 07962-1053

Container Purchase Specifications

lo.: S-7816yf	Page	2	of	2	Ĺ
2/18/13					Ĺ
edes Spec. No.: New	Rev 1				Ĺ
e: J color					Ĺ
t: 1234yf					Ĺ
on: Danville					
•	2/18/13 edes Spec. No.: New :: J color t: 1234yf	2/18/13 edes Spec. No.: New Rev 1 e: J color t: 1234yf	2/18/13 edes Spec. No.: New Rev 1 e: J color t: 1234yf	2/18/13 edes Spec. No.: New Rev 1 e: J color t: 1234yf	2/18/13 edes Spec. No.: New Rev 1 e: J color t: 1234yf

2. Detail Requirements:

i. **Markings:** Tank is to be marked on the valve end chime in accordance with 49CFR, Section 179.30018(a). Marking to include owner's registered symbol, as follows, and tare weight.

"Honeywell"

Brass owner's nameplate to be stamped with the following information:

HONEYWELL--MORRISTOWN, NEW JERSEY (circumferentially in ¼" letters)DOT-110A800W(5/16" letters)SOLSTICE®(1/2" letters)

OOLOHIOL	(1) -	1011010)
SERIAL	(1/4"	letters)
TEST DATE	(1/4"	letters)
TARE LBS.	(1/4"	letters)

- j. Painting: Solstice® 1234YF- Cylinder to be painted white, valve opening to be protected from overspray. A contrasting 2" wide red [Pantone 485C] band is to be painted around the circumference of the cylinder positioned just below the cylinder shoulder radius at the top of the cylinder, per SAE J2844, AHRI Guideline N-2008: 4.8.
- k. Test Reports: Copies of complete test reports are to be supplied to Honeywell, Morristown, NJ office. Attn: To the buyer issuing the PO Tank manufacturer will also maintain copies of these reports.
- I. Miscellaneous: Tank to be shipped with all fittings and protective bonnet installed.

Solstice® yf Refrigerant User Guide

ISO Container Specification



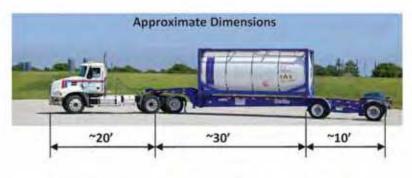
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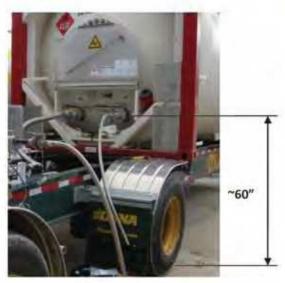


Delivery Quantity: 33,000 lbs / 15,000 kg

Water Capacity: 6,470 gals / 24,500 liters

Features: Bulk Deliveries for OEM facilities





Quest Unloading Skid Pump





Part 4 - Page 132



Tank container full specification

EURU504500-8				
GENERAL				
Туре	IM5	Group	Gas tank	
ISO Type	1 CC	# of compartments	1	
Length	20'	Height	8' 6"	
Width	8'	T-Code	Т50	
Regulation	New	Nominal capacity	24,500 I	
Manufacturer	GASCON	Maximum gross weight	34,000 kg	
Date of manufacturer	11-Oct-2011	Tare weight	7,670 kg	
TANK VESSEL				
Max. allowable working pressure	27.50 bar			
Vacuum pressure	1.00 bar			
Test pressure	36.30 bar	Material	CS- P460 NL1 modified	
RID design pressure		Design temperature	50 °C	
Inside diameter	2386 mm	Design code	ASME sect. Vill div.2 - Stamp U2	
Bafles	Yes	Internal lining	Zinc	
FRAME				
Frame type	Beam tank	Walkway	No	
Stacking	170,000 kgs	Collapsible handrall	No	
		Grip lift	No	
FITTINGS				
Manhole position	At the rear			
Manhole nominal diameter	500 mm - 20 in			
Number of closures	24			
Closure type	Bolt			
Manhole gasket	PTFE with SS core			
Spill box	Yes with lids			
Callibration card	No			
Guaging fitting	No			

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Tank container full specification

	EURU504500-8			
DISCHARGE				
Discharge Type	Bottom only	Bottom only		
Liquid Line	Quantity: 1	Gas Line	Quantity: 1	
Position	At the rear	Position	At the rear	
Internal valve type	Stainless steel	Internal valve type	Stainless steel	
Internal valve diameter	50 mm - 2 in	Internal valve diameter	50 mm - 2 in	
Internal valve brand	Fort Vale	Internal valve brand	Fort Vale	
Valve type	Ball-SS	Valve type	Ball-SS	
Valve diameter	50 mm - 2 in	Valve diameter	50 mm - 2 in	
Valve brand	Fort Vale	Valve brand	Fort Vale	
Coupling type	ACME	Coupling type	ACME	
Coupling diameter	82.55 mm - 3.25 in	Coupling diameter	44.45 mm - 1.75 in	
Closure type	Cap 3"1/4	Closure type	Cap 1"3/4	
Gasket between valves	PTFE with SS core	Gasket between valves	PTFE with SS core	
SAFETY DEVICES				
Safety devices	1 SRV + 1 BD in series			
Breather	No	Protection cover	No	
Relief valve 1 / Brand	Fort Vale			
Relief valve 1 / Type	Stainless steel			
Relief valve 1 / Diameter	80 mm - 3 in			
Relief valve 1 / Settings	27.50 bar - 399 psi			
Flame trap	Yes	Flame trap	No	
Manometer	0/40 bar - 0/580 psi			
Rupture disc 1 / Brand	Continental Disc			
Rupture disc 1/Type	SS 316L			
Diameter	80 mm - 3 in			
Settings	30.25 bar - 438.00 psi			



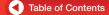


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Tank container full specification

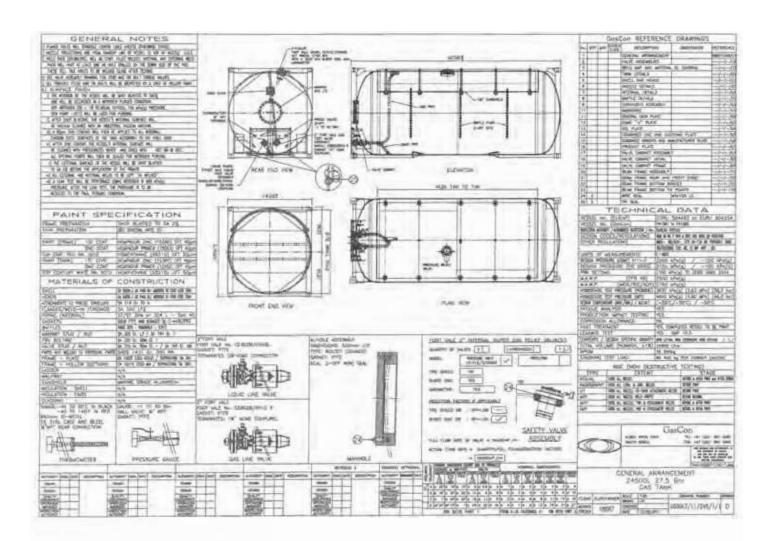
EURU504500-8				
INSULATION				
Composition		Cladding	Not specified	
Insulation thickness		Sunshield	Yes	
APPROVALS				
CSC	Yes	AAR600	Yes	
IMDG	Yes	FRA	No	
RID / ADR	Yes	стс	Yes	
US DOT / CFR49	UN + U Stamp 2	Japanese fire approval	No	
Exemption	SP 14301	МІТІ	Hydro tested	
UIC	Yes	SQLO	Yes	
		TPED	Yes	
TEST DATES				
	Last		Next	
CSC inspection	11 Oct 2011		11 Oct 2016	
Hydraulic test 11 Oct 2011			11 Oct 2016	
Air test	11 Oct 2011		11 Apr 2014	



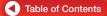
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ISO Container Specification

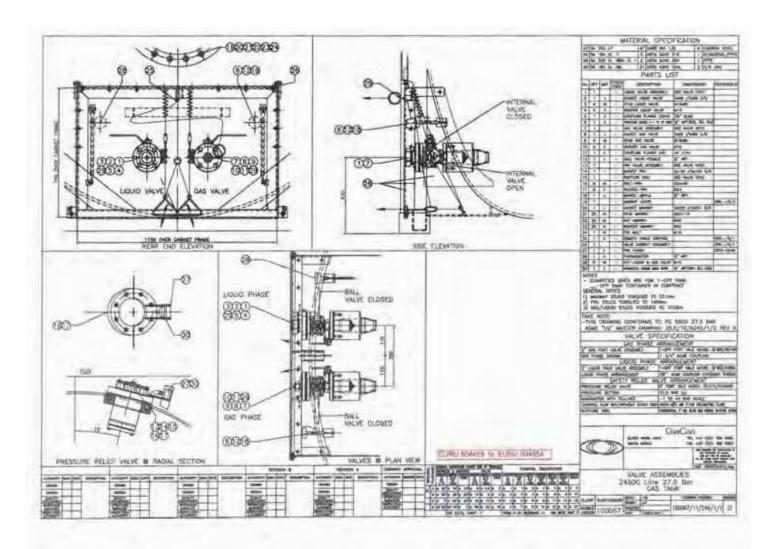
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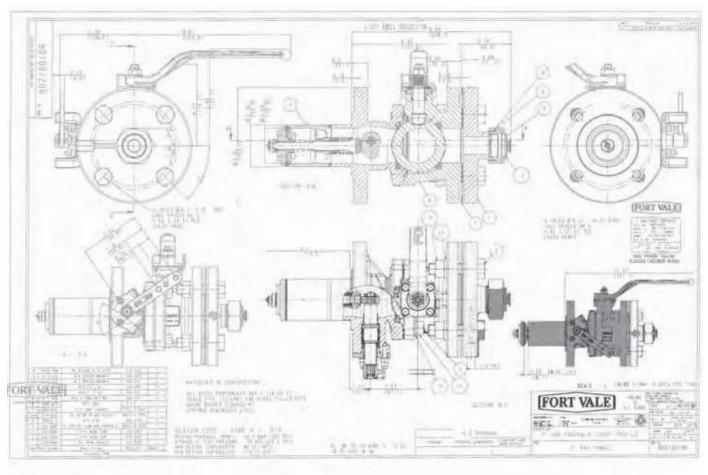




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ISO Container Specification

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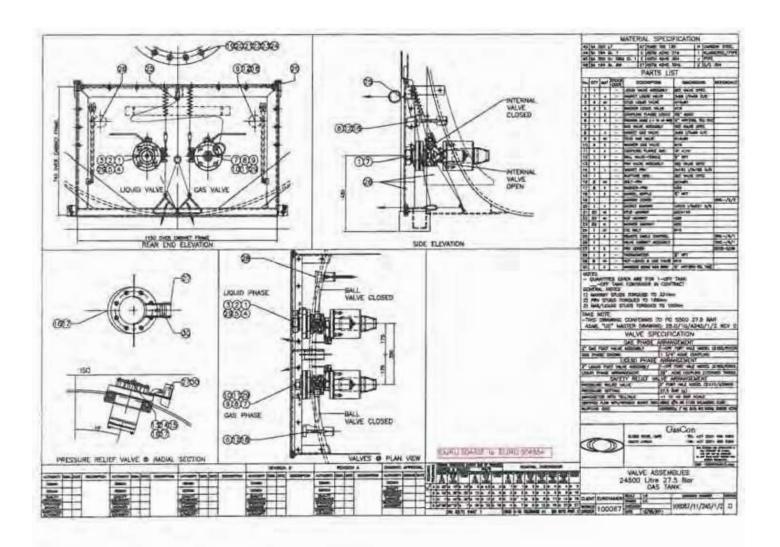


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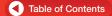
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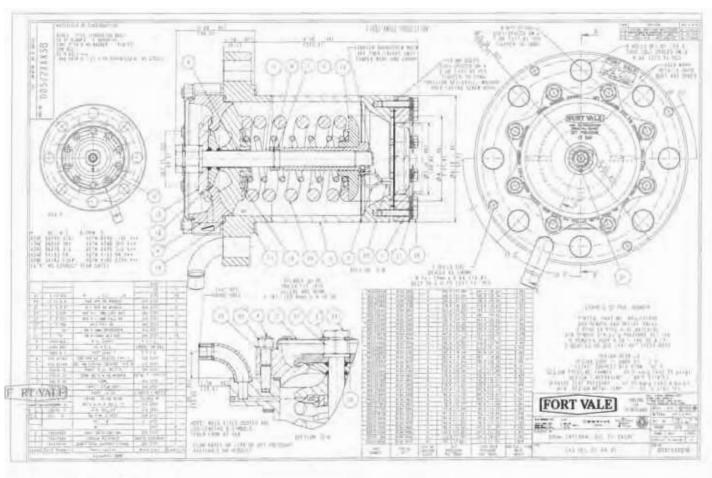


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ISO Container Specification

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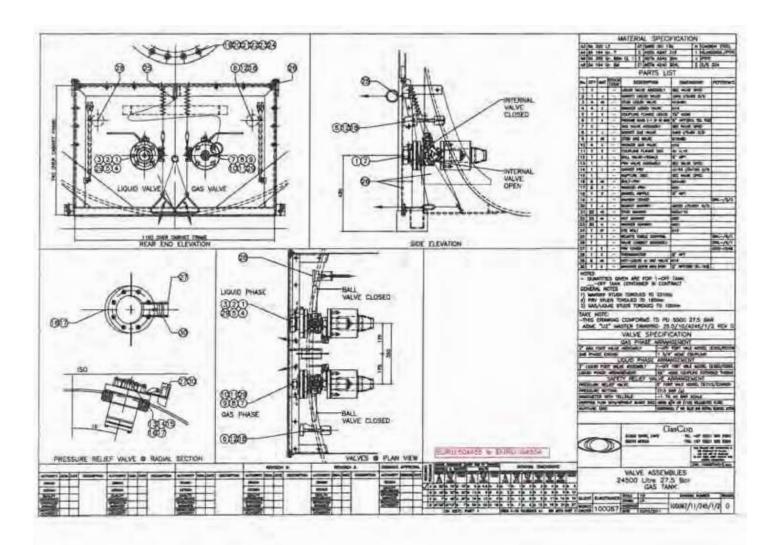
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ISO Container Specification

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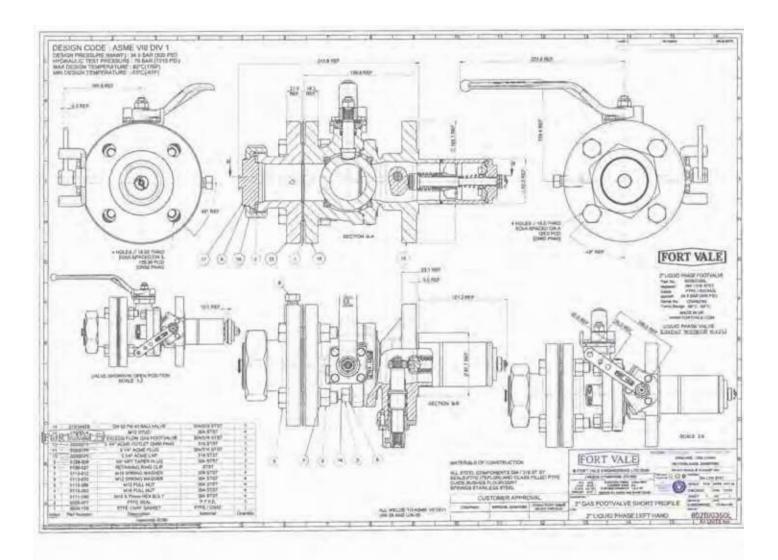




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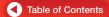
ISO Container Specification

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Solstice[®] yf Refrigerant User Guide

25 lb (10 kg) Reclaim Cylinder Specification



Doc Number: M-8005 Part 4 - Page 142



Regions: North America

Delivery Quantity: Each (Delivered As Empties)

Water Capacity: 27.5 lbs / 6 liters

Features: Light Weight, Ergonomic Design, Dual Handle, CGA 166 Dual Outlet Valve

Valve Outlet: CGA 166

Thread Pattern: 0.500 – 16 ACME – 2G – LH – EXT (Left Handed Threads)





1234yf Reclaim

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

25 lb (10 kg) Reclaim **Cylinder Specification**

Honeywell **Fluorine Products** P.O. Box 1053 Morristown, NJ 07962-1053

Container Purchase Specifications

Container Purchase Specifications	Spec No.: Date: Supersedes Spec. No.:	M-8005 7/19/12 New	Page	1	of	2
1. Type: Recovered Refrigerant (Composite-metal) Returnable Steel Cylinder 30 lb. Water Capacity Nominal DOT SP14457	Change: Product: Location:	J color 1234yf (Re RECOVER Danville	'	DER		

2. Detail Requirements:

a. Capacity:	27.5 lbs. water actual (12.5 Liter/27.5# W.C.)
--------------	--

- b. Material: Steel Liner, Reinforced with polypropylene fiber winding pressure vessel, encased in HDPE shell.
- c. Construction: To comply with DOT SP 14457 specifications for service pressure of 400 psig. Must be nestable for stacking.

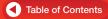
Reference drawings: Amtrol/Alfa Numbers H013-04-00

- d. Opening: Top spud to have 3/4 in. NPT opening.
- e. Valve and Pressure Relief Device:

Dual Handle/dual port Cavagna (Omega) Model number for 400 psi rated cylinders is7601900356. The valve is to be equipped with a burst disc set to relieve at 620 psig (=40 psig or -40 psig) with CGA 166 (1/4" SAE Flare LH) outlets.

Each valve to be assembled with a securely clamped polyethylene dip tube extending to the base of the cylinder. Valve to be installed such that the outlet faces the handle opening. Omega Drawing Number 1201101645

- f. Tare Weight: Approximately 11 lbs. (5 kg)
- g. Dimensions: 12.2 in. (310 mm) diameter x 15.9 in. (404 mm) height.
- h. Interior: Must be dry, clean, and free of rust, oil, water and other foreign matter.



25 lb (10 kg) Reclaim Cylinder Specification

Honeywell **Fluorine Products** P.O. Box 1053 Morristown, NJ 07962-1053

Container Purchase Specifications

Container Purchase Specifications	Spec No.: Date:	M-8005 7/19/12	Page	2	of	2
1. Type: Recovered Refrigerant (Composite-metal) Returnable Steel Cylinder 30 lb. Water Capacity Nominal DOT SP14457	Supersedes Spec. No.: Change: Product: Location:	New J color 1234yf (Rec RECOVERY Danville	,	DER		

2. Detail Requirements:

i. Markings:	Collar to bear required DOT/TC 4BA markings and manufacturer's registered symbol and serial number. Purchaser's identification to be included as follows:
	Tare Plate: Gross mass of complete cylinder, last permissible retest date.
	Bottom Plate: DOT SP14457, Registration symbol and serial number. Blank area for retest date, service pressure, water capacity, manufacture date, mass of cylinder, plus jacket without a valve.
j. Coloring:	Base and Handle inserts to be Pantone 485C.
	Remainder of cylinder to be "grey"
k. Test Reports:	Cylinder test reports are to be sent to:
	Honeywell Fluorine Products 101 Columbia Road Morristown, NJ. 07962 ATTN: The issuer of the PO

Solstice[®] yf Refrigerant User Guide

Cylinder Labels and Tags

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WARKING! FLAMMABLE LIQUID AND GAS UNDER PRESSURE, CAN CALISE RAPID SUFFOCATION. CONTACT WITH HOT METAL SURFACES CAN RELEASE TOXIC, CORROSIVE DECOMPOSITION PHODUCTS.

Store and use with adequate ventilation. Cylinder temperature should not exceed 120°F (50°C). Do not drop cylinder. Do not apply open fiame to cylinder. Close valve after each use and when empty. Use is accordance with Honeywell Material Safety Data Sheet,

FIRST AID: If inhalied, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

Do not mix with oxygen or air above atmospheric pressure for leak testing or any other purpose.

Parthase of this product includes the limited right under the Honeywell patents identified at <u>www.12348acts.com/patents</u> to use the purchased product at the lone refrigerant in an automobile air conditioning system. Use of the purchased product is a different application or in a biend with exother refrigerant or the same refrigerant from a different supplier is expressly prohibited.



Solstice[™] yf Refrigerant (R-1234yf)

2,3,3,3-TETRAFLUOROPROP-1-ENE CAS No. 754-12-1 For manufacturing use only. Not for food, drug or cosmetic use.

Product of US, China and Japan

4.5 kg Net

Honeywell

RESIDUAL CONTENTS OF THIS CONTAINER MUST BE RECOVERED. DO NOT VENT TO THE ATMOSPHERE.

HONEYWELL Fluorine Products Morristown, New Jersey 07962 1-800-522-8001 www.genetron.com

FLAMMABLE LIQUEFIED GAS NEVER REFILL OR INTRODUCE FOREIGN LIQUIDS AND/OR GASES INTO THIS CYLINDER ANY MISUSE CAN BE DANGEROUS

X-0105429 YF 4.5-02/12

CUSTOMER: HONEYWELL	COLOR PROOPS ARE NOT INTENDED TO BE USED FOILEXACT COLO
PART NUMBER: YF 4,5-02/12	
DESIGN NUMBER: X-0105429	Black 485 Non-Spet Dielina
LABEL SIZE: 7.00" X 3.50" # PER BAG: 50 MATERIAL: WATER TRANSFER	
	Flexo • Screen • Digital Printing
APPROVED: CORRECTIONS NEEDED:	3901 Virginia Ave. Tel: 513-271-3800 Cincinnati, OH 45227 Fax: 513-271-5963 Email: championgraphics@aol.com

Solstice[®] yf Refrigerant User Guide

Cylinder Labels and Tags

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WARNING:

Never refill or introduce foreign liquids and/or gases into this cylinder. Any such misuse can be dangerous.

ATTENTION:

Gaz liquéfié inflammable. Ne jamais remplie ou introduire des liquides et/ou des gaz étrangers dans cette bouteille. Tout mauvais usage peut être dangereux.

Honeywell ASCa, Inc. 3333 Unity Drive Mississauga, Ontario L5L 3S6 1-800-553-9749



Solstice[™] yf Refrigerant (R-1234yf)

UN3161, LIQUEFIED GAS FLAMMABLE, N.O.S., (R-1234yf) GAZ LIQUÉFIÉ, INFLAMMABLE, N.O.S., (R-1234yf)

Product of US, China and Japan

4.5 kg Net

Honeywell

Caution: liquid and gas under pressure. Do not apply open flame. Never drop cylinder.

Liquide et gaz sous pression. Ne pas approcher de flamme nue. Ne jamais laisser tomber la bouteille.

Purchase of this product includes the limited right under the Honeywell patents identified at <u>www.1234facts.com/patents</u> to use the purchased product as the lone refrigerant in an automobile air conditioning system. Use of the purchased product in a different application or in a blend with another refrigerant or the same refrigerant from a different supplier is expressly prohibited.

Before using, read attached WHMIS tag. Se référer à l'étiquette SIMDUT avant usage.

X-0105431 YFTC 4.5-02/12

CUSTOMER: HONEYWELL	COLOR PROOFS ARE NOT INTENDED TO BE USED FOR EXACT COLOR MAT
PART NUMBER: YFTC 4.5-02/12	
DESIGN NUMBER: X-0105431	Black 485 Dielina
LABEL SIZE: 7.00" X 3.50" * PER BAG: 50 MATERIAL: WATER TRANSFER	
APPROVED: CORRECTIONS NEEDED: COMMENTS:	Flexo • Screen • Digital Printing 3901 Virginia Ave. Tel: 513-221-3800 Cincinnati, OH 45227 Fax: 513-221-5963 Email: championgraphics@aol.com

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Cylinder Labels and Tags

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CUSTOMER: HONEYWELL	COLOR PROGES ARE NOT INTENDED TO BE USED FOR EXACT COLO
PART NUMBER: YF 13.6-02/12	
DESIGN NUMBER: X-0105430	Black 485 Non-Spec Disline
LABEL SIZE: 8.875" X 4.50" # PER BAG: 50 MATERIAL: WATER TRANSFER	
	Flexo - Screen - Digital Printing
APPROVED: CORRECTIONS NEEDED: COMMENTS:	3001 Virginia Ave. Tel: 513-271-3800 Cincinnati, OH 45227 Fax: 513-271-5963 Email: championgraphics@aol.com

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WARNING:

Never refill or introduce foreign liquids and/or gases into this cylinder. Any such misuse can be dangerous.

ATTENTION:

Gaz liquéfié inflammable. Ne jamais remplie ou introduire des liquides et/ou des gaz étrangers dans cette bouteille. Tout mauvais usage peut être dangereux.

Honeywell ASCa, Inc. 3333 Unity Drive Mississauga, Ontario L5L 3S6 1-800-553-9749



Solstice[™] yf Refrigerant (R-1234yf)

UN3161, LIQUEFIED GAS Flammable, N.O.S., (R-1234yf) Gaz Liquéfié, Inflammable, N.O.S., (R-1234yf)

Product of US, China and Japan

11.3 kg Net

Honeywell

Caution: liquid and gas under pressure. Do not apply open flame. Never drop cylinder.

Liquide et gaz sous pression. Ne pas approcher de flamme nue. Ne jamais laisser tomber la bouteille.

Purchase of this product includes the limited right under the Honeywell patents identified at <u>www.1234facts.com/patents</u> to use the purchased product as the lone refrigerant in an automobile air conditioning system. Use of the purchased product in a different application or in a blend with another refrigerant or the same refrigerant from a different supplier is expressly prohibited.

Before using, read attached WHMIS tag. Se référer à l'étiquette SIMDUT avant usage.

X-0106432 YFTC 13.6-02/12

CUSTOMER: HONEYWELL	COLOR PROOFS ARE NOT INTENDED TO BE USED FOR ERACT COLO
PART NUMBER: YFTC 13.6-02/12	
DESIGN NUMBER: X-0105432	Burk 485 Dieling
LABEL SIZE: 8.875" X 4.50" # PER BAG: 50 MATERIAL: WATER TRANSFER	
APPROVED: CORRECTIONS NEEDED:	Flexo + Screen + Digital Printing 3901 Virginia Ave. Tel: 513-271-3800 Cincinnati, OH 45227 Fax: 513-271-5963 Email: championgraphics@aol.com
SIGNATURE:	DATE :

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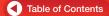
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PART NUMBER: YF-01/12	
DESIGN NUMBER: X-0105357	Black PMS 485 Non-Spins
LABEL SIZE: 12.75" X 7.5" # PER SHEET: 5 MATERIAL: WATER TRANSFER	
	Flexo - Screen - Digital Printing
APPROVED: CORRECTIONS NEEDED:	3901 Virginia Ave. Tel: 513-271-3800 Cincinnati, OH 45227 Fax: 513-271-5963 Email: championgraphics@aol.com





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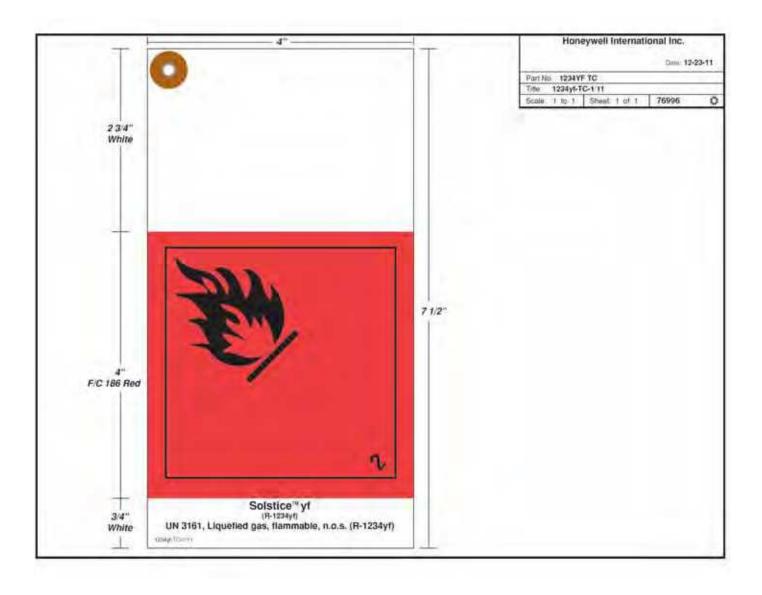


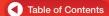
PART NUMBER: YFTC-01/12	
DESIGN NUMBER: X-0105358	Black PMS 485
LABEL SIZE: 12.75" X 7.5" * PER SHEET: 5 MATERIAL: WATER TRANSFER	
	Flexo • Screen • Digital Printing
APPROVED: CORRECTIONS NEEDED: COMMENTS:	3903 Virginia Ave. Tel: 513-271-3800 Cincinnati, DH 45227 Fax: 513-271-5963 Email: championgraphics@aol.com

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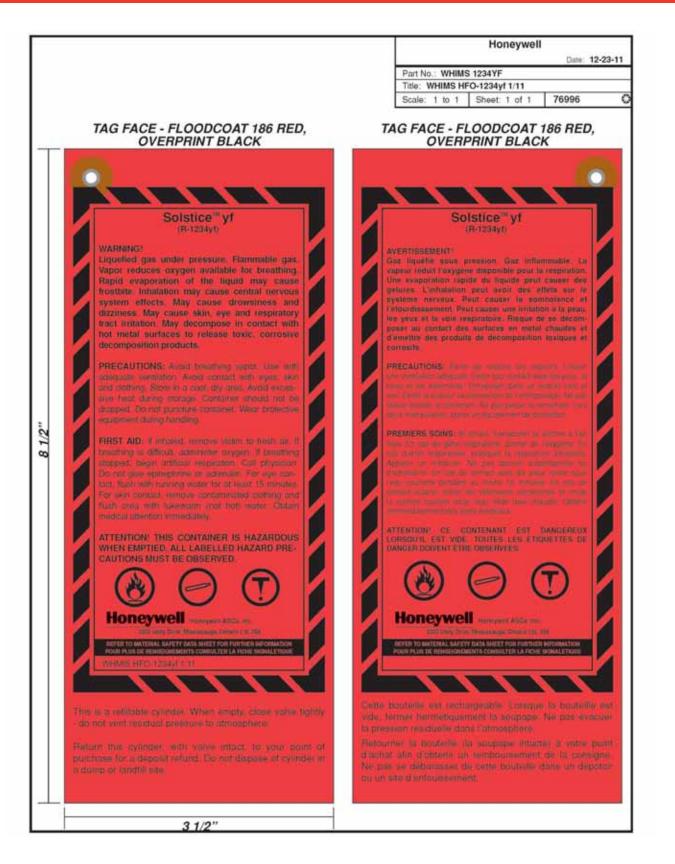




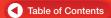
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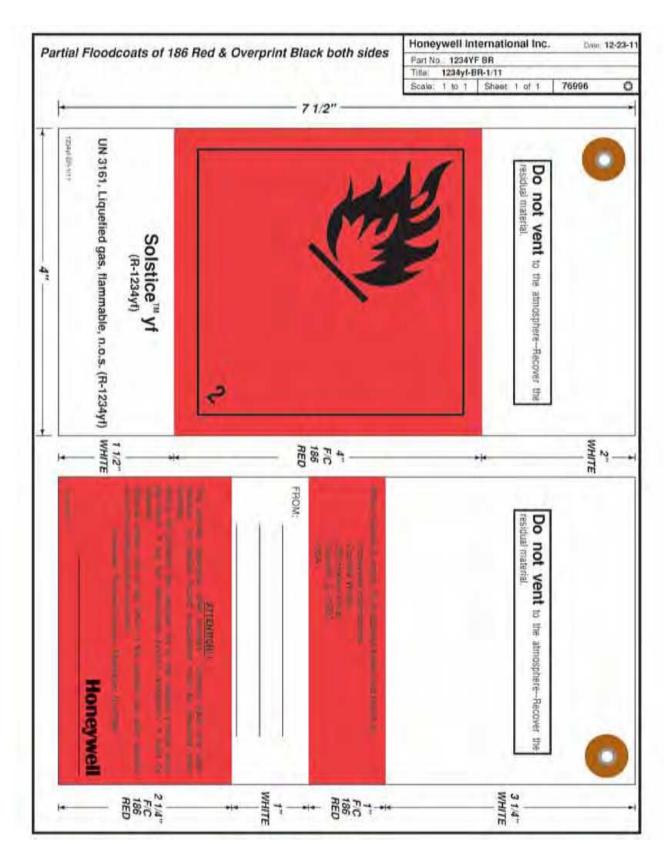
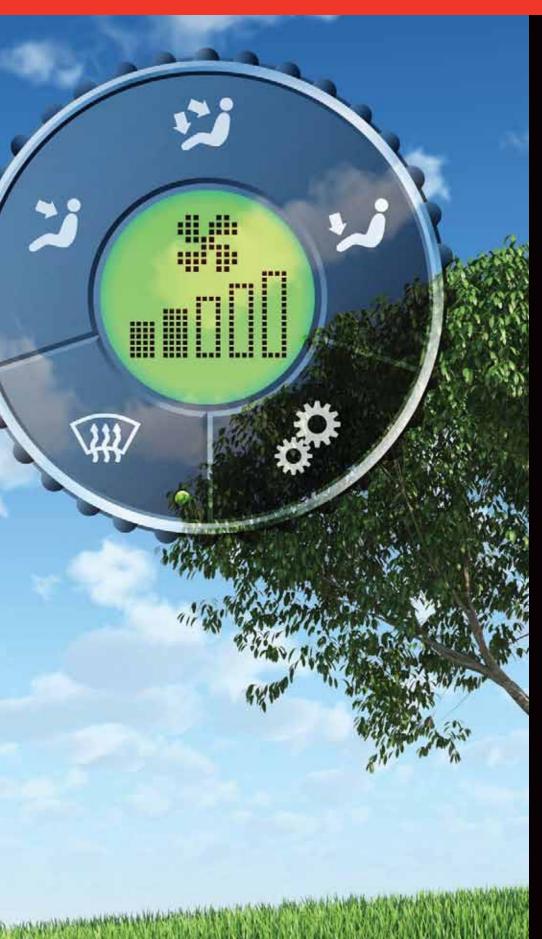


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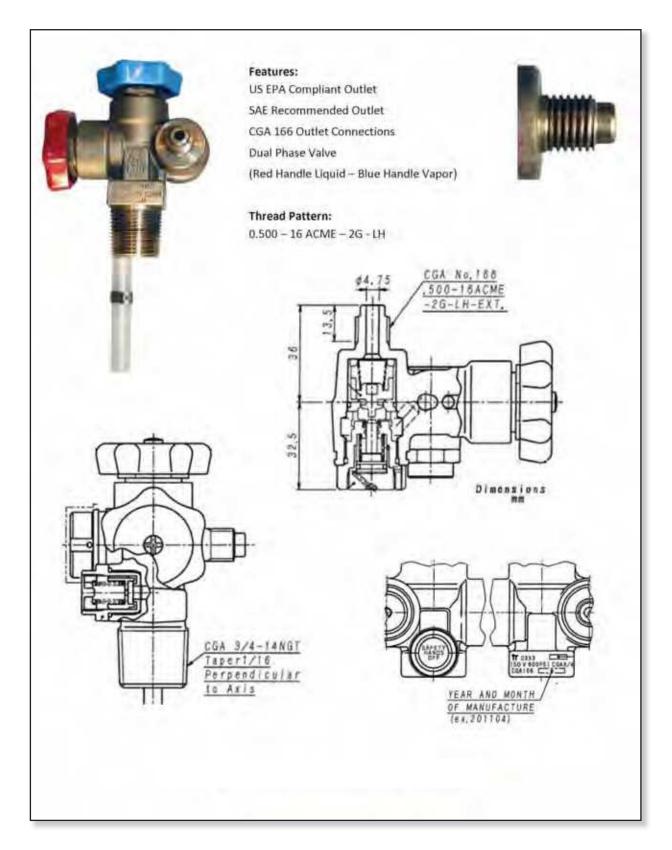


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CGA 166 Valve Specification

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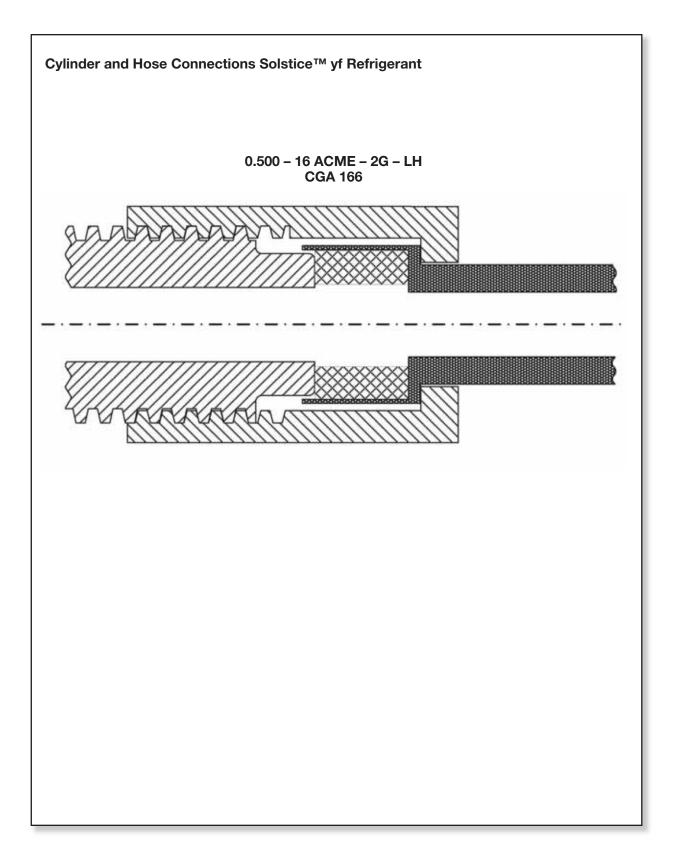




CGA 166 Valve Specification

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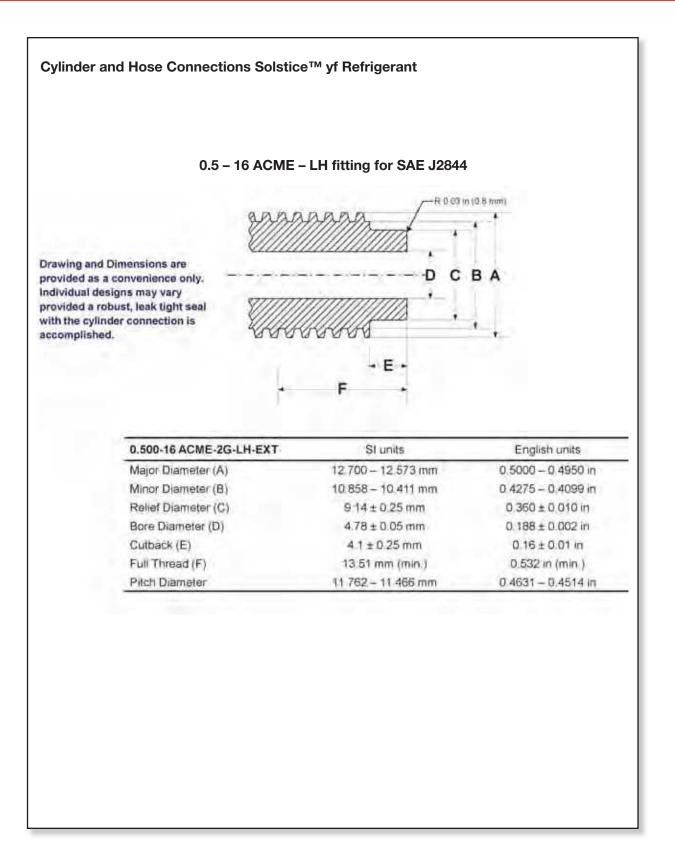




CGA 166 Valve Specification

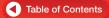
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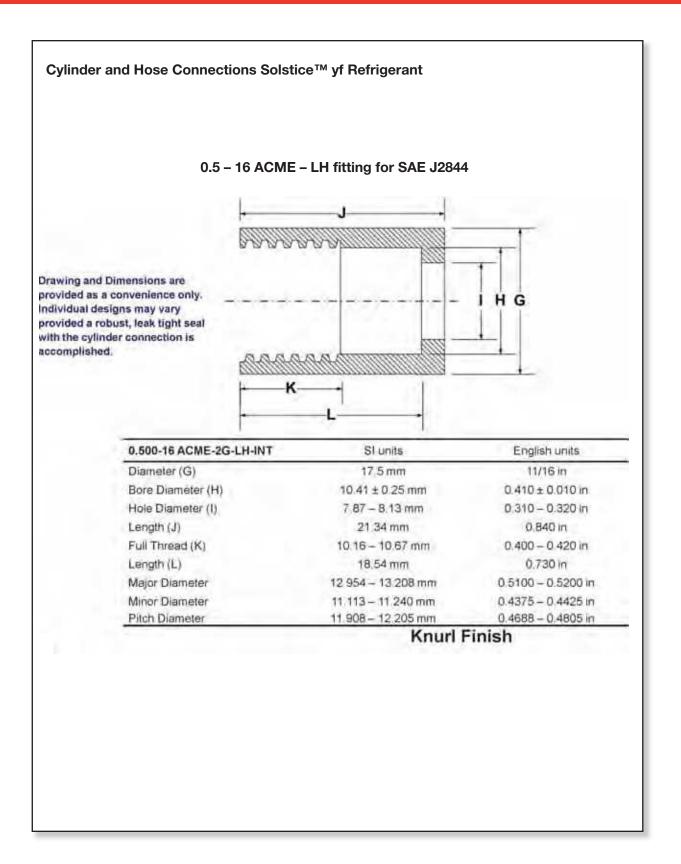




CGA 166 Valve Specification



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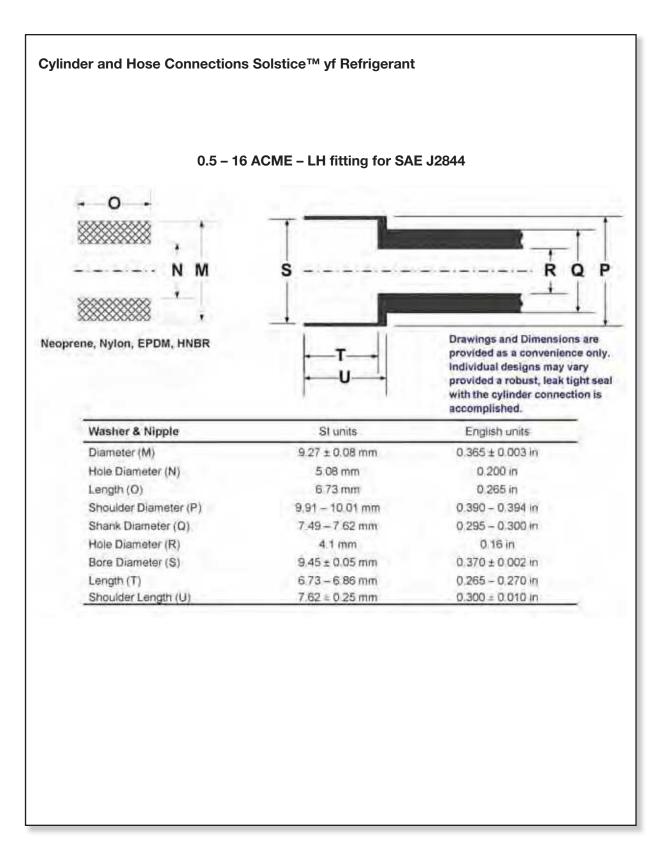




CGA 166 Valve Specification

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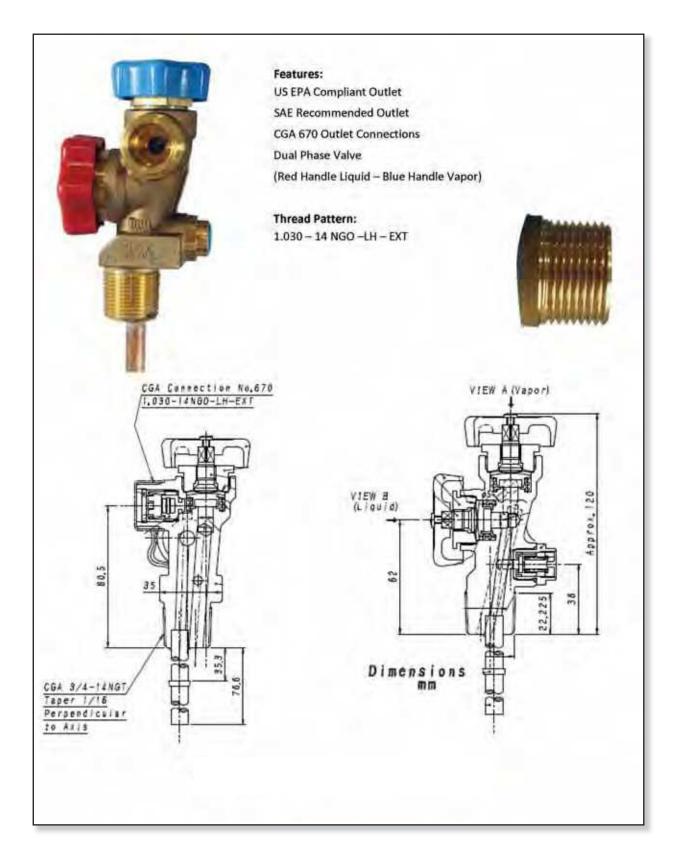


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CGA 670 Valve Specification

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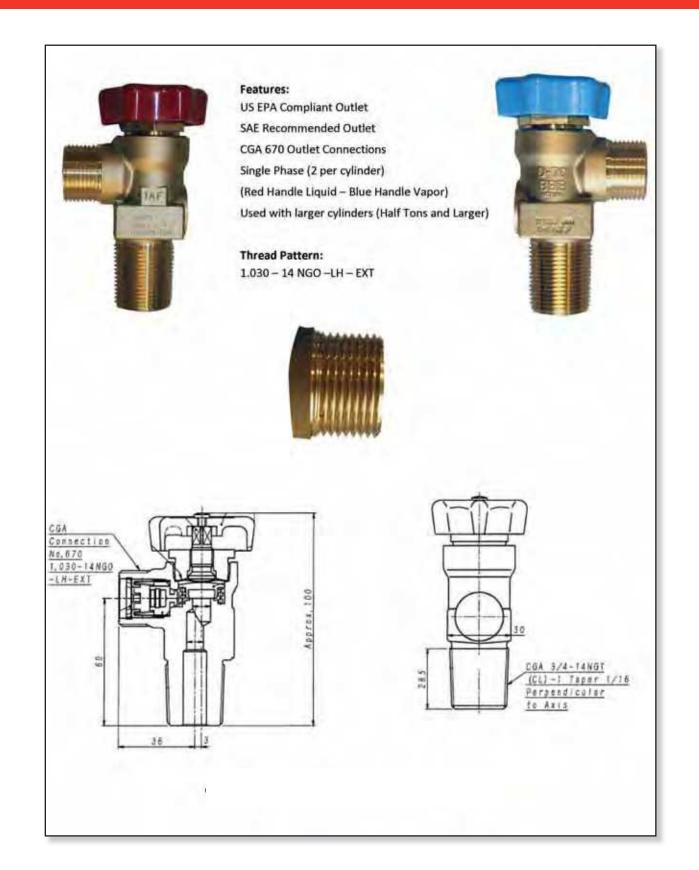
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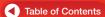


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CGA 670 Single Phase Valve Specification

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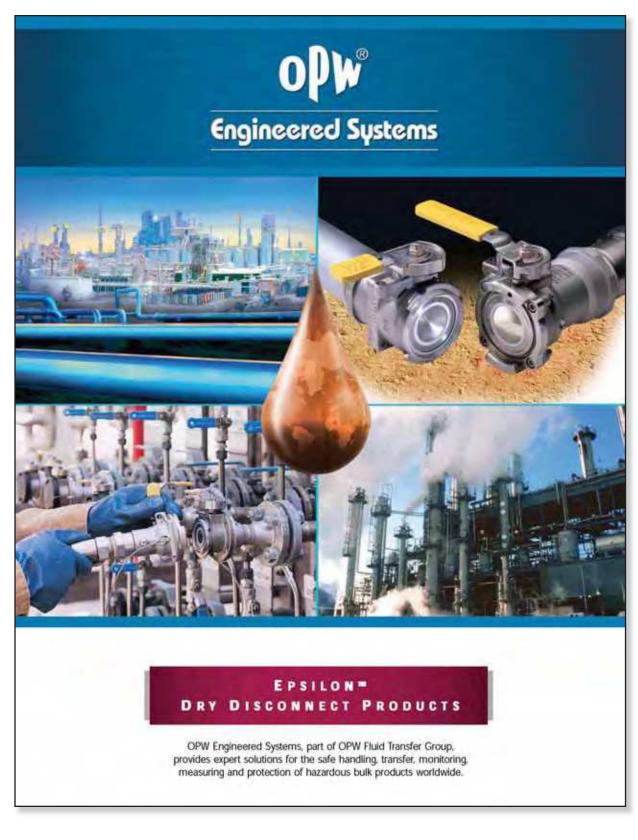


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Epsilon Valves (Skid Pump Connections)



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THE EPSILON' COUPLING -

OPW Engineered Systems offers the most comprehensive line of dry disconnect products in the industry. OPW's line of dry disconnects include Drylok[™], Kamvalok® and Epsilon[™], all suitable for a broad range of hazardous liquid applications.

OVERVIEW

KAMVALOK[®]

OPW Karnvalok* dry disconnect couplings are considered the standard of the industry. Used at liquid transfer points where product loss could occur, OPW Karnvaloks* provide a reliable solution to prevent spillage during connection or disconnection.

OPW Karrvalok" dry disconnect couplings are used by manufacturers of paint, lacquers, inks, adhesives, fatty acids, pharmaceuticals, liquid soaps and many other liquid products. They are particularly well suited for handling petroleum products, solvents, ag-chemicals, vegetable oils, detergents and many acids and caustics.

DRYLOK"

Drylok" is designed to safely transfer hazardous corrosive, volatile liquids such as acids, solvents and petrochemicals. An interlocking handle averts accidental spills by preventing uncoupling while the valve is open. And, the unit's flat face minimizes fluid loss, further reducing exposure to risk during operation. Drylok" is ideal for all kinds of hazardous fluids where product loss is a problem, such as high-pressure lines, high flow rates, sturries and gases.

EPSILON"

The EPSILON[®] Coupling System is designed to prevent chemical spills and reduce fugitive emissions of Volatile Organic Compounds (VOC's), particularly in the process facility and during transfer to and from truck tanks and railroad tank cars. During in-plant chemical transfers, the EPSILON[®] Chemical Containment System will provide your plant with process flexibility while improving operator safety, enhancing environmental compliance and reducing overall capital expenditures and operating costs.

EPSILON[®] is a low spill coupling, based on a double ball valve system integrating a sophisticated safety design in sizes of 1[°], 2[°] and 3[°]. The design is constructed to handle a pressure of 435 psi (30 Bar) and temperature up to 450°F (230°C) and is available with end connections complying to ANSI and DIN standards.

All wetted materials are 316/316L stainless steel (1.4401/1.4404) with TFM or PFA seals. Hastelloy" C is also available for use with more aggressive fluids.

Beyond the common advantages of a ball valve design, EPSILON[™] provides for flow through an unrestricted flowpath and double shut off reliability in the coupling connection.



Manifold station with EPSILONTM adapters.

SAFETY:

EPSILON^{*} coupling is equipped with safety interlocks, which force the valves to open and close only with a deliberate action, preventing accidental opening of the valve.

ENVIRONMENT:

EPSILON" is a low spill system, specified to less than 1 ml spillage for the 2" coupling (2000 cycles test average 0.6 ml) and less than 0.7 ml for the 1" coupling.

MAINTENANCE:

EPSILON" was not only engineered for easy operations, but also for quick replacement of the transfer seal without any lockout. No special tools are required for replacement of seals.

MPORTANT: CPW products should be used in compliance with applicable federal, state, provincial, and local laws and regulations. Product selection should be tasked on physical specifications and limitations and compatibility with the exvironment and materials to be handled. OPW MAKES NO WARRANTY OF FITNESS FOR A MARTICULAR USE All flustrations and specifications in the literature are based on the later product information available at the time of publication. OPW reserves the right to make strangest and prime to prior, materials, specifications and mathet and to discontinue models without notice or obligation.



Epsilon Valves (Skid Pump Connections)

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SI.	-	-	End			onsiona			
No.	Type COUPLER HALF, NPT	1º.	Connection	A.7	3.6	C 4.2	45	E 2.7	3
		1"	1*	4.7	3.6	4.2	4.5	2.7	3
		2	13/2*	7.0	5.6	5.3	5.2	2.9	4
		2	2	70	5.6	5.3	5.2	2.9	4
	H. H. Joseff	37	3,	9.6	7.5	8.1	7,4	4.4	5
2	ADAPTER HALF NPT	1"	3/4"	4.5	3.6	3.3	4.3	2.7	2
	Constant Automatical Constant	1.	10	4.5	3.6	3.3	4.3	2.7	2
		2"	110°	4.8	3.6	3.8	4.6	2.9	3.
		2"	2'	4.8	3.6	3.8	4.6	2.9	3.
	1 10 10 10 1	3"	3-	9.5	7.5	5.5	72	4.4	4.
a	COUPLER HALF, FLANGED 150 LBS ANSI	1.	3/4"	4.7	3.6	5.8	4.6	27	2
1	E	¥-	17	4.7	3,6	5.8	4.8	2.7	2
	I The	2"	1 1/2*	7.0	5.6	6.8	7.2	4.7	4.
		2"	2.	7.0	5.6	6.8	7.7	4.7	4.
		3'	3*	9.6	7.5	10.8	8.2	4.4	5.
	ADAPTER HALF, FLANGED 150 LBS ANSI	р	244	4.5	3.6	5.4	4.6	27	3,
		P.	1"	4.5	3.6	5.4	4.8	2.7	3,
		2"	1.1/2*	4.8	3.6	6.3	5.4	2.9	3.
	4 - 10	2"	2	4.8	3.6	6.3	6.0	2.9	3.
-		3"	3.	9.5	75	8.2	8.9	5.2	4)
6	COUPLER HALF, BUTT WELD SHEDULE 40	17	3/10	4.5	3.6	6.9	4.3	2.7	3.
	F	1.	14	4.5	3.6	6.3	4.3	2.7	3.
		2"	1 1/2*	4.8	3,6	6.8	4.6	2.9	3
	i Lateri	2"	2*	4.8	3,6	6,8	4.6	2.9	3,
		3"	3.	9.5	75	8.5	7,4	4,4	4
	ADAPTER HALF, BUTT WELD SHEDULE 40	1"	3/4'	4,5	3.6	6.3	4.3	2.7	3.
		4.	17	4.5	3.6	6.3	4.3	2.7	3.
		2"	1.1/2*	4.8	3,6	6.8	4.6	2.9	3,
		2"	2*	4.8	3.6	6.8	4.6	2.9	3.
	t the first	3"	3.	9.5	7.5	8.5	7.4	4.4	4.

Epsilon Valves (Skid Pump Connections)

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91.			End		Din	ension	I Data	- mm	
No.	Туре	Sizo	Connection	•	(8)	C	D	٤	F
.7	COUPLER HALF, BSP	1.	G 3/4"	119	91	107	114	69	8
		1*	G 1*	119	91	107	114	69	8
		2"	G 1 1/2*	178	142	135	132	74	10
	i lille j	2'	G 2"	178	142	135	132	74	10
		3.	G 3"	244	191	206	188	112	11
	ADAPTER HALF, BSP	17	G 3/4"	114	91	84	109	69	6
	47	G 1*	114	91	84	109	69	6	
	2"	G 1 1/z*	122	91	97	117	74	8	
		2*	G 2"	122	91	97	117	74	8
		3*	63'	241	191	140	183	112	12
-	COUPLER HALF, FLANGED DIN 2833	4+	DN20	142	115	131	152	95	8
	E4	P	DN25	142	115	131	152	95	8
		2"	DN40	180	144	155	202	120	10
		2"	DN50	180	144	155	202	120	10
		3"	DN80	244	191	274	208	112	12
10	ADAPTER HALF. FLANGED DIN 2633	r	DN20	137	115	121	152	95	6
	· · · · 1	1.45	DN25	137	115	121	152	95	6
	1 IT .	2"	DN40	176	144	141	202	120	8
		2'	DN50	176	144	141	202	120	8
	1 - 10 - + P	3*	DN80	241	191	208	226	132	12
-11	COUPLER HALF	11	20	114	91	160	109	69	6
		1.	25	114	91	160	109	69	6
	1 SEE	2	40	122	91	173	117	74	8
		2"	50	122	91	173	117	74	8
	tori to	37	80	241	191	216	188	112	12
12	ADAPTER HALF.	t.	DN20	114	91	160	109	69	6
	WELD END DIN 2559	1.	DN25	114	91	160	109	69	6
		2"	DN40	122	91	173	117	74	8
1		2	DN50	122	91	173	117	74	8
		3"	DN80	a particular		1/253	and the second	112	2
	c	3	DIARO	241	191	216	188	112	12

Epsilon Valves (Skid Pump Connections)

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THE EPSILON' COUPLING

Wetted components are available in either 316 Stainless Steel or Hastelloy*.

Spring Energized and Spring Loaded Teflon® TFM or PFA U-Cup Seals. Each U-Cup Seal is energized with a Hastelloy C276 Slant Colled Spring to provide initial sealing, including reverse pressure (each coupling is rated to full vacuum). With the U-Cup design, load is increased on the sealing surface as internal pressure increases.

TFM

Next generation PTFE with best combination of temperature (ranging from -22°F to 450°F (230°C), sealing, and sliding characteristics.

PFA

Best chemical compatibility, best sealing characteristics (zero fugitive emissions at operator exposable distance*). Will operate in temperatures ranging from -22°F (-30°C) to 250°F (120°C).

WARNING: Due to the variety of chemicals that these couplings may be used to transfer, the user is responsible to verify the compatibility of the coupling body and the seal materials with the chemical being conveyed.

Performance Characteristics

Volum Ster	Sellings	Maximum Ensistemen	Floor Rate GPM (I/min)	99	Max Worklog Pressure put (ber)	Weight Adapte	- Bos (kg) Goophie	-Million	Temp = "F (PG) Mex PF4	MALTIM
1-irsch	x0.7 ml	<25 ppm	50 (189)	42	435 (30)	2.7 (1.2)	3.0 (1.4)	-224F (-304C)	250 (121)	450 (230)
2-indt	(m 8.0>	<25 ppm	160 (668)	160	435 (30)	4.0 (1.8)	8.0 (2.7)	-22°F (-30°C)	250 (121)	450 (230)
3-inth	-2 mi	<25 ppm	305 (1135)	240	360 (25)	16.0 (7.3)	19.0 (8.6)	-22"F1-30"C)	250 (121)	450 (230)

The features of the EPSILON[®] dry disconnect coupling are extensive. Chart 1 below provides the specifics of these features.

- Flow rates from 50 GPM for the 1" to 300 GPM for the 3" product line. This coupling will keep up with demand, whatever your application.
- Flow coefficient (Cv) for valves. Flow rate shown in gallons per minute of 70°F water with1.0 psi, pressure drop across the valve, 2°coupling features (Cv) of 160.
- Fugitive emissions of less than 25 ppm, is standard. In most cases, it is below the limit of analytical detection.

Valve Size

EPSILON^{*} couplings can be attached to hose or pipe sizes ranging from 3/4" to 3" or DN 20 to DN 80. There are three different valve body sizes that are machined to accept the different sizes and different connection types. Chart 2 indicates the valve body size that would be used with a given port size.

Pressure Drop vs. Flow 1", 2" & 3" EPSILON"* Coupling Flow vs. Pressure Drop - 70" F Water

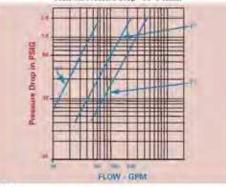


Chart 1

Metvie Mizer	Port Size
1-inch	3/4", 1", DN 20 or DN 26 Part
2-indr	1-1/2", 2", DN 40 or DN 50 Port
3-inch	3" or DN 80 Part

Chart 2

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Flange Connection Interfaces

Ramped lug and flange interfaces are first aligned and then connected with a push, followed by a guarter (90°) turn. This "instant" connection method is done by hand without tools in order to create compression on the critical interface seal.

Concave/Convex

Full-Flow Shut-Off Valve

A convex ball nests in a concave ball to virtually eliminate any cavity between the mating halves. The positive shutoff ball valves, and the absence of a cavity between them, minimize chemical loss when the coupling is disconnected. Each half is an independently operated, positive shut-off ball valve that is controlled by manually rotating the valve handles. The straight-through EPSILON" valve design also provides unrestricted, high flow in either direction and low pressure drop. All metal wetted components are 316 stainless steel or Hastelloy".

Independent and Redundant Safety Interlocks

EPSILON" technology involves five independent and redundant mechanical interlocks. They require deliberate sequential action by users, thereby eliminating unintentional spills and catastrophic chemical releases that threaten worker safety and the environment.



Spring-Energized and Spring-Loaded Tellon" U-Cup Sealing

A spring-energized stem and face and flange seal provide initial sealing. The spring supplies all the load required for sealing when the media pressure is too low to fully actuate the lips of the seal. Testing confirms the ultra-low spillage and emission specifications are still achieved after 2,000 cycles.



Ultra Low Spill Face Seal

This seal reduces the amount of spillage at disconnect to .2 cc. This seal is not pressure assisted and should only be used for applications lower than 100 psi.

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ADDITIONAL FEATURES AND BENEFITS



Cavity Filled

Designed to reduce the possibility of contamination by entrapment of process fluid in the void normally found behind the ball and the valve body. Ideal for applications where cross-contamination and cleanliness is a concern. Back side of the valve balls are bored for efficient cleaning.





Polyethylene Dust Cap Used to protect the ball from damage and debris when coupling is closed and disconnected.



Stainless Steel Pressure Cap

Used to increase the level of safety when coupling is closed, disconnected and under operating pressure.

**National Emission Standards for Hazardous Air Pollutants

Transportation Coupling System (TCS)

Specially designed for railcar, truck, isotainer or tote equipment used in transporting chemicals safely. Contact us for more information.



Keyed Couplings

For extremely critical operations, EPSILON^{*} offers the unique Keyed interface which locks out and isolates transfer lines, preventing cross-contamination.

Designed for Maintainability

OPW Engineered Systems' EPSILON[®] designs allows for easy maintenance. Seals, stems and bearings can be replaced easily to keep the connections performing like new.

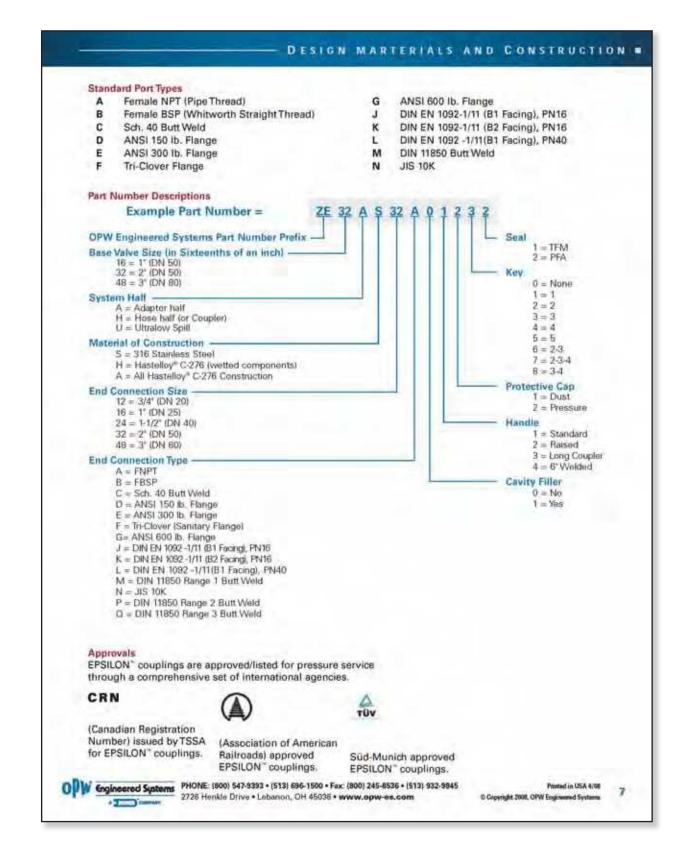
Engineered Systems PHONE: (800) 547-9393 • (513) 696-1500 • Fax: (800) 245-8536 • (513) 932-9845 2726 Henkle Drive • Lebanon, OH 45036 • www.opw-es.com

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ISO 13341:2010(E)

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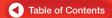


Fitting of Valves to Gas Cylinders (ISO Standard 13341)

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ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization. International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2. The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as are International Standard requires approval by at least 75 % of the member bodies casting a vote. Attention is drawn to the possibility that some of the elements of this document may be the subject of paten rights. ISO shall not be held responsible for identifying any or all such patent rights. ISO 13341 was prepared by Technical Committee ISO/TC 58, <i>Gas cylinders</i> . This second edition cancels and replaces the first edition (ISO 13341:1997), which has been technically
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Fitting of Valves to Gas Cylinders (ISO Standard 13341)

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INTERNATIONAL STANDARD	ISO 13341:2010(E
Gas cylinders — Fitting of valves to g	as cylinders
1 Scope	
This International Standard specifies the procedures to be follo cylinders. It specifically applies to all valve and cylinder combi specified in ISO 10920 and ISO 11363-1. It defines routines for both taper and parallel screw threads.	nations connected with ISO screw threads a
Torque values are given in Annex A for steel and aluminium ga steel or aluminium boss.	as cylinders including composite cylinders with
NOTE The procedures and practices specified in this International to cylinder screw thread connection systems. ISO/TR 11364 ^[4] lists the gives details of the thread identification codes, whether the threads are procedure and torque values specified in this International Standard or for the method and torque for all listed inlet threads, which are not inter-	e valve to gas cylinder threads in use worldwide. I e interchangeable with ISO threads and if the tapin can be used. ISO/TR 11364 ^[4] gives clear guidance
2 Normative references	
The following referenced documents are indispensable for t references, only the edition cited applies. For undated refe document (including any amendments) applies.	
ISO 11114-2, Transportable gas cylinders — Compatibility contents — Part 2: Non-metallic materials	of cylinder and valve materials with ga
ISO 11119-2, Gas cylinders of composite construction — Sp wrapped fibre reinforced composite gas cylinders with load-shar	
ISO 11119-3, Gas cylinders of composite construction — Sp wrapped fibre reinforced composite gas cylinders with non-load-	
ISO 15245-1, Gas cylinders — Parallel threads for connect Specification	ction of valves to gas cylinders — Part 1
3 General requirements and recommendations	
Gas cylinders and valves shall be connected so that when in u cannot be removed inadvertently from the cylinder.	use the combination is gas tight and the valve
The tools used to screw the valve into the gas cylinder shall fit to secured against rotation during the torquing process. The tools the cylinder. Minor marks to the valve and the cylinder are access shall be aligned.	shall not cause damage to either the valve of
In addition, some composite cylinders need special treatment t neck/metal boss during torquing.	for the valving process, for example fixing the
Any special instructions given by the cylinder manufacturer shall	l be followed.



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Sealing materials used between the valve stem and cylinder neck threads shall be compatible with the gas to be contained in the cylinder (e.g. oxygen), in accordance with ISO 11114-2.

Except as described in 7.3, the torque applied to the valve shall be within the relevant range given in Annex A. Valve manufacturers shall make available instructions if their specific recommendations regarding their product differ from those included in this International Standard (e.g. if their maximum torque recommendation is less than the maximum allowed in the relevant range included in Annex A).

For all threads, the maximum level of torque should not be exceeded as this will give rise to a high stress in the valve stem and/or cylinder neck.

Care shall be taken with aluminium alloy cylinders, for which valving torques are lower than for steel cylinders. Aluminium alloy cylinders shall not be valved at temperatures above ambient because, on cooling, differential contraction between the cylinder and the valve will give rise to a high stress in the cylinder neck.

High difference of temperature between cylinder neck and valve should be avoided. Some valve designs can be unsuitable to be valved at elevated temperatures (e.g. above 65 °C).

All tools and equipment used for valving cylinders shall be periodically validated for accuracy. Accuracy shall be established by measuring the torque applied to the valve of a valved cylinder as indicated in 5.4.3 for taper threads and in 6.5 for parallel threads.

NOTE Some machine tools rely on the friction between the valve and gas cylinder threads to stop the machine turning once the correct torque has been reached. For fast running machines, the inertia to be absorbed before the machine stops can result in valving torques being in practice far higher than the machine set point.

4 Preparation

4.1 Each valve and cylinder thread shall be examined to ensure that they are to the same dimensional standard, for example ISO 11363-1 or ISO 15245-1.

NOTE 1 Equivalent dimensional standards will make up the subject of the future ISO/TR 11364.

NOTE 2 Some standards require that valve and cylinder threads be identified by marking (e.g. ISO 10297 and ISO 13769).

4.2 The valve and cylinder threads shall be visually inspected for integrity and, where applicable, for damaged O-ring sealing surfaces. In particular, when valving aluminium alloy cylinders, the bottom threads on the stem of valves and the lower threads within the cylinder neck shall be fully formed at the root of the thread and free from ragged edges or burs. Similar care is required when fitting stainless steel valves to all cylinders. Acceptance criteria for used valves are given in ISO 22434.

4.3 Threads and sealing surface on both valve and cylinder shall be checked for cleanliness. Any remnants of old PTFE sealing tape or other sealants, paints and other contaminants shall be completely removed. Care should be taken to prevent any debris falling into the cylinder. Depending on the gas service and application, before fitting the valve, it shall be ensured that the internal surface of the cylinder is clean and dry.

4.4 The top face of the cylinder, where a parallel thread is used, shall be free of paint, debris or other contamination so that the valve flange can rest directly on it when the cylinder has been valved.

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	ISO 13341:2010(E
5 Va	lving procedure for taper threaded valves
5.1 (General
with 5.3	sealing can be achieved using sealant tape in accordance with 5.2 or soft metal caps in accordance. Atternative sealing methods may be used, for example paste (see Annex B) or PTFE caps (in whic fer to the manufacturer's instructions).
5.2 V	Vrapping with sealant tape
5.2.1 shall be	Wrapping of the valve stem with tape shall commence at the small end of the taper; the sealant tap wound clockwise when looking from the base of the valve.
3 mm a Tape s top the	Wrapping shall be such that it protrudes beyond the small end of the valve stem by a maximum of ind a minimum of 1 mm. At the small end, there shall be a minimum of three layers of tape (see 5.2.5 hall then be overlapped during wrapping to give an even double thickness all the way up to include the ead of the valve stem. The number of layers may be adjusted depending on thickness of tape ive tape thickness may increase the stress or push the tape out.
5.2.3	The tape shall not be excessively stretched during wrapping and shall be carefully torn or cut.
5.2.4	Tape shall be carefully worked into the valve thread profile.
Adhere	nce between the tape and the valve stern thread form should be established.
	Roll back the tape which protrudes beyond the bottom of the valve stem to leave the bottom face of we stem clear of tape; this will result in a doubling of the layers of tape covering the first valve ster at the small end. The valve shall then be fitted to the cylinder by hand prior to torquing.
5.3 A	pplication of soft metal caps
5.3.1	Soft metal caps containing lead shall not be used with aluminium alloy cylinders.
5.3.2	The soft metal cap used shall be of the correct size.
5.3.3 with a s valve is	After the cap is pulled over the valve stem, it shall be carefully worked into the valve thread profil suitable tool or a leather glove, to prevent the bottom end of the soft metal cap being cut off when th fitted.
5.3.4	Valves shall be fitted to the cylinder by hand prior to torquing.
5.4 \	alve torquing
5.4.1 threads	After the valve has been screwed in by hand as far as possible and after making sure that sufficier are engaged, a properly fitting tool shall be used to tighten the valve into the cylinder (see Clause 3).
5.4.2	For threads according to ISO 11363-1, the torque applied shall be as specified in Annex A.
	To validate the torque that was applied for fitting, the value shall be measured by further tightening th The minimum value obtained to move the valve shall be within the limits of Annex A. A proper ed torque wrench shall be used.
should	If curing type of sealant fluid is used, the method described above is not applicable. A specific metho be validated and applied because anaerobic pastes solidify very quickly when the valve is fitted at the id torque.
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6 Valving procedure for parallel threaded valves

6.1 An O-ring seal dimensionally in conformance with ISO 15245-1 and compatible with the gas in service (see ISO 11114-2) shall be placed onto the valve stem. It shall be correctly positioned in the sealing area and shall not be damaged during placement.

6.2 No lubricant, sealant or tape shall be applied to the threads.

6.3 With the cylinder secured against rotation, the valve shall be fitted by hand paying particular attention to prevention of damage to the O-ring as it is engaged into the cylinder sealing area.

6.4 Once the valve has been screwed in by hand as far as possible, a properly fitting tool shall be used to apply the torque specified in Annex A.

6.5 To validate the torque that was applied for fitting, the value shall be measured by unscrewing the valve. The minimum value obtained to move the valve shall be within the limits specified in Annex A. The checked valve/cylinder assembly shall be retorqued properly after this procedure.

A calibrated torque wrench shall be used.

7 Procedure for achieving valve alignment for cylinders with fixed (e.g. welded) shroud and taper threads

7.1 The valve shall be inserted as specified in Clause 5.

7.2 Torque the valve to the minimum value, as indicated in the appropriate table, given in Annex A.

7.3 If necessary, screw the valve in further to achieve alignment of the valve outlet with the shroud opening. Do not in any case partially unscrew the valve.

NOTE Once the minimum torque in the range given in Annex A has been achieved, further rotation to align the valve should ideally continue at a lower speed without stopping; this is particularly important if a curing paste or fluid is used.

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Annex A (normative)

Valving torques for threads in accordance with ISO 11363-1 and ISO 15245-1

A.1 General

This annex applies to valves made from conventional material, e.g. stainless and carbon steels and brass.

The torque values given in this annex are based on the recommendations of gas cylinder and valve manufacturers. Many years of experience have proven that they are safe, give gas tight connections and are reliable for the full retest period.

However, for special valves (e.g. some valves with integrated pressure regulators) or special cylinders (e.g. composite cylinders with plastic liner or without liner), the manufacturers may specify reduced torque values (even below the minimum values given in this annex) that shall be applied (see Clause 3). In such a case the torque range values shall be identified by marking the cylinder in accordance with ISO 11119-2 and ISO 11119-3 and by issuing of installation instructions by the valve manufacturers. In case of doubt the manufacturer shall be consulted.

A.2 Valving torques for seamless steel cylinders and composite cylinders with steel boss

Table A.1 — Taper threads according to ISO 11363-1

Taper valve stem size	Torque Nm		
	Minimum ^a	Maximum ^o	
17E	120	150	
25E	200	300	
NOTE Users should be aware that use ^a All values shall be reduced to 2/3 of th		sibility of valve stem thread deformation eel valves.	

Table A.2 - Parallel threads according to ISO 15245-1

Parallel valve stem size		rque Im
	Minimum	Maximum
M18	100	130
M25	100	130
M30	100	130

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A.3 Valving torques for aluminium alloy cylinders and composite cylinders with aluminium alloy boss

Table A.3 - Taper threads according to ISO 11363-1

	Torque Nm			
Taper valve stem size		Maximum		
	Minimum	Without cylinder neck reinforcement	With cylinder neck reinforcement	
17E	75	95	140	
25E	95	110	180	

NOTE A method to reduce tensile stress in the cylinder neck is by a shrunk-on-neck-ring reinforcement (this puts the neck into compression). Material for the neck ring should be chosen with care to ensure compatibility with the cylinder material, e.g. to avoid galvanic corrosion. This method of reducing local tensile stresses should be done by the manufacturer or with the manufacturer's guidance. It might be difficult to distinguish between a simple neck ring and a neck ring providing neck reinforcement; in case of doubt consult the cylinder manufacturer or use the lower maximum value.

Table A.4 — Parallel threads according to ISO 15245-1

Parallel valve stem size		rque Im
	Minimum	Maximum
M18	85	100
M25	95	130
M30	95	130

A.4 Valving torques for welded steel cylinders

Table A.5 - Taper threads according to ISO 11363-1

Taper valve stem size		Torque Nm	
	Minimum	Maximum	
17E	90	150 (120 ^a , 130 ^b)	
25E	110	300 (200 ⁴ , 250 ^b)	
NOTE Users should be aware t	that use of high torque levels gives the po	ssibility of stem thread deformation	
Reduced values for stainless sl Reduced values for dedicated l	teel. LPG valves in accordance with ISO 14245	and ISO 15995	

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Annex B (informative)

Application of paste as sealant

B.1 General

For some applications, for example refrigerant gases, an anaerobic paste is generally used. During tightening, the paste sticks very quickly. If the protection of the valve on the cylinder is a shield, it is necessary to angle the valve after tightening in order to put the connection just in front of the opening of the shield.

B.2 Proposed procedure

Apply the paste on the first thread of the valve, then fit the valve to the cylinder one turn by hand; the operator continues to apply paste at the base of the thread with each rotation of the valve by hand, and the valve is then fitted at a specific torque on the valving machine. This method makes it possible to avoid introducing paste inside the cylinder.

Anaerobic pastes stick very quickly when the valve is fitted at the specified torque. Apply specific procedures as recommended by the manufacturers of the cylinder, the valve and the paste.

After fitting the valve at the specified torque, it can be necessary to angle the valve after tightening. At that time the torque can be substantially greater than the applied torque. In such cases the specified torque must be regulated with a lower value. Apply specific procedures as recommended by the manufacturers of the cylinder, the valve and the paste.

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	Bibliography
[1]	ISO 10297, Transportable gas cylinders — Cylinder valves — Specification and type testing
[2]	ISO 10920, Gas cylinders — 25E taper thread for connection of valves to gas cylinders — Specification
[3]	ISO 11363-1, Gas cylinders — 17E and 25E taper threads for connection of valves to gas cylinders — Part 1: Specifications
[4]	ISO/TR 11364 ¹⁾ , Gas Cylinders — Compilation of national and international valve stem/gas cylinder neck threads and their identification and marking system
[5]	ISO 13769, Gas cylinders — Stamp marking
[6]	ISO 14245, Gas cylinders — Specifications and testing of LPG cylinder valves — Self-closing
[7]	ISO 15995, Gas cylinders — Specifications and testing of LPG cylinder valves — Manually operated
[8]	ISO 22434, Transportable gas cylinders — Inspection and maintenance of cylinder valves
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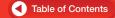
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Part 6 Regulatory Information





Transportation Regulation of Hazardous Materials



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Transportation regulation of hazardous materials

For information on transportation of hazardous materials by highway, rail, vessel, and air, please contact Travis Williams.

Travis Williams Honeywell International Inc Conversion Manager (225) 405-1865 travis.williams2@honeywell.com

To download The Code of Federal Regulation (CFR) please visit the US government website http://www.phmsa.dot.gov/hazmat/regs.

The regulations for gases are not all located in one section. The Hazardous Material Regulation (HMR) are in Subchapter C, Parts 171, 172, 173, 174, 175, 176, 177, and 178 non-bulk packaging. Parts 172, 173, and 178 are the most referenced.





US EPA SNAP Final Rule EPA-HQ-OAR-2008-0664 2011-6268

Doc Number: HFO-1234yf

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1 17488

Federal Register/Vol. 76, No. 60/Tuesday, March 29, 2011/Rules and Regulations

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 82

[EPA-HQ-OAR-2008-0664; FRL-9275-8] RIN 2060-AP11

Protection of Stratospheric Ozone: New Substitute in the Motor Vehicle Air **Conditioning Sector Under the** Significant New Alternatives Policy (SNAP) Program

AGENCY: Environmental Protection Agency (RPA). ACTION: Final rule.

SUMMARY: The Environmental Protection. Agency's (EPA) Significant New Alternatives Policy (SNAP) program is expanding the list of acceptable substitutes for use in the motor vehicle. air conditioning end-use as a replacement for oxone-depleting substances. The Clean Air Act requires-EPA to review alternatives for ozonedepleting substances and to disapprove substitutes that present overall risks for human health and the environment more significant than these presented by other alternatives that are available or potentially available. The substitute addressed in this final rule is for use in now passenger cars and light-duty trucks in the motor vehicle air conditioning end-use within the refrigeration and air conditioning sector. EPA finds hydrofluoroolefin (HFO)-1234yFacceptable, subject to use conditions, as a substitute for chlorofluorocarbon (CFC)-12 in motor vehicle air conditioning for new passenger cars and light-duty trucks. The substitute is a non-ozone-depleting gas and consequently does not contribute to stratespheric ozone depletion.

DATES: This final role is effective on May 31, 2011. The incorporation by reference of certain publications listed. in the rule is approved by the Director of the Federal Register as of May 31. 2011.

ADDRESSES: EPA has established a docket for this action under Docket 10 No. EPA-HQ-OAR-2008-0664. All documents in the docket are listed on the http://www.cegulations.gov.Web site, Although listed in the index, some information is not publicly available.

... confidential business information (CB) or other information whose disclosure is restricted by statute Certain other material, such as copyrighted material, is not placed on the Internet and will be publicly available only in hard copy form. Publicly available docket materials are wailable either electronically through http://www.zogulations.gov.or.in.hard copy at the Air Docket, EPA/DC, EPA West, Room 3334, 1303 Constitution Ave., NW., Washington, DC, This Docket Facility is open from 6:30 a.m. to 4:30 p.m., Monday through Friday, excluding legal holidays. The telephone number for the Public Reading Room is (202) 566-1744, and the telephone number for the Air Docket is (202) 566-1742.

FOR FURTHER INFORMATION CONTACT:

Margaret Sheppard, Stratospheric Protection Division, Office of Atmospheric Programs; Environmental Protection Agency, Mail Code 62051, 1200 Pennsylvania Avenue, NW., Washington, DC 20460; telephone number (202) 343-9163, fax number, (202) 343-2338; e-mail address at shoppard margaretterpit.gov.

Notices and rulemakings under the SNAP program are available on EPA's Stratospheric Ozone Web site at http:// www.apa.gov/ozone/snap/ regulations.html. The full list of SNAP docisions in all industrial soctors is available at http://www.cpa.gov/orone/snitti

SUPPLEMENTARY INFORMATION: This final rule provides motor vehicle manufacturers and their suppliers an additional refrigerant option for motor vehicla air conditioning (MVAC) systems in new passenger cars and lightduty trucks, HFO-1234yf (2.3.3.3tetrafluoroprop-1-ene), the refrigerant discussed in this final action, is a nonovene-deploting substance.

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- H. Executive Order 13211: Actions That Significantly Afford Unonjy Supply, Distribution, or Use
- 1. National Technology Transfer and Advancement Act.
- Executive Order 12808: Federal Actions To Address Environmental Justics in Minority Populations and Low-Immus-Populations
- K. Compressional Review Act.
- X. References

L Does this action apply to me?

This final rule regulates the uso of the chemical HFO-1234yf (2,3.3.3tetrafluoroprop-t-one, Chemical Abstracts Service Registry Number (CAS Reg. No.1764-12-11 as a refrigerant in new motor vehicle air conditioning (MVAC) systems in new passenger cars and light-duty trucks. Businesses in this und-use that might want to use HFO-1234yFin new MVAC systems in the future include

Automobile manufacturers.

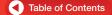
 Manufacturers of motor vehicle air conditioners.

Regulated outities may include:

TABLE 1-POTENTIALLY REGULATED ENTITIES, BY NORTH AMERICAN INDUSTRIAL CLASSIFICATION SYSTEM (NAICS) CODE

Category	NAICS code	Description of regulated entities
Industry Industry		Automobile Manufacturing. Motor Vehicle Air-Conditioning Manufacturing

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US EPA SNAP Final Rule EPA-HQ-OAR-2008-0664 2011-6268

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Federal Register/Vol. 76, No. 60/Tuesday, March 29, 2011/Rules and Regulations

This table is not intended to be exhaustive, but rather a guide regarding entities likely to be regulated by this action. If you have any questions about whether this action applies to a particular entity, consult the person listed in the preceding section, FOR FURTHER INFORMATION CONTACT. II. What abbreviations and acronyms are used in this action?

100-yr-one-hundred year time horizon AEGL—Acute Exposure Guideline Level AIST—the National Institute for Advanced Industrial Science and Technology of Japan ASHRAE—American Society for Heating. Refrigerating, and Air-Conditioning Engineers ATSDR—the U.S. Agency for Toxic Substances and Disease Registry BAM-Bundesanstalt für Materialforschung und-prüfung (German Federal Institute for Materials Research and Testing) CAA-Clean Air Act CAS Reg. No.—Chemical Abstracts Service Registry Number CBI-Confidential Business Information CFC-chlorofluorocarbon CFC-12-the ozone-depleting chemical dichlorodifluoromethane, CAS Reg. No. 75-71-8 *CFD*--Computational Fluid Dynamics *CFR*--Code of Federal Regulations cm/s—centimeters per second CO₂—carbon dioxide, CAS Reg. No. 124–38– 9 CRP-Cooperative Research Program DIN-Deutsches Institut für Normung (designation for standards from the German Institute for Standards) DIY-"do-it-yourself" DOT-the United States Department of Transportation EPA-the United States Environmental Protection Agency EO-Executive Order FMEA-Failure Mode and Effect Analysis FB-Federal Register GWP-Global Warming Potential HF-Hydrogen Fluoride, CAS Reg. No. 7664-39-3 HI-Hazard Index HFC-hydrofluorocarbon HFG-134a-the chemical 1.1.1.2tetrafluoroethane, CAS Reg. No. 811-97-2 HFG-152a—the chemical 1,1-diffuoroethane, CAS Reg. No. 75–37–6 HFO-hydrofluoroolefin HFO-1234yf-the chemical 2.3.3.3tetrafluoroprop-1-ene, CAS Reg. No. 754-12 - 1ISO-International Organization for Standardization JAMA—Japan Automobile Manufacturers Association JAPIA-Japan Auto Parts Industries Association LCA-Lifecycle Analysis LCCP-Lifecycle Climate Performance LFL-Lower Flammability Limit LOAEL-Lowest Observed Adverse Effect Level

mm-millimeter MOE-Margin of Exposure MPa-megapascal MBL-Minimal Risk Level MVAC-Motor Vehicle Air Conditioning NAICS-North American Industrial **Classification System** ng/L-nanograms per liter NHTSA--the U.S. National Highway Traffic Safety Administration NOAEL-No Observed Adverse Effect Level NOEC-No Observed Effect Concentration NPRM-Notice of Proposed Rulemaking NTTAA-National Technology Transfer and Advancement Act ODP-Ozone Depletion Potential ODS-zmOzone-Depleting Substance OEM-Original Equipment Manufacturer OMB-Office of Management and Budget OSHA-the United States Occupational Safety and Health Administration PAG-Polyalkylene Glycol PMN-Pre-Manufacture Notice POCP-Photochemical Ozone Creation Potential POD-Point of Departure ppm-parts per million ppt-parts per trillion psig-pounds per square inch gauge B-1234vf-ASHRAE designation for refrigerant HFO-1234yf B-134a-ASHRAE designation for refrigerant HFC-134a R-1520-ASHRAE designation for refrigerant HFC-152a **B-744**—ASHRAE designation for refrigerant CO. BCRA-the Resource Conservation and Recovery Act RFA—Regulatory Flexibility Act SAE-SAE International, formerly the Society of Automotive Engineer SBA-the United States Small Business Administration SIP-State Implementation Plan SNAP-Significant New Alternatives Policy SNUN-Significant New Use Notice SNUR-Significant New Use Rule SO2-sulfur dioxide, CAS Reg. No. 7446-09-TEWI-Total Equivalent Warming Impact TFA-Triffuoroacetic acid, CF3COOH, also known as trifluoroethanoic acid, CAS Reg. No. 76-05-1 TSCA-the Toxic Substances Control Act TWA-Time-Weighted Average UBA-Umweltbundesamt (German Federal Environment Agency) UF—Uncertainty Factor UMRA—Unfunded Mandates Reform Act VDA-Verband der Automobilindustrie (German Association for the Automobile Industry) VOC-Volatile Organic Compound v/v-volume to volume WEEL-Workplace Environmental Exposure

Limit

III. What is EPA's final decision for HFO-1234yf for motor vehicle air conditioning (MVAC)?

In this final rule, EPA is finding HFO-1234yf acceptable, subject to use conditions, as a substitute for CFC-12 in new MVAC systems for passenger cars and light-duty trucks. This determination does not apply to the use of HPO-1234yf as a conversion or retrofit for existing MVAC systems. In addition, it does not apply to the use of HFO-1234yf in the air conditioning or refrigeration systems of heavy-duty trucks, refrigerated transport, or off-road vehicles such as agricultural or construction equipment.

EPA is not mandating the use of HFO-1234yf or any other alternative for MVAC systems. This final rule is adding HFO-1234yf to the list of acceptable substitutes, subject to use conditions, in new MVAC systems. Automobile manufacturers have the option of using any refrigerant listed as acceptable for this end-use, so long as they meet any applicable use conditions.

⁴ Under this decision, the following enforceable use conditions apply when HFO-1234yf is used in a new MVAC system for passenger cars and light-duty trucks:

 HFO-1234yf MVAC systems must adhere to all of the safety requirements of SAE¹ [639 (adopted 2011), including requirements for a flammable refrigerant warning label, high-pressure compressor cutoff switch and pressure relief devices, and unique fittings. For connections with refrigerant containers of 20 lbs or greater, use fittings consistent with SAE J2844 (adopted 2011).

2. Manufacturers must conduct Failure Mode and Effect Analysis (FMEA) as provided in SAE J1739 (adopted 2009). Manufacturers must keep the FMEA on file for at least three years from the date of creation.

IV. What are the final use conditions and why did EPA finalize these conditions?

Summary of the Use Conditions

The first use condition requires that MVAC systems designed to use HFO-1234yf must meet the requirements of the 2011 version of the industry standard SAE J639, *Safety Standards for Motor Vehicle Refrigerant Vapor Compression Systems." Among other things, this standard sets safety standards that include unique fittings to connect refrigerant containers to the MVAC system; a warning label indicating the refrigerant's identity and indicating that it is a flammable refrigerant; and requirements for engineering design strategies that include a high-pressure compressor cutoff switch and pressure relief devices. This use condition also requires that fittings for refrigerant

³ Designates a standard from SAE International, formerly the Society of Automotive Engineers.

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mg/L-milligram per liter

m/-millijoule

MIB-Maximum Incremental Reactivity



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containers of 20 lbs or greater will be consistent with SAE J2844 (same fittings as for low-side service port in SAE J639).

The second use condition requires the manufacturer of MVAC systems and vehicles (*i.e.*, the original equipment manufacturer [OEM]) to conduct and keep records of a risk assessment and failure Failure Mode and Effects Analysis (FMEA) for at least three years from the date of creation. There is an existing industry standard, SAE J1739, that gives guidance on how to do this. It is standard industry practice to perform the FMEA and to keep it on file while the vehicle is in production and for several years afterwards (U.S. EPA, 2010a).

Reasons for Revised Use Conditions

EPA proposed five use conditions in the Notice of Proposed Rulemaking (NPRM) (October 19, 2009; 74 FR 53445). One use condition required manufacturers to meet all the safety requirements in the standard SAE J639, "Safety Standards for Motor Vehicle Refrigerant Vapor Compression Systems" and required use of unique servicing fittings from that standard. Another use condition required automobile manufacturers to perform Failure Mode and Effect Analysis (FMEA) and to keep records of the FMEA.

The remaining three proposed use conditions specifically addressed risks of flammability of HFO-1234yf and indirectly addressed risks of generating hydrogen fluoride (HF) from combustion of HFO-1234yf. For the first of those proposed use conditions, which addressed the passenger compartment, the concentration of HFO-1234yf was not to exceed the lower flammability limit (LFL) in the free space for more than 15 seconds. For the second proposed use condition, which addressed the engine compartment, the concentration of HFO-1234yf was not to exceed the LFL for any period of time. A third proposed use condition, which also addressed the engine compartment, would have required protective devices, isolation and/or ventilation techniques in areas where there is a potential to generate HFO-1234yf concentrations at or above 6.2% volume to volume (v/v) in proximity to exhaust manifold surfaces and hybrid or electric vehicle electric power sources

EPA based our determination of the appropriate use conditions to include in the final rule using information in the docket at the time of proposal, comments received on the proposed rule, and additional information we have received since the NPRM was

published. We provided additional opportunities for comment on the public comments and additional information we received with them when we re-opened the comment period on the proposed rule (74 FR 68558, December 28, 2009; 75 FR 6338, February 9, 2010). First, SAE International's Cooperative Research Program (hereafter called the SAE CRP) issued a new report on December 17 2009 assessing risks of HFO-1234yf and carbon dioxide (CO2) as refrigerants for MVAC. This report found that the risks of HFO-1234yf were low overall, and somewhat less than risks for another potential alternative refrigerant (CO2, also know as R-744). The December 2009 CRP report found that the greatest risks from HFO-1234yf are likely to come from generation of HF, both from thermal decomposition and from ignition, rather than direct fire risks from ignition of HFO-1234yf (EPA-HQ-OAR-2006-0664-0056.2). (HF is a severe irritant to the skin, eyes, and respiratory system.) The SAE CRP estimates risks of excessive HF exposure at approximately 4.6 × 10⁻¹² occurrences per vehicle operating hour and risks of ignition at approximately 9×10⁻¹⁴ occurrences per vehicle operating hour. These correspond roughly to one occurrence in the entire U.S. fleet of passenger vehicles over 2 years for HF risks and one occurrence in the U.S. vehicle fleet every 100 years for flammability risks.² For comparison, the risk for excessive HF exposure is less than one ten-thousandth the risk of a highway vehicle fire and one fortieth or ss of the risk of a fatality from deployment of an airbag during a vehicle collision (EPA-HQ-OAR-2008-0664-0056.2). Even these estimates may be conservative because they assume that refrigerant could be released in a collision severe enough to rupture the evaporator (under the windshield) while the windshield and windows would remain intact and would prevent ventilation into the passenger cabin in case of a collision (EPA-HQ-OAR-2006-0664-0056.2).

Second, we received a number of public comments regarding the proposed use conditions. Some commenters claimed that the second use condition concerning concentrations in the engine compartment was infeasible because in the event of a leak, there would always be some small volume that would have a concentration over

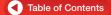
the LFL; these commenters further stated that exceeding the LFL would not necessarily create a risk of ignition, because one could have a leak that is not near a source of heat or flame (EPA-HQ-OAR-2006-0664-0116.2; EPA-HQ-OAR-2006-0664-0060). Some commenters stated that flammability was not a significant risk from use of HFO-1234yf, given the results of the SAE CRP risk assessment (December 17, 2009). These commenters stated that the use conditions limiting refrigerant concentrations were not necessary These commenters also suggested a number of alternative ways of phrasing the use conditions in order to address risks from HF as well as flammability. Most of these comments suggested relying on the performance of a risk assessment and Failure Mode and Effect Analysis (FMEA) consistent with SAE J1739 to determine appropriate protective strategies. Other commenters stated that the use conditions were not sufficiently protective as proposed because of other risks; (1) Risks due to generation of HF from HFO-1234yf, both from thermal decomposition and from combustion; (2) risks from direct toxicity of HFO-1234yf; and (3) risks from flammability of HFO-1234yf because the LFL becomes lower than 6.2% at temperatures higher than 21 °C (EPA-HQ-OAR-2006-0664-0088, -0054, -0089, -0097 and -0057).

After evaluating the comments and the additional information made available to the public through the reopened comment period, we have decided not to include the three use conditions that directly address flammability in the final rule. We believe these use conditions are not necessary to ensure that overall risks to human health and the environment from HFO-1234yf will be similar to or less than those of other available or potentially available refrigerants that EPA has already listed or proposed as acceptable for MVAC. This is because of the low overall levels of risk identified for HFO-1234yf from flammability and from ignition of HF (EPA-HQ-OAR-2008-0664-0056.2). The highest risk identified for HFO-1234yf is potential consumer exposure to HF from decomposition and ignition, which is of the same order of magnitude of risks of HF from the current most common automotive refrigerant, hydrofluorocarbon (HFC)-134a3 (order of magnitude of 10-12 events per vehicle operating hour). EPA previously

³ HFG-134a is also known as 1,1,1,2 totraffuoroothane or, when used as a refrigerant, R-134a. The Chemical Abstracts Service Registry Number (CAS Reg. No.) is 811–07–2.

^{*} Assumes a floet of approximately 250 million passenger vehicles and typical vehicle operation of 500 hours per year. Sources: U.S. Cenzus, http:// www.cenzus.gov/compendia/statab/2010/tables/ 10s1000.pdf; SAE 13760, as closed in EPA-HQ-OAR-2008-0664-0056.2

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found HFC-134a acceptable for use in new and retrofit MVAC systems (59 FR 13044; March 18, 1994; and 60 FR 31092, June 13, 1995), without use conditions addressing risks of HF. Since that time, EPA has heard of no cases where someone has been injured due to exposure to HF from decomposition of HFC-134a from an MVAC system, and a risk assessment from the SAE CRP found no published reports in the medical literature of injuries to fire fighters or vehicle passengers from HF or other decomposition products of HFC-134a (EPA-HQ-OAR-2008-0664-0008). The direct risk of flammability from HFO-1234yf is extremely small. Further, the risks of HFO-1234yf are comparable to or less than the risks from other available or potentially available alternatives in this end-use that EPA has already listed or proposed as acceptable (e.g., HFC-152a,4 HFC-134a, and CO₂) (EPA-HQ-OAR-2008-0664-0086.1). We have concluded that the use

conditions we are including in the final rule address the risks from both HF and flammability. Industry standard SAE 1639 (adopted 2011) provides for a pressure relief device designed to minimize direct impingement of the refrigerant and oil on hot surfaces and for design of the refrigerant circuit and connections to avoid refrigerant entering the passenger cabin. These conditions will mitigate risks of HF generation and ignition. The pressure release device ensures that pressure in the system will not reach an unsafe level that might cause an uncontrolled, explosive leak of refrigerant, such as if the air conditioning system is overcharged. The pressure release device will reduce the likelihood that refrigerant leaks would reach hot surfaces that might lead to either ignition or formation of HF. Designing the refrigerant circuit and connections to avoid refrigerant entering the passenger cabin ensures that if there is a leak, the refrigerant is unlikely to enter the passenger cabin. Keeping refrigerant out of the passenger cabin minimizes the possibility that there would be sufficient levels of refrigerant to reach flammable concentrations or that HF would be formed and transported where passengers might be

exposed. The last proposed use condition, requiring manufacturers to conduct and keep records of FMEA according to the standard SAE J1739, remains unchanged.

The proposed use condition regarding conducting and keeping records of a Failure Mode and Effects Analysis according to the standard SAE J1739 remains unchanged. We have revised the remaining proposed use condition by replacing the reference to SAE J639 (adopted 2009) with a reference to the 2011 version of the standard and to the fittings for large refrigerant containers in SAE J2844 (2011). This is the most recent version of the SAE J639 standard, with new provisions designed specifically to address use of HFO– 1234yf.

V. Why is EPA finding HFO-1234yf acceptable subject to use conditions?

EPA is finding HFO-1234yf acceptable subject to use conditions because the use conditions are necessary to ensure that use of HFO-1234yf will not have a significantly greater overall impact on human health and the environment than other available or potentially available substitutes for CFC-12 in MVAC systems. Examples of other substitutes that EPA has already found acceptable subject to use conditions for use in MVAC include HFC-134a and HFC-152a. HFC-134a is the alternative most 152a, HPC-1340 is the atternative movied widely used in MVAC systems today. EPA has also proposed to find CO₂ (R-744) acceptable subject to use conditions in MVAC (September 14, 2006; 71 FR 55140).

All alternatives listed as acceptable for use in MVAC systems in passenger cars and light-duty trucks are required to have unique fittings under use conditions issued previously under the SNAP Program at appendix D to subpart G of 40 CFR part 82 (61 FR 54040, October 16, 1996). Thus, all substitutes for use in MVAC systems in passenger cars and light-duty trucks are subject to those use conditions, at a minimum, if found acceptable and thus are identified as acceptable subject to use conditions. For HFO-1234yf, the unique fittings that must be used for MVAC systems are those required in the industry standard SAE J639 (2011). The fitting for refrigerant containers of 20 lbs or larger is specified in SAE J2844 (2011). The original submitter of HFO-1234yf to the SNAP program has provided EPA with a copy of and a diagram for these unique fittings. As described above, the fittings will be quick-connect fittings, different from those for any other refrigerant. The low-side service port and connections with containers of 20 lbs or greater will have an outside diameter of 14 mm (0.551 inches) and the high-side service port will have an outside diameter of 17 mm (0.669 inches), both accurate to within 2 mm. The submitter has not provided, and the SAE standards do not include, unique fittings for use with

small refrigerant containers or can taps.⁵ Thus, the final use conditions do not allow use of small containers for servicing MVAC systems.

In addition to the use conditions regarding unique fittings, which apply under appendix D to subpart G of 40 CFR part 82, EPA is requiring use conditions for the safe design of new MVAC systems using HFO-1234yf, consistent with standards of the automotive industry (e.g., SAE J1739, SAE J639). These use conditions are intended to ensure that new cars and light-duty trucks that have MVAC systems that use HFO-1234yf are specifically designed to minimize release of the refrigerant into the passenger cabin or onto hot surfaces that might result in ignition or in generation of HF. The industry standard SAE J1739 gives guidelines on designing vehicles to address these risks.

Cost and Availability

EPA received initial estimates of the anticipated cost of HFO-1234yf from the manufacturer, claimed as confidential business information, as part of the initial SNAP submission (EPA-HQ-OAR-2008-0664-0013 and -0013.1). Initial publicly available estimates on the cost of HFO-1234yf were for approximately \$40-60/pound (Weissler, 2008). The first automobile manufacturer to announce its commitment to use HFO-1234yf as a refrigerant has confirmed that the prices in its long-term purchase contracts are in the range that EPA considered at the time of proposal (Sciance, 2010).

In May 2010, two major chemical manufacturers, including the original submitter, issued a press release, committing to building a "world-scale manufacturing facility" to produce HFO-1234yf (EPA-HQ-OAR-2008-0664-0128.1). The same manufacturers have committed to providing HFO-1234yf in time to meet requirements of a European Union directive to use only refrigerants with GWP less than 150 in new automobile designs starting in 2011.

Environmental Impacts

EPA finds that HFO-1234yf does not pose significantly greater risk to the environment than the other substitutes that are currently or potentially

⁴HFG-152a is also known as 1,1-diffuoroethane or, when used as a refrigerant, R-152a. The CAS Reg. No, is 75-37-6.

⁹ The SAE [039 standard specifies unique fittings for high-ride and low-side service parts and the manufacture of HYO-1234yf support these fittings. The unique fitting for large containers for use in servicing by professionals (e.g., 20 or 30 fis) is the same as the fitting for the low-side service port in SAE [639 and is also specified in SAE [2844, "R-1234yf New Relrigerant Purity and Container Requirements Used in Mobile Air-Conditioning Systems." (U.S. EPA, 2010b)



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available. In at least one aspect, HFO-1234yf is significantly better for the environment than other alternatives currently found acceptable subject to use conditions. HFO-1234yf has a hundred-year time horizon (100-yr) global warming potential (GWP) of 4 (Nielsen et al., 2007; Papadimitriou et al., 2007), compared to a GWP of 124 for HFC-152a, and a GWP of 1430 for HFC-134a (IPCC, 2007). CO2, another substitute currently under review in this end-use, has a GWP of 1, which is lower, but comparable to the GWP of HFO-1234yf. Information on the schedule for EPA's final rulemaking on CO2 as a substitute in MVAC, RIN 2060-AM54, is available in EPA's regulatory agenda at http://www.reginfo.gov/ public/do/eAgendaMain. A number of other refrigerant blends containing HFCs or HCFCs have been found acceptable subject to use conditions in MVAC that have higher GWPs in the range of 1000 to 2400, such as R-426A. R-414A, R-414B, R-416A, and R-420A. Further, HFO-1234yf has no ozone depletion potential (EPA-HQ-OAR-2008-0664-0013), comparable to CO2, HFC-152a, and HFC-134a, and has less risk of ozone depletion than all refrigerant blends containing HCFCs that EPA previously found acceptable subject to use conditions for MVAC systems.

EPA also considered the aggregate environmental impact of all anticipated emissions of HFO-1234yf, both for the proposed rule and for this final rule. We performed a conservative analysis that assumed widespread use of HFO-1234yf as the primary refrigerant for MVAC, as well as for other refrigeration and air conditioning uses that were not included in the manufacturer's original submission (ICF, 2009; ICF, 2010a,b,c,e). Thus, we believe that actual environmental impacts are likely to be less than those we considered, either at the proposal or final stage.

Under Clean Air Act regulations (see 40 CFR 51.100(s)) addressing the development of State implementation plans (SIPs) to attain and maintain the national ambient air quality standards, HFO-1234yf is considered a volatile organic compound (VOC). Available information indicates that HFO-1234vf has greater photochemical reactivity than HFC-134a, which is exempt from the definition of "VOC" in 40 CFR 51.100(s). Some of the other acceptable substitutes in the MVAC end-use contain VOCs, such as R-406A, R-414A, R-414B, and R-426A. VOCs can contribute to ground-level ozone (smog) formation. For purposes of State plans to address ground-level ozone, EPA has exempted VOCs with negligible

photochemical reactivity from regulation (40 CFR 51.100(s)). The manufacturer of HFO-1234yf has submitted a petition to EPA requesting that the chemical be exempted from regulation as a VOC, based on a claim that it has maximum incremental reactivity comparable to that of ethane (EPA-HQ-OAR-2008-0664-0116.1). Separate from this action, EPA is reviewing that request and plans to issue a proposed rule to address it. Information on the schedule for EPA's proposed rulemaking for exemption from regulation as a VOC for HFO-1234yf, RIN 2060-AQ38, is available in EPA's regulatory agenda at http:// www.reginfo.gov/public/do/ eAgendaMain.

Regardless of whether EPA determines to exempt HFO-1234yf from regulation as a VOC for State planning purposes, other analyses available in the docket during the public comment period indicated that the additional contribution to ground-level ozone due to a widespread switch to HFO-1234yf is likely to be around 0.01% or less of all VOC emissions, based on the formation of reactive breakdown products such as OH - (Luecken et al., 2009). Since issuing the NPRM, we performed an additional analysis that finds a worst-case increase in the Los Angeles region of 0.00080 ppm, or a contribution of only 0.1% of the 1997 8hour standard for ground-level ozone of 0.08 ppm (ICF, 2010b). Our initial analysis at the proposal stage had estimated a maximum increase in ozone of 1.4 to 4.0% of the standard in the same region (ICF, 2009). The major difference between the 2009 and the 2010 versions of this analysis involved modeling of atmospheric chemistry. The 2010 study was based on the kinetics and decomposition products predicted for HFO-1234yf, rather than using the oxidation of sulfur dioxide (SO2) as a proxy for decomposition of HFO-1234yf as was done in the 2009 study. The 2010 analysis used updated baseline emission estimates that were 1.5% higher to 5.8% lower than those in the 2009 analysis." depending on the year analyzed (ICF, 2010e). We also evaluated environmental impacts based on alternative emissions estimates from a peer-reviewed journal article provided during the public comment period (Papasavva et al., 2009);7 these values

⁹ Analyzed scenarios considered HFO-1234yf emissions from MVAC and from both MVAC systems and stationary air conditioning and refrigeration systems. The analysis also considered ranged from 26.3% to 51.1% lower than EPA's estimates in the 2009 analysis (ICF, 2009; ICF, 2010c).

Another potential environmental impact of HFO-1234yf is its atmospheric decomposition to trifluoroacetic acid (TFA, CF2COOH). TFA is a strong acid that may accumulate on soil, on plants, and in aquatic ecosystems over time and that may have the potential to adversely impact plants, animals, and ecosystems. Other fluorinated compounds also decompose into TFA, including HFC-134a, However, the amount of TFA produced from HFO-1234yf in MVAC is estimated to be at least double that of current natural and artificial sources of TFA in rainfall (Luecken et al., 2009). An initial analysis performed for EPA at the proposal stage found that, with highly conservative emission estimates TFA concentrations in rainwater could be as high as 1.8 mg/L for the maximum monthly concentration for the Los Angeles area and would be no higher than 0.23 mg/L on an annual basis, compared to a no observed adverse effect concentration of 1 mg/L for the most sensitive plant species (ICF, 2009). This analysis concluded, "Projected levels of TFA in rainwater should not result in a significant risk of ecotoxicity." A more recent analysis by Luecken et al (2009) that became available during the initial public comment period reached the conclusion that emissions of HFO-1234yf from MVAC could produce TFA concentrations in rainwater of 1/800th to 1/80th the no-observed adverse effect level (NOAEL) for the most sensitive algae species expected (Luecken et al., 2009). The conclusions in the Luecken study are supported by additional analyses that have become available since we issued the proposed rule. A study from the National Institute of Advanced Industrial Science and Technology (AIST) in Japan, which became available during the re-opened comment period, estimated that concentrations of TFA in surface water would be approximately twice the level in rainwater (Kajihara et al., 2010). This study found that this higher level in surface water would be roughly 1/80th

scenarios with typical emissions from MVAC systems during the entire year aimilar to those from current MVAC systems using HPC-134e and another scenario with reduced emissions of HPO-1234yf of approximately 50 g/yr per vulticle, in line with emissions estimates in a study by Papasavva et al. (2009) (EPA-HQ-OAR-2009-0664-0114.1). Major differences between the data sources include assumptions of a lower bask rate (5.6% of charge vs. #% of charge) and a lower annualized rate of leaks during servicing (3.2% of charge vs. 10% of charge) for the Paparavua et al. paper compared to assumptions in EPA's Vintaging Model (ICF 2010a).

⁶ These changes in estimates reflect ongoing updates to EPA's Vintaging Model, a model that considers industry trends in different end-uses that historically have used ODS.



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the NOAEL for the most sensitive algae species, even with assumptions of high emissions levels (*i.e.*, assuming that all types of refrigeration and AC equipment currently using HFCs or HCFCs, not just MVAC systems, would use HFO– 1234yf). Kajihara *et al.* (2010) evaluated scenarios specific to Japan, with emissions of approximately 15,172 ton/ yr in 2050, compared to a maximum of 64,324 metric tons/yr in 2050 in ICF, 2009 or a maximum of 24,715 metric tons/yr in 2017 in Luecken *et al* (2009). All three studies noted the potential for accumulation in closed aquatic systems.

As we developed the proposed rule, the data we relied on indicated that in the worst case, the highest monthly TFA concentrations in the area with the highest expected emissions, the Los Angeles area, could exceed the no observed adverse effect concentration for the most sensitive plant species, but annual values would never exceed that value. Further, TFA concentrations would never approach levels of concern for aquatic animals (ICF, 2009). In a more recent analysis, ICF (2010a, b, c, e) performed modeling for EPA using the kinetics and decomposition products predicted specifically for HFO-1234yf and considered revised emission estimates that were slightly lower than in a 2009 analysis (ICF, 2009). The revised analysis found a maximum projected concentration of TFA in rainwater of approximately 1.700 ng/L, roughly one-thousandth of the estimate from our 2009 analysis (ICF, 2010b). This maximum concentration is roughly 34% higher than the 1,264 ng/L reported by Luecken et al. (2009), reflecting the higher emission estimates we used (ICF, 2010b). A maximum concentration of 1700 ng/L corresponds to roughly 1/ 600th of the NOAEL for the most sensitive algae species—thus, it is not a level of concern. We find these additional analyses confirm that the projected maximum TFA concentration in rainwater and in surface waters should not result in a significant risk of aquatic toxicity, consistent with our original proposal.

Human Health and Safety Impacts

Occupational risks could occur during the manufacture of the refrigerant, initial installation of the refrigerant into the MVAC system at the car assembly plant, servicing of the MVAC system, or final disposition of the MVAC system (*i.e.*, recycling or disposal). Consumer risks could occur to drivers or riders in the passenger compartment. Risks of exposure to consumers could also occur if they purchase HFO-1234yf and attempt to install or service the MVAC system without proper training or use of refrigerant recovery equipment. In addition, members of the general public, consumers, and first-responders could face risks in the case of a vehicle accident that is severe enough to release the refrigerant.

To evaluate these potential human health and safety impacts, we considered EPA's own risk assessments (EPA-HQ-OAR-2008-0664-0036 and -0038), as well as detailed risk assessments with fault-tree analysis from the SAE CRP for HFO-1234yf and CO2 (EPA-HQ-OAR-2008-0664-0008 and -0056.2), and scientific data provided in public comments on the topics of health and safety risks.# Health and safety risks that we evaluated included direct toxicity of HFO-1234yf, both long-term and short-term; toxicity of HF formed through thermal decomposition or combustion of HFO-1234yf; and flammability of HFO-1234yf.

Occupational Risks

For long-term occupational exposure to HFO-1234yf, EPA compared worker exposures to a workplace exposure limit of 250 ppm ⁹ over an 8-hour timeweighted average. For short-term occupational exposure to HFO-1234yf, we compared worker exposure to an acute exposure limit of 98,211 ppm, divided by a margin of exposure of 30,

⁹ This was based on a NOAEL of 4000 ppm from the study, "An Inhialation Prevaial Developmental Toxicity Study of HFO-1243vf (2.3.3.). Tetraflitoropropone) in Rabbita," EPA-HQ-OAR-2008-0664-0041. We used a factor of 1.9 to account for differences in blood concentrations between animals and humans, and a targin of exposure or collective uncertainty factor of 30. Uncortainty factors of 3 were assigned for animal to human extrapolation, and 10 for variability within the human population. The long-bern workplace exposure limit was calculated as follows: 4000 ppm (animal exposure) × 1.9 (ratio of estimated human exposure/animal exposure) × ½, (UF for animal to human extrapolation) × ½, (UF for animal to human extrapo for a value of 3270 ppm over 30 minutes.^{10,11}

Section 609 of the Clean Air Act requires technicians servicing MVAC systems for consideration (e.g., receiving money, credit, or services in exchange for their work) to use approved refrigerant recycling equipment properly and to have proper training and certification. Therefore, we expect that professional technicians have the proper equipment and knowledge to minimize their risks due to exposure to refrigerant from an MVAC system. Thus, we found that worker exposure would be low. Further, EPA intends to pursue a future rulemaking under Section 609 of the CAA to apply also to HFO-1234yf (e.g., servicing practices, certification requirements for recovery and recycling equipment intended for use with MVACs using HFO-1234yf, any potential changes to the rules for training and testing technicians, and recordkeeping requirements for service facilities and for refrigerant retailers). If workers service MVAC systems using certified refrigerant recovery equipment after receiving training and testing, exposure levels to HFO-1234yf are estimated to be on the order of 4 to 8.5 ppm on an 8-hour time-weighted average (as compared with a 250 ppm workplace exposure limit) and 122 ppm on a 30-minute average (as compared with a short-term exposure level of 98,211 ppm/[margin of exposure of 30] or 3270 ppm). (EPA-HQ-OAR-2008-0664-0036; EPA-HQ-OAR-2008-0664-

¹¹ For comparison, the SAE CRP used exposure limits of 500 ppm over 8 hours and 115,000 ppm over 30 minutes to evaluate risks for these same time periods. These are based on the 8-hr Workplace Environmental Exposure Limit (WEEL) for HPO-1234yf and for short-term exposure, assuming a NOAEL of approximately 405,800 ppm from the study. "Acute (4-hour) inhalation toxicity induly with HPO-1234yf in rats." Note that EPA disagrees with the finding that the acute inhalation toxicity study found a NOAEL. We consider this study to show adverse effects at all levels because of the presence of grey discoloration in the lungs of the test animals. In coder to ensure sufficient protection, IPA's risk assessment used a NOAEL, from a subocute study instead of a LOAEL from an acute study.

^{*}On September 30, 2010, we received a final report from the German Federal Environment Agency (UEA) with additional information from testing of HFO-1234yf's potential for flammability and for generating hydrogen fluoride. Although this commant was received too late in the rulemaking process for us to analyze it in depth, our preliminary review found that the precedures they used contain many innealistic provisions that are not relevant to our decision and in some tasts did not provide proper controls (e.g., locking a comparison to HFC-134a under the same conditional. Goncerning flammability risk, the iseasite do not vary significantly from these we are relying on for the final rule. Thus, our preliminary review found that does not auggest that we should re-evaluate our decision to find HFO-1234yf acceptable subject to use conditions.

¹⁸⁷This was based on a NOAEL of 51,690 ppm from the study. "Sub-acute (2-week) Inhalation Toxicity Study with HFO-1234 yf in rats." EPA-IIQ-OAR-2000-0064-0020 through 0020.4. a factor of 1.9 to account for differences in blood concentrations between animals and humans and a margin of exposure or collective uncurtainty factor of 30. Uncertainty factors of 3 were assigned for animal to human extrapolation. and 10 for variability within the human population. The shortterm workplace exposure value was calculated as follows: 51.690 ppn (animal exposure) ×1.9 (ratio of satimated human exposure/animal exposure) = 98.211 ppn This value was then divided by the expected exposure in such scenario, and compared against the target margin of exposure of 30. See EPA-HQ=OAR-2008-0064-0036 and EPA-HQ= OAR-2008-0604-0038.





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0036). We also analyzed exposure levels during manufacture and final disposition at vehicle end-of-life, and found that they would be no higher than 28 ppm on a 15-minute average or 8.5 ppm on an 8-hour time-weighted average (EPA-HQ-OAR-2008-0664-0038). Therefore, the manufacture, use, and disposal or recycling of HFO-1234yf are not expected to present a toxicity risk to workers.

We did not analyze the risk of generation of HF in the workplace. In its December 17, 2009 Risk Assessment for Alternative Refrigerants HFO-1234yf and R-744 (CO2), the SAE CRP indicated that "service technicians will be knowledgeable about the potential for HF generation and will immediately move away from the area when they perceive the irritancy of HF prior to being exposed above a health-based limit" (EPA-HQ-OAR-2008-0664-0056.2). Since there is a similar potential to form HF from other MVAC refrigerants that have been used for years, such as CFC-12 or HFC-134a, it is reasonable to assume that service technicians, recyclers, and disposers will handle HFO-1234yf similarly and that use of HFO-1234yf does not pose a significantly greater risk in the workplace with regard to HF generation than the use of those other refrigerants.

In that same report, the SAE CRP also discussed qualitatively the risks for emergency responders, such as firefighters or ambulance workers that respond in case of a vehicle fire or collision. With regard to risk of fire, the CRP report stated that "Due to the low burning velocity of HFO-1234yf, ignition of the refrigerant will not contribute substantially to a pre-existing fire" (EPA-HQ-OAR-2008-0664-0056.2). EPA considers this reasonable. given a burning velocity for HFO-1234yf of only 1.5 cm/s. This is more than an order of magnitude less than the burning velocity of gasoline, which is approximately 42 cm/s (Ceviz and Yuksel, 2005). Concerning first responder exposure to HF, the SAE CRP stated, "Professional first responders also have training in chemical hazards and possess appropriate gear which will prevent them from receiving HF exposures above health-based limits' (EPA-HO-OAR-2008-0664-0056.2). We agree with this assessment. Other MVAC refrigerants containing fluorine such as CFC-12, which was historically used, and HFC-134a, which is the predominant refrigerant currently in use, also can produce HF due to thermal decomposition or combustion, and smoke and other toxic chemicals are likely to be present in case of an automotive fire (CRP, 2008). Therefore,

it is reasonable to expect that first responders are prepared for the presence of HF and other toxic chemicals when approaching a burning vehicle and that they will wear appropriate personal protective equipment, EPA's risk screen for HFO-1234yf

evaluated flammability risks, including occupational risks. Modeling of concentrations of HFO-1234yf in workplace situations such as at equipment manufacture and during disposal or recycling at vehicle end-oflife found short-term, 15-minute concentrations of 28 ppm or less--far below the lower flammability limit (LFL) of 6.2% by volume (62.000 ppm) (EPA-HQ-OAR-2008-0664-0038). The SAE CRP's risk assessments evaluated flammability risks by comparing concentrations of HFO-1234yf with the LFL of 6.2%. The SAE CRP conducted Computational Fluid Dynamics (CFD) modeling of exposure levels in case of a leak in a system in a service shop. The SAE CRP's earlier February 26, 2008 risk assessment found that a leaked concentration of HFO-1234yf exceeded the LFL only in the most conservative simulation, with the largest refrigerant leak and with all air being recirculated within the passenger cabin (EPA-HQ-OAR-2008-0664-0010). Updated CFD modeling performed for the December, 2010 SAE CRP risk assessment found that concentrations of HFO-1234yf sometimes exceeded the LFL, but only within ten centimeters of the leak or less (EPA-HQ-OAR-2008-0664-0056.2). The risk assessment found the risk of this occupational exposure scenario to be on the order of 10⁻²⁶ cases per working hour. We note that HFO-1234yf is less flammable and results in a less energetic flame than a number of fluids that motor vehicle service technicians and recyclers or disposers deal with on a regular basis, such as oil, anti-freeze, transmission fluid, and gasoline. HFO-1234yf is also less flammable than HFC-152a, a substitute that we have already found acceptable for new MVAC systems subject to use conditions. Thus, EPA finds that the risks of flammability in the workplace from HFO-1234yf are similar to or lower than the risk posed by currently available substitutes when the use conditions are met.

Consumer Exposure

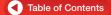
EPA's review of consumer risks from toxicity of HFO-1234yf indicated that potential consumer (passenger) exposure from a refrigerant leak into the passenger compartment of a vehicle is not expected to present an unreasonable risk (EPA-HQ-OAR-2008-0664-0036,

EPA-HQ-OAR-2008-0664-0038). However, consumer exposure from filling, servicing, or maintaining MVAC systems may cause exposures at high enough concentrations to warrant concern. Specifically, this risk may be due to a lack of professional training and due to refrigerant handling or containment without the use of refrigerant recovery equipment certified in accordance with the regulations promulgated under CAA Section 609 and codified at subpart B of 40 CFR part 82. Consumer filling, servicing, or maintaining of MVAC systems may cause exposures at high enough concentrations to warrant concern (EPA-HQ-OAR-2008-0664-0036) However, this rule does not specifically allow for use of HFO-1234yf in consumer filling, servicing, or maintenance of MVAC systems. The manufacturer's submission specifically addressed HFO-1234yf as a refrigerant for use by OEMs and by professional technicians (EPA-HQ-OAR-2008-0664-0013.1).

The use conditions in this final rule provide for unique service fittings relevant to OEMs and to professional technicians (*i.e.*, unique fittings for the high-pressure side and for the lowpressure side of the MVAC system and unique fittings for large cylinders of 20 lb or more). EPA would require additional information on consumer risk and a set of unique fittings from the refrigerant manufacturer for use with small cans or containers of HFO-1234yf before we would be able to issue a revised rule that allows for consumer filling, servicing, or maintenance of MVAC systems with HFO-1234yf.

EPA has issued a significant new use rule (SNUR) under the authority of TSCA (October 27, 2010; 75 FR 65987). Under 40 CFR part 721, EPA may issue a SNUR where the Agency determines that activities other than those described in the premanufacture notice may result in significant changes in human exposures or environmental release levels and that concern exists about the substance's health or environmental effects. Manufacturers, importers and processors of substances subject to a SNUR must notify EPA at least 90 days before beginning any designated significant new use through a significant new use notice (SNUN). EPA has 90 days from the date of submission of a SNUN to decide whether the new use 'may present an unreasonable risk" to human health or the environment. If the Agency does not determine that the new use "may present an unreasonable risk," the submitter would be allowed to engage in the use, with or without certain restrictions. The significant new

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uses identified in the SNUR for HFO-1234yf are: (1) Use other than as a refrigerant in motor vehicle air conditioning systems in new passenger cars and vehicles; (2) commercial use other than in new passenger cars and vehicles in which the charging of motor vehicle air conditioning systems with HFO-1234yf was done by the motor vehicle OEM; and (3) distribution in commerce of products intended for use by a consumer for the purposes of servicing, maintenance and disposal involving HFO-1234yf.

Under existing regulations in appendix D to subpart G of 40 CFR part 82, "A refrigerant may only be used with the fittings and can taps specifically intended for that refrigerant and designed by the manufacturer of the refrigerant. Using a refrigerant with a fitting designed by anyone else, even if it is different from fittings used with other refrigerants, is a violation of this use condition." The manufacturer and submitter for HFO-1234yf has provided unique fittings for the high-pressure side and for the low-pressure side of the MVAC system and for large cylinders for professional use (typically 20 lb or more 12). Therefore, until the manufacturer provides unique fittings to EPA's SNAP Program for use with can taps or other small containers for consumer use and until EPA publishes a final rule identifying such unique fittings, it would be a violation of the use condition in appendix D to use HFO-1234yf in small cans or containers for MVAC. Before issuing a rule allowing use of HFO-1234yf with fittings for small cans or containers for MVAC, we would first need to conclude through either review under TSCA or under the SNAP program that use of these smaller canisters would not pose an unreasonable risk to consumer

In our review of consumer risks from HFO-1234yf, we considered information concerning consumer exposure to HF from thermal decomposition or combustion of HFO-1234yf. EPA's analysis at the time of the proposed rule focused on the flammability risk to consumers, which at the time we believed to be a significant risk in its own right, as well as a way to prevent consumer exposure to HF from combustion of HFO-1234yf. However, in preparing our proposal, we had available and did consider the SAE CRP's 2008 evaluation of scenarios that might cause consumer or occupational exposure to HF (CRP, 2008). This report stated:

Decomposition of HFO-1234yf in a fire scenario might, in theory, pose a significant acute health risk to passengers or firemen. But in the event of a fire, other toxic chemicals will be produced by combustion of other automotive components and thus decomposition of the refrigerant may increase the risk for fire fighters and would not introduce an entirely new type of hazard. It is also anticipated that only a small portion of the refrigerant charge will be converted to these decomposition products. In U.S. EPA's assessment of risk of R-152a and CO₂ (R-744), the agency cited a study by Southwestern Laboratories which indicated that a 100% R-134a atmosphere only produced an HF concentration of 10 ppm when passed through a tube heated to 1,000 T (Blackwell *et al.*, 2006). A search of the medical literature also did not reveal any published reports of injuries to fire fighters or vehicle passengers resulting from exposures to COF₂ or HF produced in fires involving refrigerants. (EPA-HQ–OAR-2008– 0664–0008, p. 67)

After the SAE CRP's 2008 evaluation, SAE CRP members conducted tests to measure HF concentrations and to identify factors that were most likely to lead to HF formation (EPA-HQ-OAR-2008-0664-0056.2). One test on HF concentrations inside a car cabin found maximum concentrations were in the range of 0 to 35 ppm in trials both with HFO-1234yf and with HFC-134a, with concentrations dropping to 10 ppm or less after 10 minutes. In a second test of HF generated in the engine compartment, HF concentrations from thermal decomposition of HFO-1234yf reached as high as 120 ppm in the engine compartment in the worst case, with interior passenger cabin values of 40 to 80 ppm. Under the same extreme conditions (flash ignition, temperature of 700 °C, closed hood), HF concentrations from thermal decomposition of HFC-134a reached 36.1 ppm in the engine compartment with interior passenger cabin values of 2 to 8 ppm. The other trials with less extreme conditions found HF concentrations from HFO-1234vf in the engine compartment of 0 to 8 ppm. The SAE CRP selected an Acute

Exposure Guideline Limit (AEGL) – 2 of 95 ppm over 10 minutes as its criterion for determining toxicity risk from HF.¹³ Thus, even assuming levels inside a passenger compartment reached the highest level that occurred during the tests-80 ppm-a passenger inside a vehicle would at worst experience discomfort and irritation, rather than any permanent effects. HF levels that could result in similar effects were also observed for HFC-134a. The SAE CRP concluded that the probability of such a worst-case event is on the order of 10-12 occurrences per operating hour 14 (EPA-HO-OAR-2008-0664-0056.2). This level of risk is similar to the current level of risk of HF generated from HFC-134a (EPA-HQ-OAR-2008-0664-0086.1). To date, EPA is unaware of any reports of consumers affected by HF generated by HFC-134a, which has been used in automobile MVAC systems across the industry since 1993. Thus, we do not expect there will be a significant risk of HF exposure to consumers from HFO-1234yf.

Depending on the charge size of an HFO-1234yf MVAC system, which may range from as little as 400 grams to as much as 1600 grams (ICF, 2008), it is possible in a worst case scenario to reach a flammable concentration of HFO-1234yf inside the passenger compartment. This could occur in the case of a collision that ruptures the evaporator in the absence of a switch or other engineering mitigation device to prevent flow of high concentrations of the refrigerant into the passenger compartment, provided that the windows and windshield remain intact. As stated in the SAE CRP, ignition of the refrigerant once in the passenger cabin is unlikely (probability on the order of 10-14 occurrences per operating hour) because the only causes of ignition within the passenger cabin with sufficient energy to ignite the refrigerant would be use of a butane lighter (EPA-OAR-2008-0664-0056.2). If a passenger were in a collision, or in an emergency situation, it is unlikely that they would choose to operate a butane lighter in the passenger cabin. Additionally, it is unlikely ignition would occur from a flame from another part of the vehicle because automobiles are constructed to seal off the passenger compartment with a firewall. If a collision breached the passenger compartment such that a flame from another part of the vehicle could reach it, that breach would also create ventilation that would lower the refrigerant concentration below the

¹³ EPA has issued lists of approved unique fittings for refrigerants in MVAC (see http://www.apg.gov/ ozorw/inag/refrigerants/fittist.html). These have been issued for the high-side service post, low-side service port, 30-lb cylinders (that is, the most typical size consultance for use in professional servicing), and small cans (containers typically used by consumers). The label "30-lb cylinders" is not intended to restrict the existence of other container sizes that professional service bechniciane might use (e.g., 50 lb, 20 lb, 10 lb).

¹³ The AEGL-2 is defined as "the airborne concentration of a substance * * * above which it is predicted that the general population, including superptible individuals could experience inveverible or other sections, long lasting adverse effects or an impaired ability to escape." http:// www.epa.gov/oppl/acgl/pubs/define.htm.

 $^{^{10}}$ If we assume 250 million passenger vehicles in the U.S. and typical driving times of 500 hours per year per vehicle, a risk of 4.6 \pm 10 $^{-12}$ per operating hour equates roughly to one event every 2 years for all drivers in the entire U.S.





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lower flammability limit. Similarly, if either a window or the windshield were broken in the collision, the ventilation created would lower the refrigerant concentration below the lower flammability limit. Therefore, EPA finds that flammability risks of HFO-1234yf to passengers inside a vehicle will be low. Further, these risks are likely to be less than those from HFC-152a, another flammable refrigerant that EPA has previously found acceptable subject to use conditions, because HFC-152a has a lower LFL and a lower minimum ignition energy than HFO-1234vf (EPA-HQ-OAR-2008-0664-0008, -0013.4. -0056.2).

Overall Conclusion

EPA finds that the use of HFO-1234yf in new passenger vehicle and light-duty truck MVAC systems, subject to the use conditions being adopted in the final rule, does not present a significantly greater risk to human health and the environment compared to the currentlyapproved MVAC alternatives or as compared to CO₂, which has been proposed for approval in this end-use.

VI. What is the relationship between this SNAP rule and other EPA rules?

A. Significant New Use Rule

Under the Toxics Substances Control Act, EPA has issued a Significant New Use Rule (75 FR 65987; October 27, 2010) for 1-propene, 2,3,3,3tetrafluoro-, which is also known as HFO-1234yf. This rule requires persons who intend to manufacture, import, or process HFO-1234yf for a use that is designated as a significant new use in the final SNUR to submit a SNUN at least 90 days before such activity may occur. EPA has 90 days from the date of submission of a SNUN to decide whether the new use "may present an unreasonable risk" to human health or the environment. If the Agency does not determine that the new use "may present an unreasonable risk," the submitter would be allowed to engage in the use, with or without certain restrictions. The significant new uses identified in the final SNUR and subject to the SNUN requirement are: Use other than as a refrigerant in motor vehicle air conditioning systems in new passenger cars and vehicles: commercial use other than in new passenger cars or vehicles and in which the charging of motor vehicle air conditioning systems with HFO-1234vf was done by the motor vehicle OEM; and distribution in commerce of products intended for use by a consumer for the purpose of servicing, maintenance and disposal involving HFO-1234yf. The health

concerns expressed in the final SNUR are based primarily on potential inhalation exposures to consumers during "do-it-yourself" servicing, as well as a number of other relevant factors.

B. Rules Under Sections 609 and 608 of the Clean Air Act

Section 609 of the CAA establishes standards and requirements regarding servicing of MVAC systems. These requirements include training and certification of any person that services MVAC systems for consideration,15 as well as standards for certification of equipment for refrigerant recovery and recycling. EPA has issued regulations interpreting this statutory requirement and those regulations are codified at subpart B of 40 CFR part 82. The statutory and regulatory provisions regarding MVAC servicing apply to any refrigerant alternative and are not limited to refrigerants that are also ODS. This final SNAP rule addresses the conditions for safe use of HFO-1234yf in new MVAC systems. Thus, the requirements in this rule apply primarily to OEMs, except for specific requirements for service fittings unique to HFO-1234yf. MVAC end-of-life disposal and recycling specifications are covered under section 608 of the CAA and our regulations issued under that section of the Act.

VII. What is EPA's response to public comments on the proposal?

This section of the preamble summarizes the major comments received on the October 19, 2009 proposed rule, and EPA's responses to those comments. Additional comments are addressed in a response to comments document in docket EPA-HQ-OAR-2008-0664.

A. Acceptability Decision

Comment: Several commenters supported EPA's proposal to find HFO-1234yf an acceptable substitute for CFC-12 in MVACs. These commenters stated that available information indicates that HFO-1234yf will not pose significant health risks or environmental concerns under foreseeable use and leak conditions and that it has a strong potential to reduce greenhouse gas emissions from motor vehicles. Also, these commenters declared that HFO-1234yf's risks were similar to or less than those of other available alternatives, such as HFC-134a, HFC-152a, and CO₂. A commenter referenced the work of the SAE CRP, which

concluded that HFO-1234yf can be used safely through established industry practices for vehicle design, engineering, manufacturing, and service.

Other commenters opposed finding HFO-1234yf acceptable or stated that there was insufficient information to support a conclusion. These commenters stated that the risks of HFO-1234yf were greater than those of other available alternatives, such as HFC-134a, CO₂, and hydrocarbons.

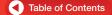
Response: For the reasons provided in more detail above, EPA has determined that HFO-1234yf, if used in accordance with the adopted use conditions, can be used safely in MVAC systems in new passenger vehicles and light-duty trucks. The use conditions established by this final rule ensure that the overall risks to human health and the environment are comparable to or less than those of other available or potentially available substitutes, such as HFC-134a, HFC-152a, or CO2 EPA did not compare the risks to those posed by hydrocarbons since we have not yet received adequate information for hydrocarbons that would allow us to make such a comparison for use in MVAC.16

Comment: Some commenters suggested that EPA should consider other substitutes for CFC-12 in MVAC, such as CO₂ or hydrocarbons. An organization representing the automotive industry stated that the risks from using CO₂ in MVAC systems are below the probability of other adverse events which society considers acceptable and are roughly 1.5 orders of magnitude greater than the risks from using HFO-1234yf.

Response: This rule only concerns EPA's decision on the use of HFO-1234yf in new passenger vehicles and light-duty trucks. In a separate action, EPA has proposed to find CO2 acceptable subject to use conditions as a substitute for CFC-12 in MVAC systems for new motor vehicles (September 16, 2006; 71 FR 55140). Information on the schedule for EPA's final rulemaking on CO2 as a substitute in MVAC, RIN 2060-AM54, is available in EPA's regulatory agenda at http:// www.reginfo.gov/public/do/ eAgendaMain. We currently have inadequate information on hydrocarbons to consider adding them to the list of substitutes for MVAC. We

¹⁵ Service for consideration means receiving something of worth or value to perform service, whether in money, credit, goods, or services.

¹⁶ EPA previously reviewed two hydrocarbon blends for use in MVAC and found them unacceptable, stating "Flammability is a serious concern. Data have not been submitted to demonstrate that (the hydrocarbon blend) can be used safely in this end-use." Appendixes A and B to subpart G of 40 CPR part 82.



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will review additional substitutes if they are submitted with complete and adequate data to allow an evaluation of whether such substitutes may be used safely within the meaning of section 612 of the CAA as compared with other existing or potential substitutes in the MVAC end-use.

B. Use Conditions

Comment: Several commenters stated that the proposed use conditions limiting concentrations of HFO-1234yf below the lower flammability limit are overly stringent or even impossible to meet and are not needed for safe usage. Some automobile manufacturers suggested relying upon established standards and practices, such as SAE protocols and standards, instead of use conditions. Some commenters suggested alternative language for use conditions. Other commenters expressed concern that the proposed use conditions limiting concentrations of HFO-1234yf would preclude the use of HFO-1234yf by any vehicle that is not initially designed to use this refrigerant. Response: As described above, EPA

agrees that the use conditions, as proposed, require modification. In this final rule, we have removed the first three proposed use conditions, which required design to keep refrigerant concentrations below the LFL. See section IV of the preamble, "What are the final use conditions and why did EPA finalize these conditions?" for our basis. With respect to the commenter who suggested that the proposed use conditions limiting concentrations of HFO-1234yf below the LFL would not allow use except in systems initially designed to use this refrigerant, we note that this decision is limited to use in new motor vehicles and light-duty trucks. Further, the proposed use conditions limiting refrigerant concentration are not included in the final rule and thus do not have implications for a future decision concerning retrofits.

Comment: One commenter provided test results from the Bundesanstalt für Materialforschung und -prüfung (BAM-Federal Institute for Materials Research and Testing) that tested various mixtures of HFO-1234vf and ethane (EPA-HQ-OAR-2008-0664-0053.3). The commenter stated that the tests show that explosions can occur at HFO-1234yf concentrations below its lower flammability limit (LFL) of 6.2% when minimal amounts of gaseous hydrocarbons are available. This commenter stated that the maximum concentrations of HFO-1234yf allowed under any use condition need to be far below the 6.2% LFL to ensure safety.

Other commenters agreed with these concerns. Yet other commenters looked at the same test data and stated that the testing was not relevant to real-world situations in MVAC because it is unlikely that such large amounts of ethane or other gaseous hydrocarbons (0.8–2.4% by volume) would form in a vehicle. One commenter stated that HFO-1234yf reduces the flammability of ethane compared to ethane alone, and that HFO-1234yf reduces flammability of ethane more than CO₂ or argon, substances used as fire suppressants (EPA-HQ-OAR-2008-0664-0115.1).

Response: We do not believe that the BAM testing of the flammability limits of mixtures of HFO-1234yf and ethane is relevant to assessing the risks of HFO-1234yf as a refrigerant in MVAC. Examples of flammable substances in the engine compartment may include compressor oil mixed with the refrigerant, motor oil, cleaners, antifreeze, transmission fluid, brake fluid, and gasoline. These are typically liquid and there is no evidence that any vapors that might form would include significant amounts of ethane. These fluids typically contain larger molecules with higher boiling points than ethane (e.g., octane, polyalkylene glycol). It seems more likely, as one commenter suggested, that these flammable fluids would ignite before breaking down into concentrations of ethane considered in the BAM testing. Further, the results of the testing are not surprising; based on a scientifically known chemical equilibrium principle known as Le Chatelier's principle-the lower flammability limit of a mixture of two flammable substances falls between the lower flammability limits of the two individual substances. The range of LFLs for flammable mixtures of ethane and refrigerants HFC-134a, HFO-1234yf, and CO2 is largest for CO2 and is similar for HFC-134a and HFO-1234yf (Besnard, 1996).

A more relevant test to compare risks for HFO-1234yf and other alternative refrigerants in MVAC is to consider flammability of a mixture of compressor oil and refrigerant, as occurs in MVAC systems. Such testing, conducted as part of the SAE CRP, found that mixtures of HFO-1234yf and 5% oil and HFC-134a and 5% oil both ignited at temperatures higher than what usually occurs in a vehicle (730 °C or higher for HFO-1234yf and 800 °C or higher for HFC-134a).

Furthermore, we note that the final use conditions do not rely on the lower flammability limit. As explained in more detail in sections IV and V of the preamble, "What are the final use conditions and why did EPA finalize these use conditions?" and "Why is EPA finding HFO-1234yf acceptable subject to use conditions?", we believe that the risks from HFO-1234yf and its decomposition products are very small and are comparable to or less than the risks from other acceptable alternatives available or potentially available for use in MVAC systems. The use conditions established in this final rule require manufacturers to design systems to prevent leakage from refrigerant system connections that might enter the passenger cabin, and to minimize impingement of refrigerant and oil onto hot surfaces, as required by SAE J639 (adopted 2011). These use conditions will further reduce already low risks from flammability and HF generation.

Comment: One commenter provided data from a presentation showing that the lower flammability limit of HFO– 1234yf decreases as temperature increases. The commenter stated that the proposed LFL of 6.2% may not be conservative enough.

Response: EPA agrees that the LFL decreases as temperature increases However, for the analysis relied on for the proposed rule, we considered an LFL relevant to the temperatures that might be expected in a collision or leak scenario and that would not be so high as to be a higher risk factor than exposure to HF. The data provided by the commenter show an LFL of 5.7% at 60 °C (140 °F) and an LFL of 5.3% at 100 °C (212 °F). If a passenger were exposed to temperatures this high in the passenger compartment for any extended period of time, he or she would suffer from the heat before there was a risk of the refrigerant igniting. However, after considering the available information, we find it is not necessary to require a concentration of HFO-1234yf below the LFL to address this refrigerant's risks; rather, risks are sufficiently addressed with the final use conditions. As discussed above in section IV of the preamble, "What are the final use conditions and why did EPA finalize these conditions?", we believe that the flammability risks from HFO-1234yf are very small and overall risks from HFO-1234yf are comparable to or less than the risks from other acceptable alternatives used in MVAC. EPA finds that the use conditions in this final rule are sufficient to manage risks of injury or adverse health effects caused by HFO-1234yf.

Comment: Regarding the first proposed use condition that would limit the concentration of HFO-1234yf below the LFL in the passenger cabin, several commenters stated that the risks of refrigerant leaking into the passenger compartment and exceeding the LFL are



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very low. Some automobile manufacturers stated that it may not be possible to keep the concentration below the LFL in the event of a collision; however, the commenters said that even if concentrations in the passenger cabin exceeded the LFL, it would be extremely difficult to ignite the refrigerant. Some commenters stated that the engineering strategies that would be necessary to implement the proposed use condition would actually increase overall risk by increasing the risk of conveying smoke and fumes from the engine compartment into the passenger compartment in the event of an accident. Some commenters suggested alternative language for the use condition to give greater flexibility in engineering responses to allow for differences between vehicles.

Response: As discussed above in section IV of the preamble, EPA is not including the proposed use condition requiring that a specific level of refrigerant concentration inside the passenger cabin is not exceeded. *Comment:* One commenter suggested

that the use conditions for limiting concentrations in the passenger cabin should require the incorporation of engineering strategies and/or devices 'such that foreseeable leaks" rising to the specified concentration levels can be avoided. Similarly, the commenter stated that any use condition limiting concentrations in the engine compartment should be limited to "prevention of ignition caused by foreseeable leaks." The commenter noted that EPA did this in a similar use condition in its final SNAP rule for HFC-152a, another flammable refrigerant for MVAC with greater flammability risk. The commenter stated that this would be consistent with safety requirements of the National Highway Traffic Safety Administration (NHTSA) and would ensure that EPA's use conditions are feasible. Response: As discussed above in

Response: As discussed above in section IV of the preamble, EPA is not including the proposed use condition and is not limiting the refrigerant concentration inside the passenger cabin or the engine compartment.

Comment: A number of commenters did not support the proposed use condition on concentrations of HFO-1234yf in hybrid and electric vehicles. One commenter recommended eliminating this use condition, as the SAE CRP risk assessment concludes there are no real world safety risks. Another commenter suggested referring to the SAE or ISO (International Organization for Standardization) standards in place of a specific use condition. One commenter stated that

electric terminals on hybrid vehicles are well protected to prevent fires and should not ignite the refrigerant. Another commenter stated that an accident severe enough to cause refrigerant leakage would also result in damage to the duct between the evaporator [in the MVAC system] and the battery pack, preventing an increase in refrigerant concentrations at the battery pack. One commenter stated that it is difficult to establish generic SNAP use conditions for hybrid vehicles, and individual manufacturers need to understand particular design features of their hybrid vehicles to ensure safe refrigerant application.

Three commenters expressed concern for using HFO-1234yf in hybrid and electric vehicles and stated that the use condition is not conservative enough. One commenter stated that the maximum concentrations of HFO-1234yf need to be far below the 6.2% LFL based on new tests done at the Federal Institute for Materials Research and Testing (BAM) and that they are unsure whether or not additional measures can effectively avoid the risk of explosive mixtures. Another commenter stated that HFO-1234yf would raise concerns in the field of battery cooling needed in electric vehicles because flammability and chemical reactions would pose major risks, which could lead to legal consequences for OEMs.

Response: As discussed above in section IV of the preamble, EPA is not including the proposed use condition and is not requiring protective devices, isolation and/or ventilation techniques where levels of refrigerant concentration may exceed the LFL in proximity to exhaust manifold surfaces or near hybrid or electric vehicle power sources. As discussed above, we do not believe that the BAM testing of the flammability limits of mixtures of HFO-1234vf and ethane is relevant to assessing the risks of HFO-1234yf as a refrigerant in MVAC. Based on information provided by OEMs that manufacture hybrid vehicles, we conclude that there will be sufficient protection against fire risk and generation of HF in the engine compartment for hybrid vehicles because they have protective coverings on power sources that will prevent any sparks that might have enough energy to ignite refrigerant and engine surfaces will not be hotter than those in conventional vehicles (EPA-HQ-OAR-2008-0664-0081.1, -0081.2). Further, we agree that it is reasonable to assume that a collision severe enough to release refrigerant from the evaporator (under the windshield) would also release it in

a location far enough away from the battery pack to keep refrigerant concentrations at the battery pack below the LFL. CFD modeling performed for the December, 2010 SAE CRP risk assessment found that concentrations of HFO-1234yf only exceeded the LFL within ten centimeters of the leak or less (EPA-HQ-OAR-2008-0664-0056.2), but the battery pack is typically placed more than ten centimeters away from the evaporator. EPA expects that OEMs will include assessment of risks from the exhaust manifold, hybrid power source, and electric vehicle power source as part of the FMEA required under one of the final use conditions in this rule.

Comment: Some commenters responded to EPA's request for comment as to whether the use conditions should apply only when the car ignition is on. These commenters indicated that it is unnecessary for the use conditions on refrigerant concentrations within the passenger compartment to apply while a vehicle's ignition is off because it is unlikely that a collision would occur, that high temperatures would occur, or that refrigerant would enter the passenger cabin when the ignition, and thus the MVAC system, is off. Another commenter stated that it should be mandatory for all electric power sources to be shut off when the ignition is off.

Response: As discussed above in section IV of the preamble, EPA is not including the proposed use conditions that specified a refrigerant concentration not to be exceeded.

Comment: Several commenters stated that the proposed limits on concentrations of HFO-1234yf in the engine compartment cannot be met, even hypothetically, and that imposition of such a use condition would delay or even prevent the use of HFO-1234yf. Other commenters stated that the engineering required to meet the proposed use condition is almost certain to preclude the use of HFO-1234yf by any vehicle that was not initially designed to use this refrigerant. *Besponse:* EPA is not including in the

Response: EPA is not including in the final rule the proposed use condition that sets a specific limit for refrigerant concentrations inside the engine compartment. See section IV of the preamble, "What are the final use conditions and why did EPA finalize these conditions?" for further rationale.

Comment: Several commenters agreed with EPA's proposal to require use of unique fittings and a warning label that identify the new refrigerant and restrict the possibility of cross-contamination with other refrigerants. Other commenters suggested that no use

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conditions are necessary because established standards and practices would be adequate for safe use of HFO-1234yf.

Response: The use conditions referenced by the commenters were established in a separate final rule, promulgated in 1996, which applies to all refrigerants used in MVAC (see appendix D to subpart G of 40 CFR part 82). EPA has not proposed to modify that existing rule for purposes of its acceptability determination for HFO-1234yf. These requirements indicate to technicians the refrigerant they are using and thus help reduce risks to the technician by ensuring that the technician will handle the refrigerant properly. In addition, these use conditions serve to prevent contamination of refrigerant supplies through unintended mixing of different refrigerants. For purposes of meeting that existing regulatory requirement, this final rule specifies use of fittings for the high-pressure side service port, the low-pressure side service port, and for refrigerant containers of 20 pounds or greater. The submitter for HFO-1234yf has provided these fittings to the Agency and they are consistent with the SAE standard J639. In addition, the final rule retains the requirement for a warning label identifying the refrigerant, consistent with SAE J639.

Comment: Some commenters agreed with EPA's proposal to require a highpressure compressor cut-off switch, as per SAE J639. Another commenter suggested that the compressor cut-off switch would be useful for all systems in which the discharge pressure can reach the burst pressure, not just those systems with pressure relief devices.

systems with pressure relief devices. *Response*: EPA is maintaining the requirement that HFO-1234yf MVAC systems must have a high-pressure compressor cut-off switch by requiring compliance with the SAE [639 standard. The SAE [639 standard requires a pressure relief device on the refrigerant high-pressure side of the compressor for all MVAC systems, and so the compressor cut-off switch will be required for all systems, as suggested by the commenter.

Comment: Several commenters supported the requirement for vehicle makers to conduct and maintain FMEAs. Other automobile manufacturers stated that the final SNAP rule finding HFC-152a acceptable as a substitute for CFC-12 in MVAC included this as a comment rather than as a use condition, and suggested that EPA do the same in the final rule for HFO-1234yf. Another commenter stated that FMEAs for each vehicle design are standard industry practice, and so no use condition is required; this commenter provided language for an alternate use condition should EPA choose to specify a use condition for vehicle design.

Response: EPA is retaining the requirement for FMEAs in the final rule as a use condition, rather than simply as an unenforceable comment. In an FMEA, vehicle designers analyze all the ways in which parts of the MVAC system could fail and identify how they will address those risks in design of the system. In addition, keeping records of an FMEA is important to ensuring safe use because it documents that vehicle designers have complied with the safety requirements of this rule. We believe that it is necessary to retain this requirement as a use condition in order to ensure that OEMs are required to analyze and address the risks and to document those efforts such that this analysis is available to demonstrate compliance to EPA in case of an EPA inspection. Information in the FMEAs complements the safety requirements in SAE J639 and is useful for demonstrating compliance. Because the revised SAE J639 standard refers to use of FMEAs more extensively, risk assessment using FMEAs is more critical for HFO-1234yf than it was for HFC-152a

Comment: A commenter requested that EPA specifically allow manufacturers to perform FMEAs according to equivalent standards developed by organizations other than SAE (e.g., the International Organization for Standardization [ISO], the German Institute for Standards [DIN], or the Japan Automobile Manufacturers Association [JAMA]].

Response: We agree that standards from other standard-setting organizations may provide equivalent assurance of safe use. However, we are not aware at this time of any standards that do so. In order to ensure safe use of HFO-1234yf, we would need to review any other standard to ensure that it provides equivalent assurances of safety before allowing its use in place of the SAE standard. An OEM, for example, could petition EPA's SNAP program and provide copies of the other standard for consideration. If we agree that the other standard is equivalent, then we would add it to the use condition on FMEAs through a rulemaking.

Comment: A commenter expressed that EPA's approach to setting use conditions infringes upon the Department of Transportation's motor vehicle safety jurisdiction and that EPA does not have the authority to protect against any fire risk associated with motor vehicles.

Response: As an initial matter, we note that the commenter does not point to any specific legislative authority that supports his claim. Regardless, EPA disagrees with this commenter. Section 612 of the CAA provides that EPA may find substitutes for ODS acceptable if they present less risk to human health and the environment than other substitutes that are currently or potentially available. Congress did not establish any limits on EPA's authority for ensuring that substitutes are not more risky than other substitutes that are available and EPA has consistently interpreted this provision to allow the Agency to establish use conditions to ensure safe use of substitutes. In this case, we find that HFO-1234yf may be used safely, and with risks comparable to or less than those of other available substitutes for CFC-12 in the MVAC end-use, so long as it is used according to the use conditions established by this action. If the commenter were correct that the Department of Transportation (DOT) has sole authority to address safety risks from MVAC systems, in the absence of standards from DOT addressing HFO-1234yf's risks, EPA would need to determine that HFO-1234yf is unacceptable for use in MVACs.

C. Environmental Impacts

1. Ozone Depletion Potential

Comment: Several commenters agreed with EPA's proposed finding that HFO-1234yf would not contribute significantly to stratospheric ozone depletion, and that the ozone depletion potential (ODP) of HFO-1234yf is at or near zero. Two commenters claimed that the ODP of HFO-1234yf should be stated as "zero" instead of "nearly zero," and one commenter requested that EPA clarify that HFO-1234yf has an ODP less than that of HFC-134a.

Other commenters disagreed with EPA's statement that the ODP of HFO-1234vf is at or near zero. One commenter expressed concern that ODS may be used in the HFO-1234vf manufacturing process, or emissions of HFO-1234vf and its by-products from the manufacturing process may break down into gases with ODPs; this commenter advised EPA against listing HFO-1234yf as an acceptable replacement for HFC-134a in MVACs. Another commenter stated that HFO-1234yf requires further investigation since unsaturated HFCs such as HFO-1234yf might break down into gases that are ozone depleting.



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Response: It is generally agreed among scientists that substances that contain chlorine, bromine or iodine may have an ozone depletion potential while those that contain only fluorine effectively have no ODP. In particular. this is because the CF3 radical produced from HFCs has negligible reactivity (Ravishankara et al., 1993); the same radicals would be expected from HFO-1234yf, HFO-1234yf contains no chlorine, bromine, or iodine. Also, the atmospheric lifetime of HFO-1234yf is estimated at only 11 to 12 days (Orkin et al., 1997; Papadimitrou et al., 2007), further reducing the amount of the chemical that could possibly reach the stratosphere. Unsaturated HFCs, such as HFO-1234yf, have at least one double bond or triple bond between two carbon atoms. Double bonds, like those in HFO-1234yf, are less stable than single bonds. A saturated HFC, such as HFC-134a, has only single bonds between atoms of carbon, and is thus more stable. Although HFO-1234yf may be more unstable than HFC-134a, EPA is not aware of any chemical reactions or decomposition pathways that would cause HFO-1234yf or its breakdown products to lead to ozone depletion and the commenter has provided no technical or scientific support for their claims. For purposes of our determination, whether its ODP is zero or nearly zero, we expect HFO-1234yf to have negligible impact on the ozone layer and we are listing it as acceptable, subject to use conditions.

2. Global Warming Potential

Comment: Several commenters agreed with EPA's statement that HFO-1234yf has a global warming potential (GWP) of 4 over a 100-year time horizon. Some commenters noted the potential environmental benefits of having a lower GWP refrigerant available. Other commenters stated that HFO-1234yf would not be a solution to high global warming impacts because of environmental and health impacts of breakdown products, including HF, trifluoroacetic acid (TFA), and aldehydes.

Response: EPA continues to believe that the 100-yr GWP of HFO-1234yf is 4, as supported by the commenters. We further agree with the commenters who state that there will be an environmental benefit if car manufacturers switch to HFO-1234yf from HFC-134a, a refrigerant with a GWP of 1430 relative to CO₂

We disagree with the commenters who claim that environmental and health impacts of breakdown products are a major cause for concern or will prevent HFO-1234yf from being a

useful solution to high global warming impacts. One commenter mentioned concerns about HF in the atmosphere, but HFO-1234yf does not decompose to form significant amounts of HF in the atmosphere. In fact, HFC-134a and HFC-152a result in more HF in the atmosphere than HFO-1234yf because those two compounds decompose to form both COF2, carbonyl fluoride (and then HF and CO2) and CF3COF, trifluoroacetyl fluoride (and then TFA); in contrast, HFO-1234yf favors forming trifluoroacetyl fluoride (and then TFA) and does not decompose to carbonyl fluoride or to HF (ICF, 2010d). For a discussion on the potential human health impacts of HF, see sections V and VII.D.3, "Why is EPA finding HFO-1234yf acceptable subject to use conditions?" and "Toxicity of Hydrogen Fluoride.

The fluorinated breakdown product that we have identified of greatest concern is TFA, because of its persistence and potential impacts on aquatic plants. As discussed above in section V and below in section VII.C.5. "Formation of Trifluoroacetic Acid and Ecosystem Impacts," the projected concentrations of TFA, based on a conservative analysis, will be far below the level expected to cause any adverse impacts on aquatic life.

EPA agrees that the breakdown products from the decomposition of HFO-1234yf will include aldehydes, but we disagree that this is a cause for concern. As part of the analysis of the atmospheric breakdown products of HFO-1234yf, we found that worst-case concentrations of formaldehyde would reach 6 to 8 parts per trillion (ppt) on a monthly basis or an average of 3 ppt on an annual average basis, compared to a health-based limit of 8000 ppt,¹⁷ i.e., a level that is roughly 1000 to 2600 times lower than the health-based limit (ICF, 2010d). Acetaldehyde levels would be even lower, with worst-case concentrations of 1.2 ppt and annual average concentrations of 0.23 ppt. compared to a health-based limit of 5000 ppt 18 (ICF, 2010d). As discussed further below in section VII.D.1 of the preamble, "Toxicity of HFO-1234yf," these concentrations are one to three orders of magnitude less than ambient

concentrations of formaldehyde and acetaldehyde without the introduction of HFO-1234yf (ICF, 2010d), Thus, aldehydes that would be decomposition products of HFO-1234yf in the atmosphere would not contribute significantly to adverse health effects for people on earth's surface.

Other fluorinated alternatives that are acceptable in the MVAC end-use, HFC– 134a and HFC–152a, also create fluorinated breakdown products, and there is not evidence to show that those from HFO–1234yf create significantly more risk for human health or the environment than breakdown products from other alternatives. Thus, even assuming that risks from breakdown products would exist, based on use of HFO–1234yf in the MVAC end-use, we do not believe those risks are greater than the risks posed by other acceptable alternatives.

3. Lifecycle Emissions of HFO-1234yf

Comment: One commenter stated that HFO-1234yf has the best global lifecycle climate performance (LCCP) and lower CO2 [equivalent] emissions compared to other alternatives However, another commenter stated that HFO-1234yf has a lower thermodynamic efficiency than HFC-134a and that its use could lead to increases in CO2 and other air pollutant emissions. The same commenter stated that there is no assurance that automakers would voluntarily add technologies to maintain current levels of MVAC efficiency when using HFO-1234yf.

Response: We note that EPA has chosen to use GWP as the primary metric for climate impact for the SNAP program, while also considering energy efficiency (March 18, 1994; 59 FR 13044). We have not used specific lifecycle metrics such as Total Equivalent Warming Impact (TEWI). Lifecycle Analysis (LCA) or LCCP as metrics for climate impact, since it is not clear that there is agreement in all industrial sectors or end-uses on which of these measures is most appropriate in which situations or how these metrics are to be calculated (SROC, 2005).

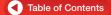
The available information on efficiency, LCCP and lifecycle emissions for MVAC does not raise concern that the indirect climate impacts from HFO– 1234yf will cause significantly greater impacts on human health and the environment than other available alternatives. Looking at some of the information referenced by the commenters, we learned that:

 Bench testing for the Japan Automobile Manufacturers Association (JAMA) and the Japan

¹² The Agency for Toxic Substances and Disease Registry (ATSDR) has established a chronic inhalation minimal risk level (MRL) of 0.008 ppm (0,000 ppt) for formaldehyde (ICF, 2010d). MRLs are available online at http://www.atsdr.cdc.gov/ unt/s/mbl_bit.html.

¹⁶EPA has established a Reference Concentration (RR) of 0.005 pairs (5.000 ppi or 0.000 mg/m³) for acctaldehyde (RCP, 2010d). A summary of EPA's documentation for its risk assessment and RRC derivation for acataldehyde is available online at http://www.epa.gov/neoa/itsi/subst/0290.htm.

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Auto Parts Industry Association (JAPIA) found a system efficiency (coefficient of performance) for HFO– 1234yf that is roughly 96% of that for HFC–134a (JAMA–JAPIA, 2008)

- LCCP analysis conducted by JAMA found that indirect CO₂ equivalent emissions from less efficient fuel usage due to use of the MVAC system were a few percent higher for HFO– 1234yf and roughly 20 to 25% higher for CO₂, compared to HFC–134a (JAMA, 2008)
- JAMA's LCCP analysis found that when both direct emissions of refrigerant and indirect emissions from less efficient fuel usage are considered, HFC-134a has higher total climate impact than either HFO-1234yf or CO₂; in hotter climates like Phoenix, Arizona, HFC-134a has higher total climate impact than HFO-1234yf but slightly lower climate impact than CO₂; and in all cases, HFO-1234yf had the lowest total climate impact of the three alternatives. (JAMA, 2008)
- MVAC systems can be designed to improve efficiency through steps such as changing the compressor, sealing the area around the air inlet, changing the thermal expansion valve, improving the efficiency of the internal heat exchanger, adding an oil separator to the compressor, and changing the design of the evaporator. Optimized new MVAC systems using either HFO-1234yf or CO₂ can reduce fuel usage compared to current MVAC systems using HFC-134a. (Benouali *et al.*, 2008; Meyer, 2008; Monforte *et al.*, 2008)

EPA believes that there is good reason to expect that automobile manufacturers will choose to design new cars using more efficient MVAC components and systems than in the past because of recent regulations. The Department of Transportation has issued new regulations raising the Corporate Average Fuel Economy standards for vehicles and EPA has issued new regulations restricting greenhouse gas emissions from light-duty vehicles (75 FR 25324; May 7, 2010). Thus, in order to ensure that their fleets meet these standards, it is highly likely that automobile manufacturers will include MVAC systems optimized for efficiency in future models, regardless of the refrigerant used.

Comment: Concerning an appropriate rate of emissions for estimating environmental impacts of HFO-1234yf, three commenters recommended that EPA use 50 g per vehicle per year total lifecycle emission rate. These commenters cited the work of Wallington et al. (2008) and Papasavva et al. (2009).¹⁹ Another commenter stated that HFO-1234yf is very likely to have a lower leak rate than HFC-134a, citing data on permeability for both refrigerants.

Response: EPA agrees that the permeability data indicate that regular leakage emissions of HFO-1234yf. which are released slowly through hoses, are likely to be lower than those from HFC-134a. However, this is only a portion of total emissions expected because emissions may also come through irregular leaks due to damage to the MVAC system, refrigerant loss during servicing, and refrigerant loss at the end of vehicle life. In response to the commenters who suggested that we use an annual emission rate of 50 g/ vehicle/yr, we reexamined environmental impacts as part of our final environmental analysis (ICF. 2010c) using the recommended 50 g/ vehicle/yr value and compared this to the impacts calculated assuming emissions are similar to those from HFC-134a in MVAC, as we did at the time of proposal (closer to 100 g/ vehicle/yr). The emission values from using 50 g/vehicle/yr (i.e., values from the Pappasavva et al. (2009) study) were 26.3% to 51.1% less than the emission estimates used in our analysis at the time of proposal (ICF, 2009; ICF, 2010a; ICF, 2010c). In either case, as described more fully in section V above and in sections VII.C.4 and VII.C.5, below, the overall environmental impacts on generation of ground-level ozone and of FFA were sufficiently low and the impacts of HFO-1234yf are not significantly greater than those of other available substitutes for MVAC. For further information, see the ICF analyses in the docket (ICF, 2010a,b,c,e).

4. Ground-Level Ozone Formation

Comment: Some commenters expressed concern about a potential increase in ground-level ozone of > 1-4% calculated in EPA's initial assessment (ICF, 2009) of environmental impacts of HFO-1234yf, Other commenters stated that HFO-1234yf will not contribute significantly to ground-level ozone. One commenter suggested that EPA provide an updated assessment of the potential contribution of HFO-1234yf to ground-level ozone, considering the additional information provided in public comments (e.g., Luecken et al., 2009 and Wallington et al., 2009).²⁰

Response: We proposed that HFO-1234yf would be acceptable, even with a worst-case increase in ground-level ozone of > 1 to 4%. In response to comments, EPA performed a new analysis that (1) used revised estimates of the expected emissions of HFO-1234yf; and (2) used reactions with ozone formation from hydroxyl radicals rather than using sulfur dioxide (SO₂) as a surrogate for the hydroxyl radical, OH, and rather than making assumptions about the relative reactivity of compounds. Our revised analysis (ICF, 2010b) estimates that emissions of HFO-1234yf might cause increases in ground-level ozone of approximately 0.08 ppb or 0.1% of the ozone standard in the worst case, rather than an increase of 1.4 to 4% as determined in our initial analysis (ICF, 2009). This value also agrees with results from Kajihara et al., 2010 and Luecken et al., 2009. This revised analysis provides additional support that HFO-1234yf will not create significant impacts on ground level ozone formation or on local air quality.

Comment: Some commenters disagreed with EPA's statement that HFO-1234yf has a photochemical ozone creation potential (POCP) comparable to that of ethylene (100), while others agreed with this conclusion. One commenter provided a peer reviewed study that estimated the POCP of HFO-1234yf to be 7 (Wallington *et al.*, 2010).

Response: Based on the comments received and additional studies, EPA believes that the initial assessment that assumed a POCP of 100 to 300 is overly conservative. We have revised our initial analysis to incorporate reaction kinetics specific to HFO-1234yf. consistent with Luecken et al., 2009, which avoids making an assumption of POCP. EPA's revised analysis estimates worst-case increases in ground-level ozone formation of approximately 0.1% (ICF, 2010b). Compared to the uncertainty in the sources of emissions, the uncertainty in the measures that localities will take to meet the ozone standard, and the uncertainty in the analysis, a projected worst-case increase in ozone of 0.1% is not significant for purposes of determining that HFO-1234yf poses substantially greater human health or environmental risk than other alternatives. This provides further support for our proposed determination that the conditioned use of HFO-1234yf does not present a

¹⁰ Papasarva et al. (2000) includes several sources of emissions of automobile refrigerant, including regular leaks through hoses, irregular leaks, refrigerant loss during servicing, and refrigerant loss at end of vehicle life.

²⁰ Prepublication version of Wallington et al., 2010 (Docket item EPA-HQ-OAR-2008-0664-0084.2)



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significantly larger risk to human health and the environment compared to HFC– 134a, and in many cases likely poses less risk. For further information, see the analysis of environmental impacts in section V of the preamble, "Why is EPA finding HFO–1234yf acceptable subject to use conditions?" and see the analysis in the docket (ICF, 2010b).

Comment: A commenter provided a link to a paper (Carter, 2009) that found the maximum incremental reactivity (MIR) for HFO-1234yf to be about the same as that for ethane, Based on the MIR value for HFO-1234yf, some commenters stated that EPA should find HFO-1234yf to be exempt from the definition of VOC.

Besponse: (Note: EPA has previously found certain compounds exempt from the definition of "volatile organic compound" [VOC] for purposes of air regulations in State Implementation Plans, 40 CFR 51.100(s), if they have a MIR equal to or less than that of ethane on a mass basis [69 FR 69298, November 29, 2004; 74 FR 29595, June 23, 2009; also see interim EPA guidance at 70 FR 54046, September 13, 2005].) In a separate rulemaking process, EPA is considering whether to list HFO-1234yf under 40 CFR 51.100(s) as exempt from the definition of VOC for purposes of air regulations that States may adopt in State Implementation Plans.

5. Formation of Trifluoroacetic Acid and Ecosystem Impacts

Comment: Several commenters agreed with EPA's proposed finding that the projected maximum concentration of TFA in rainwater from degradation of HFO-1234yf does not pose a significant aquatic toxicity risk. Other commenters raised concern about the potential impacts of TFA on biodiversity ecosystems, and human health. One commenter questioned the sustainability of HFO-1234yf, so long as there are questions remaining about its environmental fate and degradation. One commenter stated that artificial input of TFA into the environment should be avoided because of its toxicity and chemical properties. Another commenter stated that HFO-1234yf poses additional environmental concerns compared to HFC-134a and advised against finding it acceptable while the issue of TFA production is being further researched. Response: We continue to conclude

Response: We continue to conclude for purposes of our decision here that the degradation of HFO-1234yf into TFA does not pose a significant risk of aquatic toxicity or ecosystem impacts. All available research indicates that, assuming emissions are no more than twice the current level of emissions from HFC-134a from MVAC, TFA concentrations in surface water and rainwater will be on the order of 1/ 800th to 1/80th of the no observed adverse effect level (NOAEL) for the most sensitive known alga (Luecken et al., 2009; Kajihara et al., 2010). We have revised our analysis on TFA concentrations using the known reaction kinetics of HFO-1234yf. The revised estimate of the worst-case TFA concentration in rainwater is approximately 1700 ng/L, similar to the concentrations in Luecken et al. (2009) of 1260 ng/L and Kajihara et al. (2010) of 450 ng/L. We believe this provides a sufficient margin of protection to find that the use of HFO-1234yf in MVAC will not pose significantly greater risks than other available alternatives in this end-use.

Comment: Some commenters stated that further research on TFA is necessary.

Response: EPA has considered additional studies submitted during the public comment period (Luecken et al., 2009; Kajihara et al., 2010) and has performed further analysis on this issue. Luecken et al. (2009) predicted through modeling that in the U.S., HFO-1234yf used in MVAC would result in enough TFA to increase its concentration in rainwater to 1/80th to 1/800th of the NOAEL for the most sensitive plant species considered. Kajihara et al. (2010) predicted through modeling that in Japan, HFO-1234yf use in all potential refrigeration uses would increase the TFA concentration in surface water to no more than 1/80th of the NOAEL for the most sensitive plant species considered. This study also found that surface water concentrations were roughly twice those in rainwater. Thus, even with highly conservative modeling that also considered accumulation in surface water, the concentrations of TFA are likely to be at least 80 times lower than a level expected to have no impact on the most sensitive aquatic specie

We also performed a further modeling analysis using refined assumptions on emissions and the mechanisms by which HFO-1234yf might break down. We found that the worst-case concentration of TFA would be approximately 1700 ng/L, similar to the concentrations in Luecken et al. (2009) of 1260 ng/L and Kajihara et al. (2010) of 450 ng/L (ICF, 2010b). These additional studies and analyses indicate even less risk than the studies available at the time of proposal and thus provide further support that TFA emissions from MVAC system will not pose a significant risk of aquatic toxicity or ecosystem impacts.

We also note that EPA has an obligation to act on submissions in a timely manner under the Clean Air Act (§ 612(d)). Given that research to date has not indicated a significant risk, we disagree that the Agency should delay a final decision to await further studies that may be done in the future. If future studies indicate that HFO-1234yf poses a significantly greater environmental risk than we now believe, section 612(d) provides a process for an interested party to petition the Agency to change a listing decision.

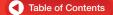
Comment: Two commenters stated that EPA's initial modeling (EPA-HQ-OAR-2008-0664-0037) greatly overestimates the local deposition of TFA from oxidation of HFO-1234yf. In particular, one commenter claimed that the modeling's use of the oxidation of SO₂ to sulfate ion, SO₃-, as a proxy for the oxidation of HFO-1234yf is overly conservative because a large portion of SO₂ is in aerosol form, unlike for HFO-1234yf. This commenter also referred to the impacts found in the peer-reviewed paper by Luecken et al. (2009).

Response: EPA agrees that the use of the oxidation of SO₂ to SO₅ - as a proxy for the oxidation of HFO-1234yf likely results in overestimating TFA concentrations. This is because the sulfate particle is a condensation nucleus in the wet deposition process and it has a very high removal efficiency compared to the gas phase process for wet deposition that acts with HFO– 1234yf and its decomposition products. Further, TFA forms more slowly from HFO–1234yf than sulfate forms from SO₂ (ICF, 2010b).

We have repeated the modeling using refined assumptions on emissions and the mechanisms by which HFO-1234yf might break down. This revised assessment (ICF, 2010b) found TFA concentrations roughly one-thousandth those in the earlier assessment (1700 ng/ L compared to 1,800,000 ng/L in ICF, 2009). This additional research provides stronger support for our conclusion that the degradation of HFO-1234yf into TFA does not pose a significant risk of acoustic toxicity or ecosystem impacts

aquatic toxicity or ecosystem impacts. *Comment:* Some commenters disagreed with a statement in the ICF (2009) analysis concerning TFA concentrations in surface waters, that "the exception to this is vernal pools and similar seasonal water bodies that have no significant outflow capacity." These commenters believe that Boutonnet *et al.* (1999) showed that accumulation of trifluoroacetate, a compound closely related to TFA, was rather limited in seasonal water bodies. The commenters also stated that Benesch *et al.* (2002) conducted an

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experimental study of the impacts of TFA on vernal pools, in which no impacts were observed.

Response: The statement from ICF, 2009 in context stated: NOECs [No-observed effect

concentrations] were compared to rainwater TFA concentrations because for most water bodies, it is difficult to predict what the actual TFA concentration will be. This is because concentrations of environmental contaminants in most fresh water bodies fluctuate widely due to varying inputs and outputs to most ponds, lakes, and streams. Comparison of NOECs to rainwater concentrations of TFA is actually more conservative because TFA is expected to be diluted in most freshwater bodies. The exception to this is vernal pools and similar seasonal water bodies that have no significant outflow capacity. (ICF, 2009)

We note that the "exception" described in the analysis is an exception to the expectation that TFA will be diluted more in freshwater bodies than in rainwater. We believe that the available evidence confirms that vernal pools do not dilute TFA as much as freshwater bodies with outflow capacity. Modeling by Kajihara et al., 2010 found surface water concentrations were roughly twice those in rainwater. However, even these concentrations were not high enough to be of significant concern for environmental impacts. As noted previously, even the highest levels of TFA concentrations were at least 80 times less than the NOAEL for the most sensitive aquatic species examined.

D. Health and Safety Impacts

1. Toxicity of HFO-1234yf

Comment: Three commenters stated that there are no toxicity concerns with using HFO-1234yf, and two commenters noted that HFO-1234yf is comparable to HFC-134a in terms of human health effects. One commenter also stated that HFO-1234vf does not present a developmental toxicity or lethality risk. Seven commenters stated that there are potential toxicity concerns with use of HFO-1234yf. One commenter cautioned EPA against listing HFO-1234yf as acceptable for use in MVACs on the grounds of increased concerns over developmental effects and other toxic effects on human health.

Response: EPA continues to believe that HFO-1234yf, when used in new MVAC systems in accordance with the use conditions in this final rule, does not result in significantly greater risks to human health than the use of other available or potentially available substitutes, such as HFC-134a or CO2. The results of most of the toxicity tests for HFO-1234yf either confirmed no observed adverse health effects, or found health effects at similar or higher exposure levels than for HFC-134a. For example, HFC-134a caused cardiac sensitization at 75,000 ppm but HFO-1234vf did not cause cardiac sensitization even at 120,000 ppm, the highest level in the study (NRC, 1996; WIL 2006). NOAELs from subacute exposure were higher for HFO-1234vf than for HFC-134a (NOAELs of 51,690 for HFO-1234yf with no effects seen in the study, compared to 10,000 ppm for HFC-134a with lung lesions and reproductive effects seen at 50,000 ppm [NRC, 1996; TNO, 2005]). No adverse effects were seen at 50,000 ppm or any other level in subchronic (13-week) studies for both HFO-1234yf and HFC-134a (NRC, 1996; TNO, 2007a).

In mutagenicity testing for HFO-1234yf, the two most sensitive of five strains of bacteria showed mutation; however, this screening test for carcinogenic potential is known to have only a weak correlation with carcinogenicity (Parodi et al., 1982; 21 Kirkland et al., 2005 22), so a positive result in this test for the two most sensitive strains is not sufficient reason to consider HFO-1234yf to be a significant health risk. Mutagenicity testing for HFC-134a by the same test found no evidence of mutagenicity, Screening for carcinogenic potential in a genomics study did not identify HFO-1234yf as a likely carcinogen (Hamner Institutes, 2007). A two-year cancer assay for HFC-134a did not find evidence of carcinogenicity (NRC, 1996].

EPA considers the results of developmental testing to date to be of some concern, but not a sufficient basis to find HFO-1234yf unacceptable for purposes of this action under the SNAP program. In a developmental study on rats, cases of wavy ribs were seen in some developing fetuses during exposure to HFO-1234yf (TNO 2007b); however, effects on bone formation were also seen for HFC-134a (NRC, 1996). It is not clear if this effect is reversible or not. Interim results from a twogeneration reproductive study did not find an association between exposure to HFO-1234yf and skeletal effects. This two-generation reproductive study for HFO-1234yf finds a NOAEL of 5000 ppm for delayed mean time to vaginal opening in F1 females (females in the first generation of offspring). A subacute (28-day) test for HFC-134a (single generation) found a NOAEL of 10,000 ppm for male reproductive effects (NRC, 1996). A developmental test on rabbits exposed to HFO-1234yf did not find effects on the developing fetus. However, some of the mother rabbits in this study died. The reason for the deaths is not known. The data on developmental effects are inconsistent depending on the test performed and the species tested. The development effects observed in the developmental study on rats are not significantly different from the developmental effects observed for HFC-134a. In any case, as discussed above in section V and below in this section, our risk assessments found that HFO-1234yf would likely be used with exposure levels well below those of concern in the uses allowed under this rule. Thus, we do not find the observed developmental effects sufficient reason for finding HFO-1234yf unacceptable in this rule.

For purposes of this action, we prepared our risk assessment for long term exposure using the level at which no deaths or other adverse health effects were seen in the rabbit developmental study-a "no observed adverse effect level" or NOAEL-to ensure that exposed people would be protected. The longer-term, repeated exposure in that study would be the exposure pattern (though not necessarily the exposure level) for a worker using HFO-1234yf on a regular basis or for a consumer exposed in a car due to a long, slow leak into the passenger compartment. Using the NOAEL concentration of 4000 ppm as a starting point, we found no situations where we expect exposure to exceed the level that EPA considers safe for long-term or repeated exposure (EPA-HQ-OAR-2008-0664-0036). Thus, we consider the potential toxicity risks of HFO-1234yf for those uses allowed under this action to be addressed sufficiently to list it as acceptable subject to use conditions

Comment: Based on a risk assessment conducted by one commenter, the commenter concluded that if HFO-1234yf is used under the conditions specified in the commenter's risk assessment, adverse health impacts would not be expected to car occupants, to servicing personnel, or to do-ityourself (DIY) consumers. This commenter noted differences between the margin-of-exposure approach to

¹¹Predictive ability of the automoliographic repair assay in rat liver cells compared with the Ames test; S. Parodi: M. Taningher; C. Balbi, L. Senti, *Journal* of *Taxkeology and Environmental Health*, Vol. 10, Isrue 4 & 5, October 1962, pages 531–539.

^{**}Kirkland et al. (2005) Evaluation of a battery of three in vitro genotoxicity tests to determine rodent carcinogens and non-carcinogens. I. Sensitivity, specificity and rolative predictivity, Matation Berearch, 504, 1~256.



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assessing risk, as in EPA's risk assessment (EPA-HQ-OAR-2008-0664-0036), and the commenter's hazard index (HI) approach. The commenter further stated that in all cases, the predicted hazard index for HFO-1234yf was only one-half of the values predicted for HFC-134a, and in some cases, only one-third of the HFC-134a values, demonstrating from a health perspective that HFO-1234yf is a viable alternative to HFC-134a.

Response: EPA agrees that adverse health impacts would not be expected to car occupants or to servicing personnel, so long as the use conditions of this rule are observed. However, EPA has issued a Significant New Use Rule under TSCA (October 27, 2010; 75 FR 65987) that would require submission of additional information to EPA prior to the manufacture, import or processing of HFO-1234yf for certain uses, including distribution in commerce of products intended for use by a consumer for the purposes of servicing, maintenance and disposal involving HFO-1234yf (e.g., "do-it-yourself" servicing of MVAC systems).

Where available, it is EPA policy to use a NOAEL (No-Observed-Adverse-Effect Level) for the point of departure (POD) for risk assessment. This is the highest exposure level that did not cause an adverse health effect in a study. In this case, EPA selected the POD from an animal (rat 2-week inhalation) study. Because animals may respond to different exposure levels than humans, there is some uncertainty when extrapolating from animals to humans. For this reason, an Uncertainty Factor (UF) is applied when extrapolating from animals to humanstypically a factor of 10 is used but, in this case, since there was a reasonable estimate of the pharmacokinetic component of the uncertainty, this UF was reduced to 3. An additional UF is applied to account for variation in the human population response to a chemical exposure-in this case, a UF of 10 was used. The two UFs give a resultant UF of 30 to yield an acceptable level of health risk. As stated in the final SNUR, EPA's policy for review of new chemicals under TSCA is to divide the POD by the exposure level to obtain the MOE. For HFO-1234yf, the "acceptable level of health risk" would be an MOE of 30 or greater.

The commenter proposed dividing the estimated exposure to HFO-1234yf by the POD levels to obtain a HL As a result, if the exposure is less than the POD, the HI is < 1 and the commenter considered this an "acceptable level of health risk," The commenter's approach to the bazard index does not factor in

uncertainties about extrapolating from animal to human responses, nor does it address variability within the human population with regard to thresholds of response to chemical exposures. EPA has consistently applied the margin of exposure (MOE) approach to evaluations of pre-manufacture notices (and for certain other risk assessments) in order to account for the uncertainties discussed above. The SNAP program considered work performed during evaluation of the pre-manufacture notice (EPA-HQ-OAR-2008-0664-0036), as well as a separate SNAP program risk screen (EPA-HQ-OAR-2008-0664-0038). SNAP program risk screens compare expected exposures to exposure limits that incorporate uncertainty factors based on EPA guidance, rather than calculating either hazard index or a margin of exposure. Any of these approaches to risk assessment will come to a similar conclusion about whether there is a potential health concern when using the same point of departure, uncertainty factors, and exposure estimates

The Agency and the commenter disagree on all three of these inputs to the risk assessment and hence have reached different conclusions. Despite these differences, the assessments relied on by both the commenter and EPA show that there is low risk both to car occupants and to service technicians. EPA's risk assessment indicates a potential risk to DIYers (EPA-HQ-OAR-2008-0664-0036). As stated previously in this action, this issue is further addressed through the Agency's authority under TSCA.

Comment: In response to EPA's risk assessment (EPA-HQ-OAR-2008-0664-0036), two commenters disagreed with the use of a 2-week study for evaluating 30 minute exposures and stated that acute toxicity (4-hour test) or cardiac sensitization test results would be more appropriate for acute exposure evaluations.

Response: Commenters have suggested that EPA use data from the 4-hour acute toxicity study or from the cardiac sensitization study as a starting point ("point of departure") for assessing risks of short-term (acute) exposure. However, cardiac sensitization studies are for very short durations-on the order of 10 minutes-and they only address cardiac sensitization, HFO-1234yf does not induce cardiac sensitization. EPA selected the point of departure for acute effects from a multiple-exposure 2-week (subacute) rat inhalation study on HFO-1234yf, reasoning that if no effects were seen in the duration of the study (6 hours per day, 5 days per week for 2 weeks), that

no effects would be seen from a single exposure at a similar exposure level, either. Further, the subacute exposure rat study included more thorough pathology examinations than those included in a cardiac sensitization study.

The acute 4-hour exposure study in rats showed some lung effects at approximately 200,000 ppm, the lowest exposure level in the study. Thus EPA considers 200,000 ppm to be a LOAEL (Low-Observed-Adverse-Effect Level). If a LOAEL were used in the risk assessment instead of a NOAEL, EPA would use an uncertainty factor to estimate a NOAEL, which would result in a lower POD than what was used. For example, if EPA had started with the LOAEL of 200,000 ppm, it would have required an additional MOE of 10 to estimate a NOAEL from a LOAEL, for a total MOE of 300 instead of 30. This would have resulted in a more conservative risk assessment than using the NOAEL from the 14-day subacute study. In the 4-hour acute toxicity study, some of the animals had grey discolored lungs at all exposure levels in the study, and we considered this an adverse effect. Thus, EPA could only determine a lowest observed adverse effect level (LOAEL) from the 4-hour acute study and could not determine a no observed adverse effect level (NOAEL). It is longstanding Agency policy to use the NOAEL where available instead of a LOAEL, because of greater assurance of a safe exposure level, EPA instead used the NOAEL for the next shortest study, the subacute 14day study, as the endpoint of concern for short term exposure because the LOAEL from the acute 4-hour study is an endpoint showing effects that may not result in safe exposure levels for humans. If we had used the value from the 4-hour acute toxicity study, we would have had to consider additional uncertainty that would have resulted in a more conservative, more restrictive risk assessment than using the NOAEL

from the 14-day subacute study. Further, EPA has uncertainties about using the available single exposure studies on HPO-1234yf to determine the MOEs for different exposure scenarios. As a result of concerns with these studies, EPA calculated single exposure MOEs from the NOAEL in the 2-week inhalation toxicity study of HFO-1234yf in rats. There are some uncertainties in the single exposure (acute) assessments because of the observation of lethality in rabbit dams after multiple exposures to HFO-1234yf in a developmental study. For these reasons, EPA recommended an acute inhalation toxicity study on rabbits in the proposed SNUR to address



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the question of whether pregnant rabbits would die from a single exposure (April 2, 2010; 75 FR 16706).

Comment: A commenter asserted that EPA's methodology to estimate the exposure levels associated with the DIY use, using the SAE CRP (2008) Phase II Report, greatly exaggerates the exposure that could be experienced in actual use conditions. Another commenter calculated exposure to a DIYer assuming that the refrigerant fills a garage and concluded that exposure would be less than the manufacturer's recommended exposure limit of 1000 ppm. The first commenter stated that the 30 minute time-weighted average (TWA) value used by the EPA is unrealistic as are the exposure estimates presented in Scenarios 1 and 2 of the supporting document EPA-HQ-OAR-2008-0664-0036. The specific exposure parameters that the commenters questioned were assumptions regarding:
 Garage volume;

· Time the user spent under the hood during recharging operations:

 The size of the space where any leaking gas would disperse;

 The air exchange rate in a service area that should be well-ventilated when the engine is running;

 Use of the refrigerant in a closed garage with no ventilation; and, · The amount of refrigerant used

during recharge operations. During the comment period for the proposed SNUR, the PMN and SNAP submitter conducted a simulated vehicle service leak testing, using HFC-134a as a surrogate, indicating that exposures from use of a 12-oz can during consumer DIY use are below the Agency's level of concern for HFO-1234yf (Honeywell, 2010a). Response: Concerning exposure

estimates for DIYers, the exposure values in the EPA risk assessment (EPA-HQ-OAR-2008-0664-0036) are bounding estimates of the maximum possible theoretical concentrations. The EPA assessment used the industrymodeled DIY scenarios and assumptions in a 2008 report by Gradient Corporation for the SAE CRP (CRP, 2008) as a starting point for creating the bounding estimates. To do so, EPA assumed that the entire leakage mass of each industry-modeled scenario was released to its corresponding volume with no air exchange. These assumptions are conservative and protective, as intended.

We considered the calculations provided by one commenter that assumed that the refrigerant fills a garage. However, this analysis assumes a longer-term, steady-state concentration after the refrigerant has diffused

throughout the garage and uses a longterm, 8-hour time-weighted average exposure recommendation for comparison. EPA's concerns about DIY consumer exposure focuses on shortterm acute exposures, including peak exposures over a few minutes near the consumer's mouth and nose because typically a DIY consumer will only need a short period of time to recharge a single MVAC system (Clodic et al., 2008). Thus, the commenter's calculations do not address EPA's concerns.

After reviewing the consumer DIY use exposure study from the SNAP/PMN submitter, EPA responded with a list of clarifying questions (U.S. EPA, 2010c). to which the submitter subsequently responded (Honeywell, 2010b). Although the submitter's responses were helpful, EPA still has concerns about potential exposures to consumers during DIY use and the inherent toxicity of HFO-1234vf. However, since this acceptability determination is limited to use with fittings for large containers, which DIYers would not purchase, our concerns about potential health risk to DIY users need not be addressed in this action. We would plan to evaluate this issue further before taking a final action on a SNAP submission for unique fittings for small containers. We further note that the Agency would analyze this issue in the context of any SNUN filed pursuant to the recently issued SNUR (75 FR 65987). Although we do not reach any conclusion in this final rule regarding safe use by DIYers, we make the following observations about the submitted study. With regards to exposure, the peak concentration values from the submitted study are as high as 3% by volume, equivalent to 30,000 ppm. These peaks appeared to occur in the first one or two minutes of each emission, Accordingly, EPA would need exposure data presented and averaged out over shorter Time Weighted Averages (TWAs) than the 30 minutes currently in the study, because it would appear that a number of these early exposure neaks could result in TWA values that would result in MOEs less than the acceptable Agency level of 30 described above in this section. This is important because the data on HFO-1234yf are insufficient to differentiate whether the toxicity is due to blood level alone from an acute exposure, is due to accumulated exposure over time ("area under the curve"), or is due to some combination of both. Since blood equilibrium levels are reached within minutes, a high level of exposure in a short duration could result in blood levels exceeding a threshold if the mode of action of the toxicity of HFO-1234yf is due to blood levels of the chemical. EPA expects that exposure data with additional TWAs of 3, 5, and 10 minutes would help to resolve these issues of consumer exposure.

Comment: One commenter stated that HFOs could harm the human nervous system. The commenter cited a diagram of breakdown products in a slide presentation given by the Montreal Protocol Scientific Assessment Panel in July 2009 and suggested that the toxic impact of aldehydes formed as breakdown products would be higher than that of carbonic acids. Response: EPA agrees that the

breakdown products from the decomposition of HFO-1234yf will include aldehydes, but we disagree that this is a cause for concern. The aldehydes that would be produced as atmospheric breakdown products of HFO-1234yf are formaldehyde and acetaldehyde (ICF, 2010d). Their health effects include respiratory effects; irritation of the eyes, nose, and throat; and corrosion of the gastrointestinal tract. EPA also considers formaldehyde and acetaldehyde to be probable human carcinogens (U.S. EPA, 2000; ICF. 2010d). The decomposition products of HFO-1234yf are not noted for causing neurotoxic effects, and toxicity tests for HFO-1234yf did not identify this as an effect.

As part of analysis of the atmospheric breakdown products of HFO-1234yf, we found that worst-case concentrations of formaldehyde would reach 6 to 8 parts per trillion (ppt) on a monthly basis or an average of 3 ppt on an annual average basis, compared to a health-based limit of 8000 ppt 23-i.e., a level that is roughly 1000 to 2600 times lower than the health-based limit (ICF, 2010d). Acetaldehyde levels would be even lower, with worst-case concentrations of 1.2 ppt and annual average concentrations of 0.23 ppt, compared to a health-based limit of 5000 ppt 24 (ICF, 2010d). Thus, aldehydes that would be decomposition products of HFO-1234yf in the atmosphere would not contribute significantly to adverse human health effects (ICF, 2010d).

Aldehydes, including formaldehyde and acetaldehyde, are already present in

¹³ The Agency for Toxic Substances and Dise Registry (ATSDR) has established a chronic inhalation minimal risk level (MRL) of 0.008 ppn (8,000 ppt) for formaldehyde (ICF, 2010d). MRLs are available at http://www.atadr.cdc.gov/mrls/ list.html. mirls

array (pr) and a setablished a Reference Concentration (RIC) of 0.005 ppm (5,000 ppt or 0.009 mg/m³) for acetaldehyde (ICF, 2010d). A summary of EPA's documentation for its risk assessment and RIC derivation for acetaldehyde is available online at http://www.spa.gov/ncea/iris/subst/0290.htm



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the atmosphere in significant amounts from natural sources such as plants. from direct emissions, from combustion products, or from breakdown of other compounds such as hydrocarbons (NRC, 1981; Rhasa and Zellner, 1987). The current background level of formaldehyde in the atmosphere ranges from 80 ppt in pristine areas to approximately 3300 ppt in New York, NY-one to three orders of magnitude more than the worst-case generation of formaldehyde from HFO-1234yf (ICF, 2010d). The maximum incremental acetaldehyde concentration calculated due to use of HFO-1234yf was approximately three orders of magnitude less than the average concentration of acetaldehyde in areas with pristine air quality (ICF, 2010d). Thus, the additional aldehydes created during decomposition of HFO-1234yf in the atmosphere are not likely to have a significant impact on human health.

Comment: Some commenters stated that additional research and review of the available information regarding toxicity of HFO-1234yf needs to be conducted.

Response: EPA has an obligation to act on submissions in a timely manner under the Act (§ 612(d)). Our risk assessments to date have found no significant risk for car passengers or drivers, professional servicing personnel, or workers disposing of or recycling vehicles containing HFO-1234vf. We believe these assessments are sufficient to support this action. We note that these assessments rely on somewhat conservative assumptions

We note that we expect there will be no toxicity risks to DÍYers because EPA must receive and take regulatory action to allow unique fittings for use with small cans of refrigerant before DIYers could be exposed, as per appendix D to subpart G of 40 CFR part 82. Further, because HFO-1234yf is not expected to be introduced into any new cars until late 2011 or later, we expect to have further information and to take further action before DIYers could be exposed. In addition, the final SNUR would not allow distribution in commerce of products intended for use by a consumer for the purposes of servicing, maintenance and disposal involving HFO-1234yf until at least 90 days after submission of a SNUN.

We recognize that more studies will be performed on HFO-1234yf, further addressing risk. EPA's New Chemicals Program has recommended additional testing of acute exposure in rabbits, including pregnant rabbits (April 2, 2010; 75 FR 16706). In addition, the manufacturer is voluntarily conducting these or other future studies call into question the basis for our decision today, section 612 allows citizens to etition EPA to change or modify a listing decision or EPA could determine on its own to reassess this decision.

Comment: In late comments, a commenter stated that EPA appears to be relying on a SNUR to reduce risks to human health from exposure to HFO-1234yf. This commenter stated that EPA must re-open the comment period on the proposed SNAP rule so that commenters may reassess the extent to which the final restrictions of the SNUR will be effective at limiting adverse human health effects. The same commenter noted that information on new price levels and availability is needed to assess the effectiveness of the SNHR.

Response: EPA's final SNUR addresses potential risks to human health from exposure to HFO-1234vf. However, as discussed above in section V of the preamble, "Why is EPA listing HFO-1234yf as acceptable subject to use conditions?", this final SNAP rule does not allow for the use of HFO-1234yf with small cans or containers (i.e. container sizes that would be purchased by DIY users, such as small cans and containers less than 5 lbs) because it does not contain specifications for unique fittings for can taps and for these smaller containers. Existing SNAP program regulations in appendix D to subpart G of 40 CFR part 82 require the use of unique fittings for specific purposes (e.g., high pressure-side service port, small can taps) for each MVAC refrigerant, as submitted by the refrigerant manufacturer. Before HFO-1234vf can be introduced in small containers typically used by DIYers, the manufacturer must submit unique fittings to EPA, we must conclude that they are unique, and we must issue new proposed and final rules specifying those fittings. In addition, the final SNUR would not allow distribution in commerce of products intended for use by a consumer for the purposes of servicing, maintenance and disposal involving HFO-1234yf until at least 90 days after submission of a SNUN. These and other requirements ensure-to the extent possible, with the information currently available to EPA-that HFO-1234yf has no greater risk overall for human health and the environment than other available refrigerants for MVAC. Under the final SNUR, it is necessary

for EPA to receive and complete its review of a significant new use notice (SNUN) with additional information on consumer exposure risks before-if the Agency so decides-HFO-1234yf may a multi-generation reproductive study. If be manufactured, imported or processed

for the purpose of use in DIY servicing, with or without other restrictions. We would also consider information in the SNUN before issuing a final rule specifying unique fittings for use with small containers of refrigerant.

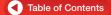
In comments EPA received on the roposed SNAP rule, the initial direct final SNUR that was withdrawn and the proposed SNUR, no commenters suggested making the provisions of the SNUR stricter or suggested adding use conditions under the SNAP program for addressing risks to consumers during DIY servicing. A number of commenters stated that no restrictions were needed to address risks to consumers during DIY servicing, while other commenters stated more broadly that EPA should find HFO-1234yf unacceptable because of its toxicity risks. We provided an additional opportunity for comment on the SNAP rule after the direct final SNUR was issued (February 1, 2010; 75 FR 4083), in response to a request to reopen the public comment period (EPA-HQ-OAR-2008-0664-0077.1), in part to allow comment on the relationship between these two rulemakings that both address HFO-1234yf. However, we do not believe that the conditions of the final SNUR are necessary to the determination that we are making here. As noted above, this final rule does not allow for the servicing of HFO-1234yf from container sizes that would be purchased by DIY users because of the lack of an approved unique fitting for smaller containers Further rulemaking under SNAP will occur prior to such use and any risks can be addressed in that rulemaking package. At that time, we will be able to fully consider the impact of the final SNUR.

2. Flammability

Comment: Five commenters stated that HFO-1234yf has a low likelihood of ignition, especially under the conditions encountered in an automotive application. One commenter stated that the mere presence of high refrigerant concentrations does not contribute to a hazardous condition because an ignition source of sufficient energy must also be present. Another commenter disagreed with EPA's view that a flammability risk exists. Other commenters stated that additional review of the available information regarding flammability of HFO-1234yf needs to be conducted. Some commenters stated that EPA should consider restricting concentrations of HFO-1234yf to much lower concentrations than to the lower flammability limit (LFL) of 6.2%

Response: The available evidence indicates that HFO-1234yf will not

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present a significant risk of flammability and that any risk it poses is not greater than the risk presented by other available alternatives. For example, because of its higher LFL, its considerably higher minimum ignition energy (5000 mJ to 10,000 mJ), and its slower flame speed (1.5 cm/s), HFO– 1234yf is less flammable than HFC– 152a, a substitute that EPA has already found acceptable subject to use conditions.

Further, an analysis conducted for SAE International's Cooperative Research Program by Gradient Corporation (CRP, 2009) found that there was a very low flammability risk (on order of 10⁻¹⁴ occurrences per operating hour or 1 occurrence in 100 years across the entire U.S. fleet of passenger vehicles). This was due to the low probability of achieving a concentration of HFO-1234yf above the LFL at the same time as having a sufficiently high energy source to cause the refrigerant to ignite. Further, even that low probability of ignition of HFO-1234yf may be overstated, because it assumes that a vehicle collision severe enough to crack open the evaporator (located under the windshield and steering wheel) is not severe enough to crack the windshield or windows that would hold refrigerant in the passenger compartment. In a sensitivity analysis, the SAE CRP considered how the flammability risk would change if a refrigerant release into the passenger compartment only occurs in a collision causing damage to more than the MVAC system. That analysis estimated that the risk of exposure to an open flame would then be reduced by a factor of 23,000, to approximately 4 × 10-19 occurrences per vehicle operating hour (EPA-HQ-OAR-2008-0664-0056.2).

For the reasons provided above in sections IV and VILB of the preamble, "What are the final use conditions and why did EPA finalize these use conditions?" and "Use conditions," EPA does not believe it is necessary to establish a use condition limiting refrigerant concentrations, whether at 6.2% or some other, lower value. We believe the final use conditions sufficiently address flammability risks.

Comment: Three commenters stated that HFO-1234yf is flammable and that the proposed regulation does not offer any restrictions to protect those persons handling HFO-1234yf, nor does it restrict its sale and use by the general public.

Response: The purpose of the use conditions is to ensure that HFO-1234yf will not pose a greater risk to human health or the environment than other available or potentially available substitutes. For all of the reasons provided in sections IV and V above. EPA has determined that HFO-1234yf will not pose a greater risk than other substitutes for MVAC. As explained above, EPA proposed restricting concentrations of the refrigerant below the LFL of 6.2% as a use condition. Based on comments and additional analysis, EPA has concluded that it is not necessary to require use conditions limiting refrigerant concentrations to below the LFL; rather, the use conditions now specify design parameters for MVAC systems and require an FMEA. This will ensure that systems are designed to minimize risk not only from flammability, but also from exposure to HF,

We will address use by service personnel through a rulemaking under ection 609 of the CAA. Although these rules will further address issues of interest to service personnel and others that might handle HFO-1234yf used in MVAC systems, we note that our risk assessments of use of HFO-1234yf found that significant flammability risks do not exist for personnel installing the refrigerant at equipment manufacture, professional servicing personnel, and personnel working with automobiles at equipment end-of-life (EPA-HQ-OAR-2008-0664-0036 and -0038). Moreover, we note that an industry-sponsored analysis of risks found the risk of ignition of HFO-1234yf to a technician is extremely small, on the order of 10occurrences per working hour (EPA-HQ-OAR-2008-0664-0056.2).

As we have explained above, this rule only addresses the use of large containers for professional use (typically 20 lbs or larger) and thus HFO-1234yf may not be used in small container sizes that would be the type purchased by the general public. We will address the issue of risk to DIY users through a future rulemaking under SNAP if we receive a request for unique fittings for smaller containers from the refrigerant manufacturer. We also are addressing risks to DIY users through the Significant New Use Rule under the Toxic Substances Control Act (October 27, 2010; 75 FR 65987).

Comment: One commenter stated that compared with HFC-134a, the explosion probability of HFO-1234yf is much higher based on testing done at the Federal Institute for Materials Research and Testing (Bundesanstalt für Materialforschung und-prüfung, BAM). Other commenters disagreed with those flammability conclusions, finding the testing results to be expected but not representative of real-world use in MVAC. These commenters stated that the flammability risks of HFO-1234yf were not significant and that the mixtures of HFO-1234yf and ethane used in the testing would not be seen in MVAC in actual operations.

Response: As explained above in section VII.B, we do not believe that these tests are relevant for assessing the flammability risks of HFO-1234yf as used in MVAC systems because they evaluated flammability based on the presence of ethane, a substance that should not be present in any situation that might cause flammability risks for MVAC systems.

3. Toxicity of Hydrogen Fluoride (HF)

Comment: Two commenters stated that there is low risk due to exposure to HF. One of these commenters stated that (1) for vehicles that do not discontinue the use of the blower after collision, the risk due to exposure to HF from use of HFO-1234yf is approximately twice the risk with the current use of HFC-134a, and (2) for vehicles that discontinue the use of the blower after collision, the risk due to exposure to HF when using HFO-1234yf is approximately the same as that with the current use of HFC-134a (on order of 10-12 occurrences per operating hour, or one in one trillion). The second commenter stated that there is no need for concentration limits to protect against exposure to HF because the risks from exposure to HF from HFO-1234yf are similar to what would be experienced with HFC-134a. One commenter also stated that concentrations of HF as low as 0.3 ppm cause a sensation of irritation. The commenter stated that this characteristic would deter someone from remaining exposed to excessive concentrations from an open hood.

Other commenters stated that there is a high probability of HF generation in cars from HFO-1234yf. One commenter stated that the flammability of HFO-1234vf makes the production of HF more likely and increases the risk of HF exposure to vehicle passengers, to workers at chemical facilities, automotive manufacturing facilities, vehicle servicing facilities, and to the general public. Two commenters stated that various health and safety concerns related to HF generation and its toxicity are well studied and documented, and three commenters stated that use of HFO-1234yf is unacceptable as there is increased potential for HF exposure and related casualties. Response: EPA has considered the

Response: EPA has considered the potential for generation of HF from HFO-1234yf, including the SAE CRP's evaluation of scenarios that might cause workplace and consumer exposure to HF (EPA-HQ-OAR-2008-0664-0056.2), SAE CRP members conducted



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tests to measure HF concentrations and to identify factors that were most likely to lead to HF formation. One set of tests conducted in a car found that HF measurements inside the passenger cabin were 35 ppm or less (EPA-HQ-OAR-2008-0664-0056.2). This highest value occurred during release of the entire charge of refrigerant of 1000 g into the passenger cabin with ignition started by a butane lighter augmented with an additional spark-a highly conservative scenario. (A more typical charge would be 575 g, and it would be unlikely to have the amount of ignition energy that occurred artificially in the experiment with use of both a butane lighter and an additional spark source.) A second set of tests focusing on HF in the engine compartment tried to simulate a major rupture in the AC system that would release 12 g/s of refrigerant across 5 cm onto an artificial hot surface at temperatures of 450 °C (typical of the exhaust manifold) and 700 °C (most extreme case), with the car hood in various positions. This testing found HF concentrations as high as 120 ppm at the hot surface in the engine compartment in the worst case, with interior passenger cabin values of 40 to 80 ppm in the worst case (EPA-HQ-OAR-2008-0664-0056.2). This test was conservative for the following reasons: The temperature was high, representing extreme conditions; the refrigerant was released extremely close to the hot surface; the hood was closed; and the refrigerant ignited briefly. The other test trials under less extreme conditions resulted in HF concentrations of a few ppm. The test trials also found somewhat lower concentrations of HF generated during testing of HFC-134a using the same procedures and apparatus, with maximum concentration of 36 ppm in the engine compartment and concentrations of less than 8 ppm in the passenger compartment in the worst case. The SAE CRP selected an Acute Exposure Guideline Limit (AEGL)-2 25 of 95 ppm over 10 minutes as its criterion for determining excessive risk. This limit was developed to protect against irreversible health effects when exposure remains below the limit of 95 ppm over 10 minutes, but short-term discomfort or irritation could still occur. Thus, even assuming a passenger inside a vehicle was exposed to HF at the highest level found in the test of 80

ppm, exposure at this level would at worst cause discomfort and irritation, rather than permanent or disabling health effects.

For both HFO-1234yf and for HFC-134a, HF concentrations in the passenger compartment fell between the level that would protect against all adverse health effects (AEGL-1 of 1.0 ppm for 10 minutes to 8 hours) and the level that would protect against irreversible or disabling health effects (AEGL-2 of 95 ppm over 10 minutes) (NRC, 2004). The SAE CRP concluded that the probability of such a worst case event is on the order of 10-12 occurrences per operating hour (EPA-HQ-OAR-2008-0664-0056.2). Commenters provided information indicating that this level of risk for HF generation is the same order of magnitude for both HFC-134a and for HFO-1234yf. EPA considers the risk level presented by HFO-1234yf to be similar to that of the refrigerant currently being used by automobile manufacturers, HFC-134a. Therefore, there is no reason to regulate HFO-1234yf more stringently to protect against HF exposure than for HFC-134a.

Comment: One commenter stated that testing with HFOs commissioned by the environmental organization Greenpeace in 2001 hinted at a multitude of decomposition products with high reactivity. The commenter stated that apparently even lubricants (polyalkylene glycol-PAG) break down to HF when in contact with HFO-1234yf in a MVAC system. The commenter further expressed that BAM testing showed that burning HFO-1234yf resulted in concentrations of HF greater than 90 ppm in the engine compartment. The commenter concluded that the tests prove that in a standard system with standard charge (900 grams) and oil, the risk for humans would be incalculable. Response: The commenter has not

provided sufficient information on the testing commissioned by Greenpeace in 2001 for the Agency to determine what the results were or whether the testing conditions are relevant to this action. Concerning the BAM testing, EPA has not seen a testing report or a detailed description of the experimental method that allows for a full evaluation. Based on the information provided by the commenter, the temperature of the released substance reached 600 °C and HF concentrations of over 90 ppm were measured in the engine compartment. According to a risk assessment from an automobile manufacturer, such a high temperature is unlikely and could only be achieved on the exhaust manifold under heavy engine loads such as when

a vehicle is climbing a hill, and the temperature of the exhaust manifold would drop in a minute or so during deceleration (EPA-HQ-OAR-2008-0664-0081.1). It is not clear what the conditions were for the study mentioned by the commenter. For example, it is not clear if the refrigerant was mixed with compressor oil as it normally would be in an MVAC; inclusion of oil with a relatively low flashpoint would be expected to lead to ignition at lower temperatures (EPA-HQ-OAR-2008-0664-0056.2; EPA-HQ-OAR-2008-0664-0118.1). It also is not clear if the compressor fan was operating during the test. During normal vehicle operation, the fan would cool down the compressor and the engine compartment, avoiding the temperature of 600 °C on hot surfaces in the engine.

Other tests have found that HF concentrations in the engine compartment were approximately 5 ppm or less and only in the worst case (hot surface temperature of 700 °C. closed hood on engine compartment) did HF concentrations attain a value of approximately 120 ppm in the engine compartment (OAR-2008-0664-0056.2). This level is slightly higher than the AEGL-2 of 95 ppm on a 10-minute average and is lower than the AEGL-3 for HF of 170 ppm on a 10minute average, the value that would protect against life-threatening exposure but would not necessarily prevent longterm health effects. However, we note that we do not anticipate any circumstance where a person would be exposed to these levels in an engine compartment because such conditions would not occur during vehicle servicing, but rather during vehicle operation. Further, in the case of a collision resulting in a fire, we would expect that professional first responders have training in chemical hazards and possess appropriate gear which would prevent them from receiving HF exposures above health-based limits (EPA-HQ-OAR-2008-0664-0056.2) and an interested by-stander would quickly back away from a fire or from irritating HF vapors, thus preventing excessive HF exposure. The concentration measured in the passenger compartment in the same worst-case situation was in the range of 40 to 80 ppm, less than the concentration in the engine compartment and less than the AEGL-2 intended to protect against long-term health effects. Thus, we disagree with the commenter's assertion that HF exposures from thermal decomposition or combustion of refrigerant would be likely to result in fatalities. We further

³⁵ An AEGL-2 is intended to apply to an emergency situation where armonose would try to move away from the bazard in a short period of time and may suffer some tempeary irritation, but no permanent health damage. Irreversible or disabling but non-fatal health effects could occur between the AEGL-2 and the higher AEGL-3.



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note that the HF concentrations found in the passenger compartment were lower than the health-based limit, the AEGL-2 of 95 ppm over 10 minutes.

We also note that the risks presented by HFO–1234yf are not significantly different than the risk posed by HFC-134a, the refrigerant currently in use in MVAC systems. Mixtures of HFC-134a and compressor oil also combust and generate HF. Testing performed using HFC-134a under worst-case conditions in the engine compartment (hot surface temperature of 700 °C, closed hood on engine compartment) found HF concentrations as high as 36 ppm in the engine compartment and 2 to 8 ppm in the passenger compartment. The amount of HF generated from a typical charge of HFC-134a, if it all burned or decomposed, could be even more than for the expected charge of HFO-1234yf because charge sizes using HFO-1234yf are expected to be smaller (EPA-HQ-OAR-2008-0664-0056.2). The SAE CRP considered potential risks of HF exposure from both HFO-1234yf and from HFC-134a. Both presented potential risks on the order of 10-12 occurrences per operating hour (EPA-HQ-OAR-2008-0664-0056.2, -0096.1). This corresponds to less than one case per year across the entire fleet of motor vehicles in the U.S. Although there is no specific testing data on HF production from HFC-152a, another acceptable refrigerant for MVAC, since this compound contains fluorine, it presents risks of HF generation as well. As discussed above in Section IV of the preamble, we are not requiring specific use conditions that regulate production of HF, either directly or indirectly, because of the low level of risk. However, the final use conditions in this rule address the risks of HF production, as well as risks of flammability, by requiring certain design safety features of MVAC systems using HFO-1234yf and by requiring risk analysis for each car model through FMEAs.

Comment: A commenter provided results from a test by IBExU on the decomposition of HFO-1234yf under heat (EPA-HQ-OAR-2008-0664-0053.3). This commenter strongly warned against a decision in favor of HFO-1234yf because it would form highly toxic HF when burning. Three commenters disagreed that the results of the IBExU testing were relevant because test conditions did not represent realistic conditions. One commenter said that the SAE risk assessment, which used actual vehicle test data for HF formation, found that actual HF formation rates are far below the levels [from the IBExU test results] cited by the first commenter, the Federal Environmental Agency (Umweltbundesamt—UBA).

Response: The IBExU testing of HF generation from HFO-1234yf is not relevant to assessing the risks of HFO-1234yf as a refrigerant in MVAC Laboratory tests concerning the nature of HF generation on hot surfaces found that this depends on the contact time of reactants on the hot surface, the temperature of the hot surface and the movement of refrigerant in diluted concentrations due to airflow (EPA-HQ-OAR-2008-0664-0056.2; EPA-HQ-OAR-2008-0664-0116.2). The IBExU testing involved heating the refrigerant steadily in a sealed flask. Thus, the contact time in that test was far greater than would occur in an engine compartment and the movement of refrigerant in that test was essentially zero, unlike in an engine compartment where there would be constant air movement.

Comment: Another test from BAM reported by UBA examined HF formation from HFO-1234yf and from HFC-134a (EPA-HQ-OAR-2008-0664-0080.1). Fifty grams of refrigerant was streamed through a hole of 2 mm diameter onto a hot metal surface. The study found that pure HFO-1234yf exploded on the hot surface whereas pure HFC-134a did not. The study also found that when HFO-1234yf was mixed with 3% oil, it exploded at 600 °C. The commenter stated that handling of HFO-1234yf in the presence of hot metal surfaces results in HF formation in concentrations far above allowed workplace concentrations.

Response: These results are not consistent with results from hot-plate tests conducted by an automobile manufacturer and by a chemical manufacturer for the SAE CRP (EPA-HO-OAR-2008-0664-0056.2; EPA-HQ-OAR-2008-0664-0115.1). Those manufacturers found that neither HFO-1234yf nor HFC-134a alone ignited at 900 °C. One of these tests found that HFO-1234yf mixed with PAG oil combusted starting at 730 °C, while HFC-134a mixed with PAG oil ignited at 800 °C and above; the other test observed no ignition of a blend of each refrigerant with PAG oil at 800 °C, but both blends ignited at 900 °C. Based on the lack of reproducibility of the specific ignition temperature, it appears that the specific ignition temperature may depend on variables in the testing (e.g., flash point of the oil used, amount of mixture used, angle of application, and air flow available). This information also shows that mixtures of refrigerant with compressor oil can combust at lower temperatures than pure refrigerant and that mixtures of HFO-1234yf and oil and mixtures of HFC-134a and oil present similar risks of ignition and HF generation. Thus, we concluded that the risks of toxicity from HF exposure due to combustion or decomposition of HFO-1234yf are comparable to those from HFC-134a.

Further, the risks from toxicity of HF posed by both refrigerants are small. The SAE CRP estimates this risk on the order of 10⁻¹² cases per operating hour (EPA-HQ-OAR-2008-0664-0086.1). This is equivalent to less than one event per year across the entire fleet of motor vehicles in the U.S. For comparison, this is less than one ten-thousandth the risk of a highway vehicle fire and one fortieth or less of the risk of a fatality from deployment of an airbag during a vehicle collision (EPA-HQ-OAR-2008-0664-0056.2).

E. Retrofit Usage

Comment: Several commenters stated that HFO-1234yf should be allowed initially in new vehicles but should not be used to retrofit vehicles using HFC-134a, or at least not unless there are industry standards to guide such a process. Other commenters stated that it is critical to allow a natural phase-out of the fleet of cars using HFC-134a as the refrigerant, rather than requiring retrofitting existing cars with HFO-1234vf. A commenter expressed concern that retrofitting of HFC-134a MVAC systems with HFO-1234yf would result in cases of cross-contamination of refrigerant, while another commenter contested this statement and found it unsupported. Other commenters opposed obstacles that would prevent older MVACs from being retrolitted to the new refrigerant. These commenters mentioned the potential for greenhouse gas benefits when retrofitting systems currently using HFC-134a with HFO-1234vf.

Response: The submitter did not request review of HFO-1234yf for retrofitting vehicles and thus EPA did not review HFO-1234yf as acceptable (or acceptable subject to use conditions) for retrofitting in MVAC in this rulemaking. Consistent with the request submitted to the Agency, we proposed to find HFO-1234yf acceptable for use subject to use conditions in new MVAC systems and evaluated its risks only for use in new systems. We will consider the retrofit use of HFO-1234yf in MVAC systems if we receive a submission that specifically addresses retrofitting and the risks that are unique to retrofitting. In response to the commenter who raised a concern about a "phase-out" of HFC-134a and the potential that we would "require" use of HFO-1234yf, we



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note that our rulemakings under SNAP do not require use of any specific substitute. Rather, under SNAP, we have established lists of substitutes that are acceptable for use in various enduses (such as for MVACs) and end-users are free to choose which substitute to use, but must do so consistent with any use conditions that apply. As stated in the rule establishing the SNAP program, "The Agency * * * does not want to intercede in the market's choice of available substitutes, unless a substitute has been proposed or is being used that is clearly more harmful to human health and the environment than other alternatives." 59 FR 13046, March 18, 1994. We further note that this rulemaking does not change the status of HFC-134a, which remains an acceptable substitute for use in MVACs, subject to use conditions.

F. Use by "Do-it-Yourselfers"

Comment: Some commenters raised concerns about EPA's statements in the proposed rule about potential health effects that might occur without professional training and the use of CAA Section 609 certified equipment. These commenters stated that the studies and testing in the docket support a finding that use of HFO– 1234yf by non-professionals is safe and do not offer valid technical support for EPA's concerns.

Response: EPA's risk assessment and risk screen both indicated that worstcase exposure levels expected during servicing by do-it-yourselfers are of potential concern (EPA-HQ-OAR-2008-0664-0036 and EPA-HQ-OAR-2008-0664-0038). In both documents, this was based upon estimated exposure levels from a 2008 risk assessment by Gradient Corporation for the SAE CRP (EPA-HQ-OAR-2008-0664-0008). In EPA's risk assessment (EPA-HQ-OAR-2008-0664-0036), we found that the level that EPA determined did not cause health effects in laboratory animals might be only 2 to 3 times higher than the exposure predicted for that use (the "margin of exposure"). Our risk assessment indicated a higher, more protective margin of exposure of at least 30 was needed to account for uncertainty in the extrapolation from animals to humans and for variability in the human population. In other words, we found that based on worst-case assumptions, a do-it-yourselfer's exposure could be 10 or more times the level that EPA considered safe. The margin of exposure was calculated using a conservative estimated exposure level of 45,000 ppm over 30 minutes and a human equivalent concentration of 98,211 ppm from a no-observed adverse

effect level that we selected as the point of departure for risk assessment (EPA-HQ-OAR-2008-0664-0036).

However, under this final rule, unique fittings have only been submitted for servicing fittings for the high-side and low-side ports and for large containers of HFO-1234yf and thus the acceptability listing is limited to use of HFO-1234yf with the unique fittings specified (e.g., for large containers of 20 pounds or more). We expect these containers would not be purchased by DIYers because of their expense (\$800 or more per container) and because they would contain enough refrigerant for 10 charges or more. We will continue to review the issue of safe use for DIYers if and when we are requested to review unique fittings for a smaller container size. In addition, EPA is further addressing the issue of risks to DIYers in the Significant New Use Rule for 1-propene-2,3,3,3-tetrafluoro- (75 FR 65987, October 27, 2010). This SNUR requires submission of a SNUN at least 90 days before sale or distribution of products intended for use by a consumer for the purpose of servicing, maintenance and disposal involving HFO-1234vf.

EPA's proposed rule on the use of HFO-1234yf as a substitute for CFC-12 in new MVAC systems did not propose to establish use conditions for servicing vehicles by certified professionals, but our analyses indicate that there is not significant risk to certified professionals, because HFC-134a, which is currently used in most MVAC systems, presents similar risks and professionals have the knowledge and equipment to mitigate any risks. We plan to further address servicing by professionals when we develop a new rule under section 609 of the Clean Air Act for servicing and maintenance of MVAC systems.

Comment: Some commenters supported prohibiting sale of HFO-1234yf in small containers. Other commenters stated that only certified technicians should be allowed to purchase and use refrigerants, including HFC-134a and HFO-1234yf. Other commenters found no data to support restrictions on the sale of HFO-1234yf to non-professionals. *Response:* As noted previously, the

Response: As noted previously, the submission only addressed unique fittings for large containers (e.g., 20 lbs or larger) of HFO-1234yf. If anyone is interested in using HFO-1234yf in small cans or other small containers, they would need to contact the refrigerant manufacturer to submit unique fittings for approval under the SNAP program. Thus, under this final rule, we believe that only certified technicians will purchase HFO-1234yf because the larger containers are likely to be prohibitively expensive for individuals performing DIY servicing (S800 or more for a 20 lb cylinder) and are likely to be too large for most individuals to use, containing enough refrigerant for 10 or more charges.

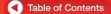
We also note that in a separate final rule under the authority of TSCA (October 27, 2010; 75 FR 65987), EPA requires among other things, that notice must be given to EPA 90 days before (1) HFO-1234yf is used commercially other than in new passenger cars and vehicles in which the charging of motor vehicle air conditioning systems with HFO-1234yf was done by the motor vehicle OEM or (2) sale or distribution of products intended for use by a consumer for the purpose of servicing, maintenance and disposal involving HFO-1234yf.

Comment: A commenter stated that banning DIY use of HFO-1234yf will mean that car owners will be forced to have professionals perform service work on their AC systems at a significantly higher cost. This commenter stated that millions of lower-income motorists may be forced to go without air conditioning each year or may seek out lower-cost alternatives such as propane or HFC-152a.

Response: While this final rule effectively prohibits DIY use because the final use conditions do not include unique fittings allowing for use with small refrigerant containers, we are not making any final determination about whether HFO-1234yf may be safely used by DIYers. As we noted above, we have not yet received a submission for DIY use or received unique fittings for small containers from the manufacturer, but would evaluate such submissions when we receive one. We note that because it is unlikely that any cars will have MVAC systems with HFO-1234yf before the 2013 model year, we believe the availability of small containers for DIY use will not be of concern until such cars are sold and there is a need to recharge a new MVAC system on a model year 2013 vehicle. The separate final Significant New Use Rule that the Agency has issued under TSCA (75 FR 65987; October 27, 2010) requires submission of a Significant New Use Notice at least 90 days before sale or distribution of products intended for DIY use

With respect to the commenter who suggests that some people may seek lower cost alternatives, presumably to repair an existing MVAC, we note that under current EPA regulations in appendix D to subpart G of 40 CFR part 82, it is not legal to top-off the

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refrigerant in an MVAC system with a different substitute refrigerant.

G. Servicing Issues

Comment: Several commenters stated that appropriate training and certification should be required to purchase HFO-1234yf for use in MVACs. Four commenters also stated that the final regulation should include a provision requiring proof of certification in order to purchase HFO-1234yf, and recommended that current AC systems tests {*i.e.*, for CAA section 609 certification be undated.

609 certification) be updated, Some commenters disagreed with EPA's statement that HFO-1234yf may cause serious health effects when used in servicing and maintaining MVACs without professional training. Another commenter stated that EPA is limiting productivity by only allowing dealerships to perform refrigerant maintenance, and that independent MVAC service shops should be allowed to be certified. The commenter also questioned who will monitor "certified" technicians employed by dealerships that may do work on the side. A commenter representing automobile dealerships specifically opposed mandatory requirements for certification of technicians because of potential costs and burden on small businesse

Response: As background for the public comments, we note that under EPA's regulations implementing section 609, one must be a section 609 certified technician in order to purchase CFC-12 or other ODS for use in MVAC (40 CFR 82.34(b)). Section 609(e) of the CAA itself specifically prohibits sale of small containers less than 20 pounds with Class I or Class II substances suitable for use as a refrigerant in MVAC, except for individuals performing service for consideration in compliance with section 609. However, there is no comparable restriction on the sale of HFC-134a or on other substitutes for MVAC that do not contain Class I or Class II ODS, such as HFO-1234yf.

In the NPRM (74 FR 53449), EPA stated that any specific training and certification requirements would be adopted through a rulemaking under the authority of CAA section 609 and would be codified in subpart B of 40 CFR part 82, which contains the regulations implementing section 609. We will address concerns regarding certification and training requirements during that separate rulemaking process. We note, however, that the CAA itself mandates that persons performing service for consideration that involve the refrigerant must be properly trained and certified, Furthermore, as noted previously, we believe that there is not a significant health risk to professionals from HFO-1234yf because they will have the knowledge and equipment to mitigate any risks. Also, because HFC-134a presents similar risks to HFO-1234yf, and the flammability risks of HFO-1234yf are less than those for HFC-152a, the health risks of HFO-1234yf are not significantly greater than those of other available substitutes.

With regard to whether independent service shops could service MVACs with HFO-1234yf or whether service would be limited to "dealerships," we note that neither this rule nor any other CAA regulation would limit servicing to dealerships. The comment may concern the withdrawn SNUR, 75 FR 4983 (February 1, 2010), which referred to the "original equipment manufacturer"; the commenter may have interpreted this term to mean an automobile dealership. The final SNUR (October 27, 2010; 75 FR 65987) requires a significant new use notice to EPA at least 90 days before "commercial use other than in new passenger cars and vehicles in which the charging of motor vehicle air conditioning systems with the PMN substance [HFO-1234yf] was done by the motor vehicle original equipment manufacturer." This requirement restricts commercial use of HFO-1234yf to use for vehicles that were initially charged with HFO-1234vf by the automobile's manufacturer, as opposed to allowing commercial use of HFO-1234yf for vehicles initially charged with a different refrigerant. The term "original equipment manufacturer" refers to the automobile manufacturer, not to dealerships.

Comment: Commenters indicated that SAE International is developing standards for safety and servicing of alternative refrigerant HFO-1234yf MVAC systems. Another commenter stated that there are appropriate mechanisms within the industry for training, One commenter representing automobile dealerships objected to mandatory Section 609 technician certification and training for use of HFO-1234yf, stating that because dealerships already train technicians on flammable substances in accordance with hazard communication standards of the Occupational Safety and Health Administration (OSHA), and since the risks associated with HFO-1234yf are similar to those that already exist in MVAC service facilities, mandatory training and proof of training is not necessary. To enable training pursuant to the OSHA hazard communication standard, the commenter stated that MVAC system and refrigerant suppliers should provide dealerships with

sufficient information on the hazards posed by HFO-1234yf. *Response:* EPA is issuing use

conditions in this final rule that reference relevant SAE technical standards on safety. This rule does not, however, include a use condition requiring technician training and does not refer to specific training standards. We agree with the commenter that current technician training generally should be sufficient to ensure that professional technicians will use HFO-1234yf safely. Although this SNAP determination does not contain a use condition regarding technician training. as noted above, section 609 of the CAA requires technician training for persons servicing for consideration. EPA will consider in a separate rulemaking under section 609, whether it is necessary to modify our existing regulations under section 609 to include additional ecifications for HFO-1234yf.

Comment: A commenter representing automobile dealerships opposed mandatory requirements for recycling and containment of the refrigerant because of potential costs and minimal environmental benefits.

Response: This rulemaking does not impose requirements for recycling or containment of the refrigerant. A separate rulemaking under CAA section 609 will address practices required in the servicing of MVAC systems using HFO-1234yf, including recycling and recovery. Further, EPA notes that Section 608 of the CAA prohibits the intentional release of any refrigerant during the maintenance, repair, service, or disposal of refrigeration and air conditioning equipment, unless the Administrator determines through rulemaking that such release does not pose a threat to the environment. We have not made such a determination for HFO-1234vf.

H. Cost, Availability, and Small Business Impacts

Comment: One late commenter stated that there was insufficient information in the record on the cost, terms of availability and anticipated market share of HFO-1234vf for EPA to make the required statutory findings that HFO-1234yf "reduces the overall risk to human health and the environment" by comparison to other alternatives that are already available. The commenter stated that this information is necessary in order for EPA to assess anticipated environmental effects adequately. The same commenter stated that EPA's environmental analysis is based on price assumptions that were not disclosed and are no longer valid, and thus, EPA should subpoena the



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information from the manufacturer and reopen the public comment period.

Response: EPA believes that there was sufficient information in the record at the time of proposal for us to complete a meaningful environmental analysis, even in the absence of definitive cost information. At the time of proposal, we had available both estimates from a trade magazine provided by the manufacturer (Weissler, 2008), as well as estimates of price provided in the initial submission from the manufacturer (EPA-HQ-OAR-2008-0664-0013). The estimates of price provided by the manufacturer were claimed as confidential business information and thus were not available in the record to the public. We typically use this type of

information for purposes of determining market penetration for a particular substance, so that we can evaluate how much of the substitute will likely be used and thus the environmental risks it might pose. In this case, however because the automobile industry tends to prefer use of a single substitute, information on the cost of the substitute was not critical to our analysis. Thus, in conducting our environmental analysis, we took a conservative approach, assuming that all new MVAC systems began using HFO-1234yf by 2020 (i.e., full market penetration). We also considered an even more conservative scenario, in which HFO-1234yf would be the only refrigerant used for stationary air conditioning and for refrigeration as of 2020, as well as for MVAC, Even with these highly conservative assumptions, we found that there would not be sufficient negative environmental impacts due to emissions of HFO-1234yf to warrant

finding it unacceptable. In the proposal, we mentioned a cost estimate for HFO-1234yf of S40-S60/lb (Weissler, 2008). More recently, the first automobile manufacturer announcing its intention to use HFO-1234vf confirmed that this range does not underestimate prices of HFO-1234vf and is consistent with the manufacturer's long-term purchase contracts (Sciance, 2010). Thus, the most recent information shows costs to be similar to those we considered at the time of proposal. This data contradicts the late commenter's assertion that the manufacturer's effective monopoly would result in significantly different, higher costs that would invalidate EPA's earlier analysis. In any event, assuming that costs were higher as suggested by the commenter, then we expect that use of HFO-1234yf would be less than assumed for our health and environmental risk analysis. As

mentioned in the proposal, emissions, and thus the resulting environmental effects such as impacts on local air quality or on production of TFA, would be expected to be less under a scenario with higher prices and less use of HFO– 1234yf. Our analysis assumes widespread use and thus its results would be protective.

We note that where a new chemical is introduced, there is some uncertainty in the price. At best, the manufacturer can provide rough estimates of price and of market share before the chemical is produced in commercial quantities and becomes subject to supply and demand pressures, EPA's requirement for information on cost, anticipated availability in the market, and anticipated market share [40 CFR 82.178(a)(14) through (16)) should not be construed as requiring precise, detailed cost estimates based upon a well-defined methodology. As noted above, we use these numbers for the purposes of predicting market penetration and thus how much of a particular substitute might be used and thus pose an environmental risk. As we did for HFO-1234yf, we typically take an environmentally-protective approach to our evaluation, assuming use at least as high as that the cost and availability information may indicate.

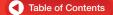
Comment: A late commenter stated that the information in the record is insufficient for EPA to make a statutory finding that HFO-1234yf is "currently or potentially available." The commenter stated that a previous decision by the United States Court of Appeals for the District of Columbia Circuit (Honeywell International, Inc. v. EPA, 374 F.3d 1363 (D.C. Cir. 2004)) implied that an interpretation of the term "available" in CAA section 612(c)(2) could potentially consider economic factors if EPA adopted such an approach as a reasonable interpretation of the statutory language. The commenter states that EPA should obtain information as to the anticipated cost of HFO-1234yf if the manufacturer does

not grant licenses to produce. Response: The CAA does not require that EPA find a substitute to be available or potentially available when finding it acceptable. Section 612(c) states: "* * It shall be unlawful to replace any class I or class II substance with any substitute substance which the Administrator determines may present adverse effects to human health or the environment, where the Administrator has identified an alternative to such replacement that—reduces the overall risk to human health and the environment; and is currently or potentially available. * **

This section makes clear that it is not the substitute under review that must be available or potentially available, but rather alternative replacements for ODS that EPA determines pose less overall risk to human health and the environment than the substitute being reviewed. Thus, if there are alternatives to the substance under review that are currently or potentially available and that pose less risk, EPA cannot find the substitute under review acceptable. Section 612(c) establishes no requirement that EPA must determine that the substitute under review is available." See also 40 CFR 82.180(b) (describing types of listing decisions EPA can make in reviewing substitutes 26). We note that even if EPA was required to determine that the substitute under review is available or potentially available before it could make an acceptability determination, we believe that the available information supports that HFO-1234vf is potentially available. EPA's definition of "potentially available" at 40 CFR 82.172 provides that "potentially available" is defined as any alternative for which adequate health, safety, and environmental data, as required for the SNAP notification process, exist to make a determination of acceptability, and which the Agency reasonably believes to be technically feasible, even if not all testing has yet been completed and the alternative is not yet produced or sold. This definition makes explicit that it is not necessary to have perfect information on a substitute nor is it necessary for the substitute to be produced or sold in order for EPA to consider it "potentially available. Instead, it is necessary for EPA to find the health, safety and environmental data adequate to make a determination of acceptability, and for the Agency to reasonably believe that the alternative is 'technically feasible," in order for the alternative to be potentially available. We believe the record contains adequate information showing that HFO-1234yf

³⁶ The regulations for the SNAP program include cost and availability as one of the criteria for review at to whether a substitute is acceptable or unacceptable as a replacement for orone depleting substances (BZ-BBO(a)(7)(vii)), along with a number of criteria for different aspects of health and environmental impacts. Gost and availability are included as criteria because they affect assumptions we may make about a substitute regarding its risks, *i.e.*, we need to know its cost and availability so we can make assumptions about the risk it might pose. In this case, we assumed that HFO-1234yf woold be used widely across the industry in new MVACs because widespread use of a single refrigerant in new car models has been the industry practice with availability of the substitute was not necessary in order to identify assumptions we should make for estimating risk.

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is potentially available. The manufacturer has submitted the information required under 40 CFR 82.178 (e.g., pre-manufacture notice form and TSCA/SNAP addendum form containing: Name and description of the substitute, physical and chemical information, information on ODP and global warming impacts, toxicity data, data on environmental fate and transport, flammability, exposure, cost and estimated production). The submitter has also provided unique fittings as required under appendix D to subpart G of 40 CFR part 82. Thus, we believe that there is "adequate health, safety, and environmental data." Even if the commenter were correct about claims that higher costs would result if the manufacturer does not grant licenses for production, as discussed above, this does not affect the adequacy of the health, safety, and environmental data for HFO-1234yf, because we have protectively assumed widespread use that would result in more emissions and greater environmental impacts. In addition, based on the experimental work conducted by the automobile industry, we reasonably believe that HFO-1234yf is technically feasible as a refrigerant. Thus, HFO-1234yf would still be "potentially available" under the SNAP program's definition.

One commenter points to Honeywell International, Inc. v. EPA, 374 F.3d 1363 in urging EPA to explicitly include cost as a consideration in determining whether a substitute is "potentially available." In that case, the court vacated and remanded a SNAP decision in which EPA listed a foam blowing substitute as acceptable subject to "narrowed use limits" on the basis that for some niche foam blowing uses, the substitutes that were already listed as acceptable might not be available. Under the narrowed use limits, the enduser would need to demonstrate and document that other substitutes were not technically feasible for a particular use. The court vacated and remanded EPA's rule on the basis that EPA had considered cost in concluding that already listed substitutes might not be available based on "technical feasibility, and that EPA had not attempted to justify the rule on the ground that the statute allows it to consider economic factors in making its SNAP determinations. The court left open the question of whether EPA could attempt to interpret the term "available" in section 612(c) as allowing for consideration of costs.

Again, we note that "available or potentially available" applies only to the substitutes against which the substitute at issue is being compared. The Agency

has not decided whether consideration of the cost of other substitutes should be a factor to consider in determining whether they are available or potentially available and thus should (or should not) be used for comparison to a substitute under review. However, we note that for purposes of the substitute under review, the Agency firmly believes that cost should not be the primary or sole basis for finding a substitute unacceptable. EPA's role is to determine the health and environmental risk associated with the use of substitutes and the market should serve to address the issue of costs. Costs will necessarily be a factor considered by the automobile manufacturers in deciding which substitute to use.

Comment: Two commenters stated that EPA needed to perform further analysis on the potential small business impacts and costs of EPA's regulations and the introduction of HFO-1234yf. A commenter representing recyclers of automobiles and scrap metal expressed concern about the regulatory burden and costs that automotive recyclers are likely to incur if they must manage flammable refrigerants that are regulated as hazardous waste under EPA's regulations implementing the Resource Conservation and Recovery Act (RCRA). The same commenter also suggests that the RCRA subtitle C regulations would need to be changed to alleviate the hazardous-waste management requirements for handling HFO-1234yf. The other commenter mentioned the costs to service and repair shops, endof-life vehicle recyclers, and automobile dealerships, and stated that EPA needed to analyze costs to these small businesses under the Regulatory Flexibility Act (RFA). This latter commenter stated that EPA should determine if a significant change in price and supply expectations would affect the way that these businesses handle and deal with automobile repairs and recycling. Response: The RFA applies only

Response: The RFA applies only when there are small entities subject to the requirements of the proposed or final rule. 5 U.S.C. §604(a)(3), We believe the potential burden of complying with RCRA regulations placed on those recycling or recovering a substitute is generally not pertinent to a decision of whether HFO-1234yf should be found acceptable under SNAP. To the extent the commenters are suggesting that we must evaluate such costs for purposes of the Regulatory Flexibility Act, we note that under the RFA we evaluate costs imposed by the enforceable regulations being promulgated. To the extent the costs referred to by the commenter are already imposed under RCRA, they would not be new costs, but costs associated with the relevant RCRA regulations Moreover, under this SNAP final rule, EPA is not requiring the use of HFO-1234yf, and thus the costs associated with its use are not due to enforceable regulatory requirements under SNAP. To the extent there are enforceable requirements for those persons who choose to use this new substitute, those requirements (the "use conditions") apply primarily to manufacturers of automobiles and MVAC systems, because they concern design of MVAC systems. The one use condition of the rule that applies to servicing of MVAC systems, and thus, could apply to small businesses, is the requirement for specific unique service fittings. However, EPA's existing SNAP regulations at appendix D to subpart G of 40 CFR part 82 already require unique service fittings as specified by the refrigerant manufacturer. Thus, the costs of purchasing new unique fittings for this refrigerant are imposed by the pre-existing regulation. This rule specifies the requirements for the type of unique fitting, in accordance with the fittings provided to EPA by the manufacturer. These fittings are part of the SAE J639 standard. It is not clear that there would be any cost differential between these specific unique fittings and others that the automotive industry could adopt instead. For these reasons, EPA is able to certify that this regulation will not create a significant impact on a significant number of small entities.

Regulations concerning disposal of refrigerant from MVAC systems and other refrigerant-containing appliances under section 608 of the CAA are at subpart F of 40 CFR part 82. Cost and benefit estimates for these regulations are at http://www.regulations.gov, docket EPA-HQ-OAR-2003-0167. EPA notes that there may be costs of servicing or of disposal (end-of-life) to small businesses under future regulations under section 609 or 608 of the CAA. We will conduct an analysis of such costs, and any potential significant impacts on small entities, as necessary, as part of those future rulemakings.

Comment: A commenter stated that to comply with requirements of the Unfunded Mandates Reform Act (UMRA), EPA needed to perform further analysis on the potential costs of EPA's SNAP regulations for HFO–1234yf to determine if the rule would result in the expenditure of \$100 million or more per year by the private sector. In particular, the commenter stated that EPA must obtain more information on pricing and



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the effect of the manufacturer's patent to 3. Petition Process analyze this.

Response: UMRA applies only to "enforceable duties" imposed on State, local, and Tribal governments or on the private sector. The SNAP rule does not impose duties on governments. As we have noted previously, the SNAP program does not mandate the use of any specific substitute for ozone depleting substances. Rather, through this action, we are expanding the choices of MVAC refrigerants available to the private sector. The issue raised by the commenter concerning the cost of the refrigerant and the effect of the manufacturer's patent on pricing is not related to any requirement of the rule. and thus, EPA is not required to consider that cost under UMRA.

VIII. How does the SNAP program work?

A. What are the statutory requirements and authority for the SNAP program?

Section 612 of the Clean Air Act (CAA) requires EPA to develop a program for evaluating alternatives to ozone-depleting substances (ODS). EPA refers to this program as the Significant New Alternatives Policy (SNAP) program. The major provisions of section 612 are:

1. Rulemaking

Section 612(c) requires EPA to promulgate rules making it unlawful to replace any class I (i.e. chlorofluorocarbon, halon, carbon tetrachloride, methyl chloroform, methyl bromide, and hydrobromofluorocarbon) or class II (i.e., hydrochlorofluorocarbon) substance with any substitute that the Administrator determines may present adverse effects to human health or the environment where the Administrator has identified an alternative that (1) reduces the overall risk to human health and the environment, and (2) i currently or potentially available.

2. Listing of Unacceptable/Acceptable Substitutes

Section 612(c) requires EPA to publish a list of the substitutes unacceptable for specific uses and to publish a corresponding list of acceptable alternatives for specific uses. The list of acceptable substitutes is found at http://www.epa.gov/ozone/ snap/lists/index.html and the lists of "unacceptable", "acceptable subject to use conditions", and "acceptable subject to narrowed use limits" substitutes are found at subpart G of 40 CFR part 82.

Section 612(d) grants the right to any person to petition EPA to add a substance to, or delete a substance from, the lists published in accordance with section 612(c). The Agency has 90 days to grant or deny a petition. Where the Agency grants the petition, EPA must publish the revised lists within an additional six months.

4. 90-Day Notification

Section 612(e) directs EPA to require any person who produces a chemical substitute for a class I substance to notify the Agency not less than 90 days before new or existing chemicals are introduced into interstate commerce for significant new uses as substitutes for a class I substance. The producer must also provide the Agency with the producer's unpublished health and safety studies on such substitutes.

5. Outreach

Section 612(b)(1) states that the Administrator shall seek to maximize the use of Federal research facilities and resources to assist users of class I and II substances in identifying and developing alternatives to the use of such substances in key commercial applications.

6. Clearinghouse

Section 612(b)(4) requires the Agency to set up a public clearinghouse of alternative chemicals, product substitutes, and alternative manufacturing processes that are available for products and manufacturing processes which use class I and II substances.

B. What are EPA's regulations implementing section 612?

On March 18, 1994, EPA published the original rulemaking (59 FR 13044) which established the process for administering the SNAP program and issued EPA's first lists identifying acceptable and unacceptable substitutes in the major industrial use sectors (subpart G of 40 CFR part 82). These sectors include: Refrigeration and air conditioning; foam blowing; cleaning solvents; fire suppression and explosion protection; sterilants; aerosols; adhesives, coatings and inks; and tobacco expansion. These sectors compose the principal industrial sectors that historically consumed the largest volumes of ODS.

Section 612 of the CAA requires EPA to list as acceptable only those substitutes that do not present a significantly greater risk to human health and the environment as

compared with other substitutes that are currently or potentially available.

C. How do the regulations for the SNAP program work?

Under the SNAP regulations, anyone who plans to market or produce a substitute to replace a class I or II ODS in one of the eight major industrial use sectors must provide notice to the Agency, including health and safety information on the substitute at least 90 days before introducing it into interstate commerce for significant new use as an alternative. This requirement applies to the person planning to introduce the substitute into interstate commerce,27 typically chemical manufacturers, but may also include importers, formulators, equipment manufacturers, or end-users 28 when they are responsible for introducing a substitute into commerce.

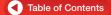
The Agency has identified four possible decision categories for substitutes: acceptable; acceptable subject to use conditions; acceptable subject to narrowed use limits; and unacceptable. Use conditions and narrowed use limits are both considered "use restrictions" and are explained below. Substitutes that are deemed acceptable with no use restrictions (no use conditions or narrowed use limits) can be used for all applications within the relevant end-uses within the sector. Substitutes that are acceptable subject to use restrictions may be used only in accordance with those restrictions. It is illegal to replace an ODS with a substitute listed as unacceptable, unless certain exceptions (e.g., test marketing, research and development) provided by the regulation are met.

After reviewing a substitute, the Agency may determine that a substitute is acceptable only if certain conditions in the way that the substitute is used are met to minimize risks to human health and the environment. EPA describes such substitutes as "acceptable subject to use conditions." Entities that use these substitutes without meeting the

28 As defined at 40 CFR 82.172 "end-use" in processes or classes of specific applications within major industrial sectors where a substitute is used to replace an ozone-depleting substance.

²⁷ As defined at 40 CFR 82.104 "interstate - restaurment at 49 CFR 02, 104 "IDMPRIME continence" means the distribution or transportation of any product between one state, herritory, possession or the District of Columbia, and another state, territory, possession or the District of Columbia, or the sale, use or manufacture of any Communic or more than one or manufactures or any product in more than one state, herritory, possession or District of Cohambia. The entry points for which a product is introduced into intentate commerce are the release of a product from the facility in which the product were manufactured, the entry into a warebouse from which the domestic manufacturer releases the product for sale or distribution, and at the site of United States Customs clourance.

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associated use conditions are in violation of section 612 of the Clean Air Act and EPA's SNAP regulations.

For some substitutes, the Agency may permit a narrowed range of use within an end-use or sector. For example, the Agency may limit the use of a substitute to certain end-uses or specific applications within an industry sector. The Agency requires a user of a narrowed use substitute to demonstrate that no other acceptable substitutes are available for their specific application by conducting comprehensive studies. EPA describes these substitutes as "acceptable subject to narrowed use limits." A person using a substitute that is acceptable subject to narrowed use limits in applications and end-uses that are not consistent with the narrowed use limit is using the substitute in an unacceptable manner and is in violation of section 612 of the CAA and EPA's SNAP regulations

The Agency publishes its SNAP program decisions in the Federal Register (FR). EPA publishes decisions concerning substitutes that are deemed acceptable subject to use restrictions (use conditions and/or narrowed use limits), or for substitutes deemed unacceptable, as proposed rulemakings to allow the public opportunity to comment, before publishing final decisions.

In contrast, EPA publishes decisions concerning substitutes that are deemed acceptable with no restrictions in "notices of acceptability," rather than as proposed and final rules. As described in the rule initially implementing the SNAP program (59 FR 13044), EPA does not believe that rulemaking procedures are necessary to list alternatives that are acceptable without restrictions because such listings neither impose any sanction nor prevent anyone from using a substitute.

Many SNAP listings include "comments" or "further information" to provide additional information on substitutes. Since this additional information is not part of the regulatory decision, these statements are not binding for use of the substitute under the SNAP program. However, regulatory requirements so listed are binding under other regulatory programs. The "further information" classification does not necessarily include all other legal obligations pertaining to the use of the substitute. While the items listed are not legally binding under the SNAP program, EPA encourages users of substitutes to apply all statements in the "further information" column in their use of these substitutes. In many instances, the information simply refers to sound operating practices that have

already been identified in existing industry and/or building-codes or standards. Thus, many of the statements, if adopted, would not require the affected user to make significant changes in existing operating practices.

D. Where can I get additional information about the SNAP program?

For copies of the comprehensive SNAP lists of substitutes or additional information on SNAP, refer to EPA's Ozone Depletion Web site at http:// www.epa.gov/ozone/snap/index.html. For more information on the Agency's process for administering the SNAP program or criteria for evaluation of substitutes, refer to the SNAP final rulemaking published March 18, 1994 (59 FR 13044), codified at subpart G of 40 CFR part 82. A complete chronology of SNAP decisions and the appropriate citations are found at http:// www.epa.gov/ozone/snap/chron.html.

IX. Statutory and Executive Order Reviews

A. Executive Order 12866: Regulatory Planning and Review

Under Executive Order (EO) 12866 (58 FR 51735, October 4, 1993), this action is a "significant regulatory action." It raises novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order.

Accordingly, EPA submitted this action to the Office of Management and Budget (OMB) for review under EO 12866 and any changes made in response to OMB recommendations have been documented in the docket for this action.

B. Paperwork Reduction Act

This action does not impose any new information collection burden. Today's action is an Agency determination. It contains no new requirements for reporting. The only new recordkeeping requirement involves customary business practice. Today's rule requires minimal record-keeping of studies done to ensure that MVAC systems using HFO-1234yf meet the requirements set forth in this rule. Because it is customary business practice that OEMs conduct and keep on file Failure Mode and Effect Analysis (FMEA) on any potentially hazardous part or system from the beginning of production of a car model until three or more years after production of the model ends, we believe this requirement will not impose an additional paperwork burden. However, the Office of Management and Budget (OMB) has previously approved

the information collection requirements contained in the existing regulations in subpart G of 40 CFR part 82 under the provisions of the Paperwork Reduction Act, 44 U.S.C. 3501 *et seq.* and has assigned OMB control numbers 2060– 0226. The OMB control numbers for EPA's regulations are listed in 40 CFR Part 9.

C. Regulatory Flexibility Act

The Regulatory Flexibility Act (RFA) generally requires an agency to prepare a regulatory flexibility analysis of any rule subject to notice and comment rulemaking requirements under the Administrative Procedure Act or any other statute unless the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities, Small entities include small businesses, small organizations, and small governmental jurisdictions.

For purposes of assessing the impacts of today's rule on small entities, small entity is defined as: (1) A small business as defined by the Small Business Administration's (SBA) regulations at 13 CFR 121.201; for NAICS code 336111 (Automobile manufacturing), a small business has < 1000 employees; for NAICS code 336391 (Motor Vehicle Air-Conditioning Manufacturing), a small business has < 750 employees; (2) a small governmental jurisdiction that is a government of a city, county, town, school district or special district with a population of less than 50,000; and (3) a small organization that is any not-forprofit enterprise which is independently owned and operated and is not dominant in its field.

After considering the economic impacts of today's final rule on small entities, I certify that this action will not have a significant adverse economic impact on a substantial number of small entities. The only new requirement on small entities in this final rule is a requirement specifying the type of unique service fittings required when servicing MVAC systems using the refrigerant HFO-1234yf. Existing regulations at appendix D to subpart G of 40 CFR part 82 already require that there be unique service fittings for each refrigerant used in MVAC systems. Thus, the costs of purchasing new unique fittings for this refrigerant have already been imposed by the pre-existing regulation. This rule specifies the requirements for which type of unique fitting, in accordance with the fittings provided to EPA by the manufacturer. These fittings are part of the SAE J639 standard. It is not clear that there would be any cost differential between these specific unique fittings



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and others that the automotive industry could adopt instead. Thus, cost impacts of this final rule on small entities are expected to be small. This final rule is expected to relieve burden for some small entities, such as car repair shops, by allowing them the flexibility to use a new refrigerant that otherwise would have been prohibited under previous requirements at appendix B to subpart G of 40 CFR part 82 and by allowing them to use the easy-to-use "quickconnect" fittings for this refrigerant. Other final rule requirements apply to original equipment manufacturers which are not small entities. These final rule requirements are the least burdensome option for regulation.

Original equipment manufacturers are not mandated to move to MVAC systems using HFO-1234yf, EPA is simply listing HFO-1234yf as an acceptable alternative with use conditions in new MVAC systems. This rule allows the use of this alternative to ozone-depleting substances in the MVAC sector and outlines the conditions necessary for safe use. By approving this refrigerant under SNAP, EPA provides additional choice to the automotive industry which, if adopted, would reduce the impact of MVACs on the global environment. This rulemaking does not mandate the use of HFO-1234yf as a refrigerant in new **MVACs**

D. Unfunded Mandates Reform Act

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA), Public Law 104-4, establishes requirements for Federal agencies to assess the effects of their regulatory actions on State, local, and Tribal governments and the private sector. Under section 202 of the UMRA, EPA generally must prepare a written statement, including a cost-benefit analysis, for proposed and final rules with "Federal mandates" that may result in expenditures to State, local, and Tribal governments, in the aggregate, or to the private sector, of \$100 million or more in any one year. Before promulgating an EPA rule for which a written statement is needed, section 205 of the UMRA generally requires EPA to identify and consider a reasonable number of regulatory alternatives and adopt the least costly, most costeffective or least burdensome alternative that achieves the objectives of the rule. The provisions of section 205 do not apply when they are inconsistent with applicable law. Moreover, section 205 allows EPA to adopt an alternative other than the least costly, most cost-effective or least burdensome alternative if the Administrator publishes with the final rule an explanation why that alternative

was not adopted. Before EPA establishes any regulatory requirements that may significantly or uniquely affect small governments, including Tribal governments, it must have developed under section 203 of the UMRA a small government agency plan. The plan must provide for notifying potentially affected small governments, enabling officials of affected small governments to have meaningful and timely input in the development of EPA regulatory proposals with significant Federal intergovernmental mandates, and informing, educating, and advising small governments on compliance with the regulatory requirements.

EPA has determined that this rule does not contain a Federal mandate that may result in expenditures of \$100 million or more for State, local, and Tribal governments, in the aggregate, or the private sector in any one year. Today's rule does not affect State, local, or Tribal governments. The enforceable requirements of today's rule related to system design and documentation of the safety of alternative MVAC systems affect only a small number of original equipment manufacturers. Further those requirements are consistent with requirements that the automotive industry has already adopted through consensus standards of SAE International. We expect that most manufacturers of automobiles and MVAC systems would attempt to meet those requirements or something very similar, even in the absence of EPA's regulations. The only requirement that is applied more widely than for original equipment manufacturers is a requirement specifying the type of unique service fittings required when servicing MVAC systems using the refrigerant HFO-1234yf. Existing regulations at appendix D to subpart G of 40 CFR part 82 already require that there be unique service fittings for each refrigerant used in MVAC systems. The fittings required in this final rule are part of the SAE J639 standard. Thus, the costs of this rule are consistent with standard industry practice and are expected to be much less than \$100 million per year.

This action provides additional options allowing greater flexibility for industry in designing consumer products. The impact of this rule on the private sector will be less than \$100 million per year. Thus, today's rule is not subject to the requirements of sections 202 and 205 of the UMRA. EPA has determined that this rule contains no regulatory requirements that might significantly or uniquely affect small governments. This regulation applies directly to facilities that use these substances and not to governmental entities. This rule does not mandate a switch to HFO-1234yf and the limited direct economic impact on entities from this rulemaking is less than \$100 million annually.

E. Executive Order 13132: Federalism

Executive Order 13132, entitled "Federalism" (64 FR 43255, August 10, 1999), requires EPA to develop an accountable process to ensure "meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications." "Policies that have federalism implications" is defined in the Executive Order to include regulations that have "substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government,"

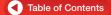
This action does not have federalism implications. It will not have substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government, as specified in Executive Order 13132. This regulation applies directly to facilities that use these substances and not to governmental entities. Thus, Executive Order 13132 does not apply to this rule.

F. Executive Order 13175: Consultation and Coordination With Indian Tribal Governments

Executive Order 13175, entitled "Consultation and Coordination with Indian Tribal Governments" (59 FR 22951, November 6, 2000), requires EPA to develop an accountable process to ensure "meaningful and timely input by tribal officials in the development of regulatory policies that have tribal implications." This final rule does not have Tribal implications, as specified in Executive Order 13175. It does not significantly or uniquely affect the communities of Indian Tribal governments, because this regulation applies directly to facilities that use these substances and not to governmental entities. Thus, Executive Order 13175 does not apply to this rule.

G. Executive Order 13045: Protection of Children From Environmental Health Risks and Safety Risks

This action is not subject to EO 13045 (62 FR 19685, April 23, 1997) because it is not economically significant as defined in EO 12866, and because the Agency does not believe the environmental health or safety risks



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addressed by this action present a disproportionate risk to children. This action's health and risk assessments are discussed in sections V and VII.D of the preamble and in documents EPA-HQ-OAR-2008-0664-0036 and HQ-OAR-2008-0664-0038 in the docket for this rulemaking.

H. Executive Order 13211: Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use

This action is not a "significant energy action" as defined in Executive Order 13211 (66 FR 28355 (May 22, 2001)). because it is not likely to have a significant adverse effect on the supply, distribution, or use of energy. This action could impact manufacturing and repair of MVAC systems using an alternative refrigerant. This rule does not mandate a switch to HFO-1234yf. Preliminary information indicates that these new systems are more energy efficient than currently available systems in some climates. Therefore, we conclude that this rule is not likely to have a significant adverse effect on energy supply, distribution or use.

I. National Technology Transfer and Advancement Act

Section 12(d) of the National Technology Transfer and Advancement Act of 1995 ("NTTAA"), Public Law 104-113, 12(d) (15 U.S.C. 272 note) directs EPA to use voluntary consensus standards in its regulatory activities unless to do so would be inconsistent with applicable law or otherwise impractical. Voluntary consensus standards are technical standards (e.g., materials specifications, test methods, sampling procedures, and business practices) that are developed or adopted by voluntary consensus standards bodies. NTTAA directs EPA to provide Congress, through OMB, explanations when the Agency decides not to use available and applicable voluntary consensus standards.

This rulemaking involves technical standards. EPA has decided to use SAE International's most recent version of the SAE J1739 and SAE J639 standards. These standards can be obtained from http://www.sae.org/tochnical/ standards/. These standards address safety and reliability issues in motor vehicle design, including MVAC systems using alternative refrigerants.

J. Executive Order 12898; Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations

Executive Order (EO) 12898 (59 FR 7629 (Feb. 16, 1994)) establishes Federal executive policy on environmental justice. Its main provision directs Federal agencies, to the greatest extent practicable and permitted by law, to make environmental justice part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations in the United States.

ÉPA has determined that this final rule will not have disproportionately high and adverse human health or environmental effects on minority or low-income populations because it increases the level of environmental protection for all affected populations without having any disproportionately high and adverse human health or environmental effects on any population, including any minority or low-income population. HFO-1234yf is a non-ozone-depleting substance with a low GWP. Based on the toxicological and atmospheric work described earlier, HFO-1234yf will not have any disproportionately high and adverse human health or environmental effects on any population, including any minority or low-income population. This final rule requires specific use conditions for MVAC systems, if car manufacturers chose to make MVAC systems using this low GWP refrigerant alternative.

K. Congressional Review Act

The Congressional Review Act, 5 U.S.C. 801 et seq., as added by the Small Business Regulatory Enforcement Fairness Act of 1996, generally provides that before a rule may take effect, the agency promulgating the rule must submit a rule report, which includes a copy of the rule, to each House of the Congress and to the Comptroller General of the United States. EPA will submit a report containing this rule and other required information to the U.S. Senate, the U.S. House of Representatives, and the Comptroller General of the United States prior to publication of the rule in the Federal Register, A Major rule cannot take effect until 60 days after it is published in the Federal Register. This action is not a "major rule" as defined by 5 U.S.C. 804(2). This rule will be effective May 31, 2011.

X. References

The documents below are referenced in the preamble. All documents are located in the Air Docket at the address listed in section titled **ADDRESSES** at the beginning of this document. Unless specified otherwise, all documents are available in Docket ID No. EPA-HQ- OAR-2008-0664 at http:// www.regulations.gov.

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List of Subjects in 40 CFR Part 82

Environmental protection, Administrative practice and procedure, Air pollution control, Incorporation by reference, Reporting and recordkeeping requirements, Stratospheric ozone layer.

Dated: February 24, 2011. Lisa P. Jackson,

Administrator.

For the reasons set out in the preamble, 40 CFR part 82 is amended as follows:

PART 82—PROTECTION OF STRATOSPHERIC OZONE

 1. The authority citation for part 82 continues to read as follows:

Authority: 42 U.S.C. 7414, 7601, 7671-

Subpart G—Significant New Alternatives Policy Program

2. Appendix B to Subpart G of Part 82 is amended as follows:

 a. By adding one new entry to the end and by adding a note at the end of the first table.

 b. By revising the entry for "CFC-12 Motor Vehicle Air Conditioners (Retrofit and New Equipment/NIKs)" in the table titled "Refrigerants—Unacceptable Substitutes".

The additions and revisions read as follows:

Appendix B to Subpart G of Part 82— Substitutes Subject to Use Restrictions and Unacceptable Substitutes



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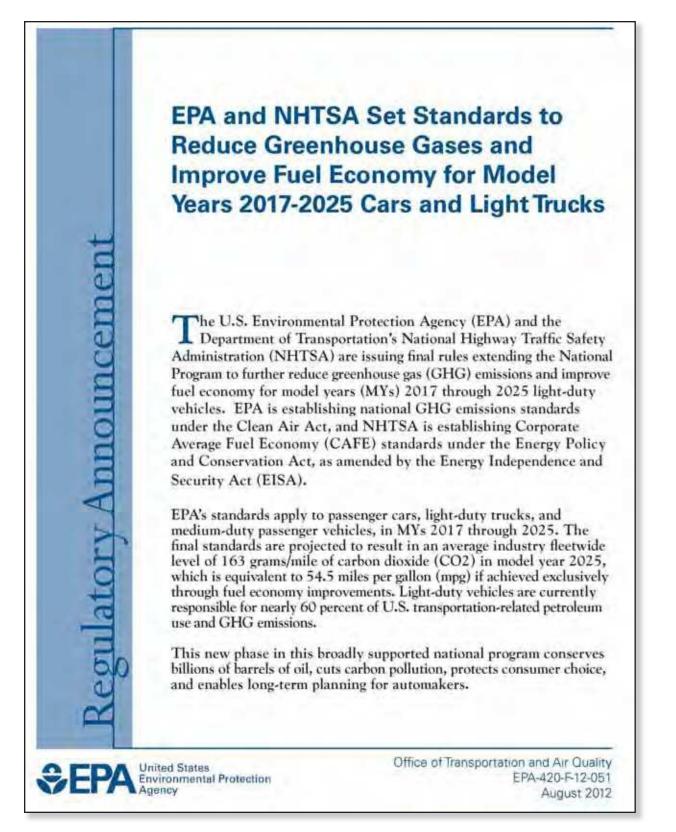
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Note: The use condition contain references to certa SAE International. The sta incorporated by reference sections are made part of to part 82: 1. SAE J639. Safety Star Vehicle Refrigerant Vapor Systems. February 2011 en International. 2. SAE J1739. Potential Effects Analysis in Design Potential Failure Mode an in Manufacturing and Ass	in standards from indards are and the referenced he regulations in idards for Motor Compression lition. SAE Failure Mode and (Design FMEA), d Effects Analysis embly Processes	Refrigera Requirem Condition edition. S The Dii approves accordan part 51. Y Customes Warrendi <i>Customes</i> 877–606– 724–776–	12844, R=1234 at Purity and C lents for Use in ing Systems. F IAE Internation rector of the Fe this incorporat ce with 5 U.S.C 'ou may obtain 'Service, 400 C le, PA 15096-4 Service@sole.or -7323 (U.S. and 4970 (outside 1 NTS—UNACC	ontainer Mobile Air- 'ebruary 2011 al. deral Register tion by referent 5.552(a) and 1 a copy from S. Jommouwealth 0001 USA; e-m y: Telephone: I Canada only) the U.S. and G	ce in CFR AE Drive, ail: 1– or 1– mada);	Docket: EPA West Bui 1301 Constitution Ave DC or at the National J Administration (NAR/ regarding access to the telephone number of E 202-568-1742. For inf availability of this mat 202-741-6030, or go to www.archives.gov/fed code of_federal_regal locations.html.	, NW.; Washington, Archives and Records M. For questions see standards, the PA's Air Docket is formation on the erial at NARA, call or: http:// eral_register/
End-use	Substitut	0	Deci	ision		Commen	ts
CFC-12 Motor Vehicle Air Conditioners (Retrofit an New Equipment/NIKs).		•	* Unacceptable		trem	A contains R-c318, a F ely high GWP and life which do not contain PF	time. Other Substitutes
	Hydrocarbon Blen	d B	Unacceptable		subr	ability is a serious conce nitted to demonstrate it end-use.	
	Flammable Substitutes, other than R-152a or HFO-1234yf in new equipment.		Unacceptable	(except R-152a a have not been ad		sks associated with usin ept R-152a and HFO- not been addressed by a and HFO-1234yf may	1234yf) in this end-use a risk assessment. R- be used in new equip-

[FR Doc. 2011-6268 Filed 3-28-11: 8:45 am] BILLING CODE 6580-50-P



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Building on Success

This MYs 2017-2025 program builds on the success of the first phase of the National Program for MYs 2012-2016 vehicles, which is projected to result in an average light-duty vehicle tailpipe CO2 level of 250 grams per mile by MY 2016, equivalent to 35.5 mpg (if achieved exclusively through fuel economy). Vehicles meeting the MYs 2012 and 2013 standards are on the road today, already saving consumers money at the pump.

Combined with the MYs 2012-2016 standards, today's final program will result in MY 2025 vehicles emitting one-half of the GHG emissions of a MY 2010 vehicle, representing the most significant federal action ever taken to reduce GHG emissions and improve fuel economy.

As with the first phase of the National Program, this second phase of the program was built on strong support from a wide range of stakeholders, including the automobile manufacturers. After President Obama announced plans for the second phase National Program on July 29, 2011, thirteen auto manufacturers representing over 90 percent of U.S. vehicle sales announced support for the program, as well as the State of California. The United Auto Workers, consumer organizations, environmental organizations, veterans groups, state/local governments, and nearly 300,000 individuals have also expressed strong support for the program.

Continuing the National Program ensures that auto manufacturers can build a single fleet of U.S. vehicles that satisfy requirements of both federal programs as well as California's program, thus helping to reduce costs and regulatory complexity while providing significant energy security and environmental benefits to the nation as a whole.

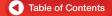
Benefits to Consumers

These standards will provide significant savings for consumers at the pump. Higher costs for new vehicle technology are projected to add, on average, about \$1,800 for consumers who buy a new vehicle in MY 2025. Those consumers who drive their MY 2025 vehicle for its entire lifetime will save, on average, \$5,700 to \$7,400 (7 and 3 percent discount rates, respectively) in fuel savings, for a net lifetime savings of \$3,400 to \$5,000 (when compard to a vehicle meeting the MY 2016 standards). For those consumers who purchase their new MY 2025 vehicle outright, the discounted fuel savings will offset the higher vehicle cost in less than 3.5 years, and fuel savings will continue for as long as the consumer owns the vehicle.

Those consumers who purchase a new MY 2025 vehicle with a standard 5-year loan will immediately benefit as the monthly fuel savings offset the higher monthly payment by about \$12 or about \$140 per year. These savings assume a gasoline price of \$3.87 in 2025 with small future increases throughout the vehicle's lifetime; if gas prices soar consumers would save even more money as a result of these more fuel-efficient vehicles.

The final standards preserve consumer choice -- that is, the standards should not affect consumers' opportunity to purchase the size of vehicle with the performance, utility and safety features that meet their needs. The standards have been designed in a way that does not create incentives to manufacture vehicles of any particular size (for example, there is no incentive to downsize.

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Benefits from Greenhouse Gas Reductions and Less Oil Dependency

Over the lifetimes of the vehicles sold in MYs 2017-2025 standards, this program is projected to save approximately 4 billion barrels of oil and reduce GHG emissions by 2 billion metric tons, with net benefits to society in the range of \$326 billion to \$451 billion (7 and 3 percent discount rates, respectively). These savings come on top of savings that would already be achieved through the continuation of the MY 2016 standards.

The combined National Program for MYs 2012-2016 and MYs 2017-2025 is projected to save families more than \$1.7 trillion in fuel costs and reduce America's dependence on oil by more than 2 million barrels per day in 2025, which is equivalent to one-half of the oil that we currently import from OPEC countries each day. In addition, the combined program will cut 6 billion metric tons of greenhouse gases over the lifetimes of the vehicles sold in MYs 2012-2025 – more than the total amount of carbon dioxide emitted by the United States in 2010. Consumers who purchase a new MY 2025 vehicle will save more than \$8,000 in fuel costs over that vehicle's lifetime (when compared to a vehicle meeting the MY 2011 CAFE standards).

EPA's Greenhouse Gas Standards

EPA is finalizing a set of fleet-wide average carbon dioxide (CO2) emission standards for cats and light trucks. These standards are based on CO2 emissions-footprint curves, where each vehicle has a different CO2 emissions compliance target depending on its footprint value (related to the size of the vehicle). Generally, the larger the vehicle footprint, the higher the corresponding vehicle CO2 emissions target. As a result, the burden of compliance is distributed across all vehicles and all manufacturers. Manufacturers are not compelled to build vehicles of any particular size or type (nor does the rule create an incentive to do so), and no single vehicle is required to meet its individual target. Each manufacturer will have its own fleet-wide standard that reflects the vehicles it chooses to produce, and the GHG program provides a wide range of credit programs and flexibilities for manufacturers to meet the standards.

Table 1 shows the projected fleet-wide CO2 emission targets under this footprint-based approach. The car CO2 emission levels are projected to increase in stringency from 212 to 143 grams per mile (g/mi) between MY s 2017 and 2025. Similarly, fleet-wide CO2 emission levels for trucks are projected to increase in stringency from 295 in MY 2017 to 203 g/mi in MY 2025. EPA projects that the average light vehicle (combined car and truck) tailpipe CO2 compliance level in MY 2017 will be 243 g/mi, phasing down by MY 2025 to 163 g/mi, corresponding to 54.5 mpg in MY 2025 if all reductions were made through fuel economy improvements.

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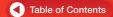
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Tabl	e 1 - Proj		Constant and the second				ts under t Economy		rint-Base	d
	2016 base	2017	2018	2019	2020	2021	2022	2023	2024	2025
Passenger Cars (g/mi)	225	212	202	191	182	172	164	157	150	143
Light Trucks (g/ml)	298	295	285	277	269	249	237	225	214	203
Combined Cars & Trucks (g/mi)	250	243	232	222	213	199	190	180	171	163
Combined Cars & Trucks (mpg)	35.5	36.6	38.3	40,0	41.7	44.7	46.8	49.4	52.0	54.5

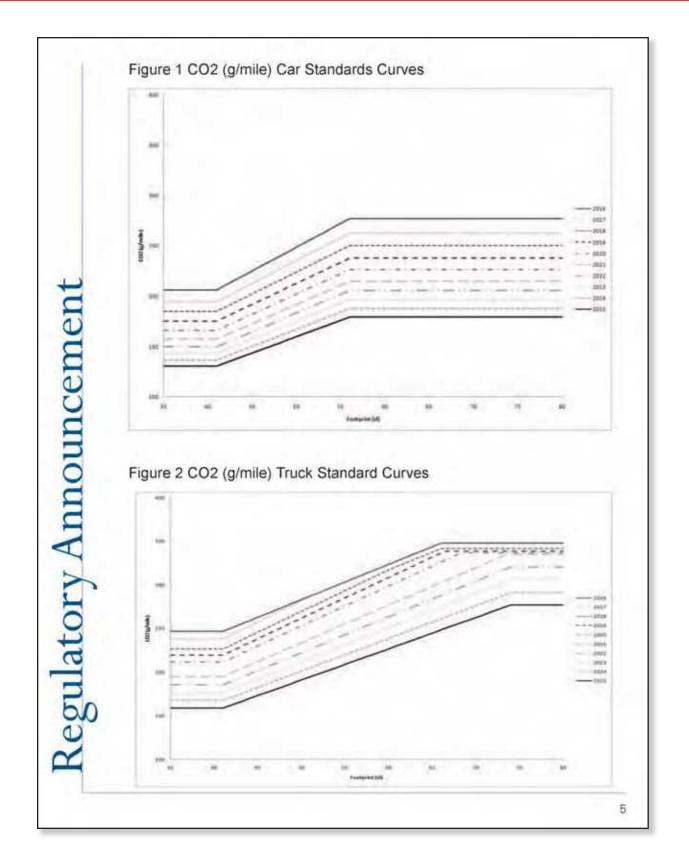
Figures 1 and 2 show the actual footprint curves for cars and trucks, respectively. For passenger cars, the CO2 compliance values associated with the footprint curves would be reduced on average by 5 percent per year from the MY 2016 projected passenger car industry-wide compliance level through MY 2025. To address the challenges facing light-duty trucks, as we transition from the MY 2016 standards to MY 2017 and later, while preserving the utility (e.g., towing and payload capabilities) of those vehicles, EPA's standards provide a lower annual rate of improvement for light-duty trucks in the early years of the program. The average annual rate of CO2 emissions reduction in MYs 2017 through 2021 is 3.5 percent per year and 5 percent per year for MYs 2022 through 2025.

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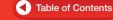


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Example footprint targets for popular vehicle models are shown in Table 2, illustrating the fact that different vehicle sizes will have varying CO2 emissions and fuel economy targets under the footprint-based standards. Vehicle CO2 emissions will be measured over the EPA city and highway tests.

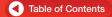
Vehicle Type	Example Models	Example Model Footprint (sq. ft.)	EPA CO ₂ Emissions Target (g/mi)*	NHTSA Fuel Economy Target (mpg)
Example Passenger	Cars			
Compact car	Honda Fit	40	131	61.1
Mid-size car	Ford Fusion	46	147	54.9
Full-size car	Chrysler 300	53	170	48.0
Example Light-duty	Trucks			
Small SUV	4WD Ford Escape	43	170	47.5
Midsize crossover	Nissan Murano	49	188	43.4
Minivan	Toyota Sienna	56	209	39.2
Large pickup truck	Chevy Silverado (extended cab,6.5 foot base)	67	252	33.0

* Real-world CO2 is typically 25 percent higher and real-world fuel economy is typically 20 percent lower than the CO2 and CAFE values discussed here.

** The fael commy upg targets shown in the lan column would be higher if using the MPG-equivalent values corresponding to the CO2 emissions rargets, i.e., if all CO2 reductions were achieved exclusively with higher fiel economy technologies.

Vehicle Technologies to Reduce GHGs and Improve Fuel Economy

EPA projects that manufacturers will comply with the MYs 2017-2025 standards by using a wide range of technologies, including continual advances in gasoline engines and transmissions, vehicle weight reduction, lower tite rolling resistance, vehicle aerodynamics, diesel engines, and more efficient vehicle accessories. EPA expects that the majority of improvements will come from advancements in internal combustion engines, although we also expect to see some increased electrification of the fleet through the expanded production of stop/start, hybrid vehicles, plugin hybrid electric vehicles, and electric vehicles. EPA also expects that vehicle air conditioning systems will continue to become more efficient, reduce leakage, and use alternative refrigerants with lower hydrofluorocarbon emissions.



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Mid-Term Evaluation

Given the long time frame at issue in setting standards for MYs 2022-2025, and given NHTSA's obligation to conduct a separate rulemaking in order to establish final standards for vehicles for those model years, EPA and NHTSA will conduct a comprehensive mid-term evaluation and agency decision-making process. As part of this undertaking, EPA and NHTSA will develop and compile up-to-date information for the evaluation, through a collaborative, robust and transparent process, including public notice and comment. EPA and NHTSA fully expect to conduct this mid-term evaluation in coordination with the California Air Resources Board (CARB), given our interest in maintaining a National Program to address GHG emissions and fuel economy. The comprehensive evaluation process will lead to final agency action by both agencies.

EPA's Program Flexibilities

EPA's final program includes provisions that offer compliance flexibility to auto manufacturers. Together these flexibilities are expected to provide sufficient lead time for manufacturers to make necessary technological improvements and to reduce the overall cost of the program, without compromising overall environmental objectives. The flexibilities also provide incentives to facilitate market penetration of the most advanced vehicle technologies.

Credit Banking and Trading - EPA will continue the same comprehensive program for averaging, banking, and trading of credits established in the MYs 2012-2016 program. Together, these provisions help manufacturers in planning and implementing the orderly phase-in of GHOreducing technology in their production, consistent with typical redesign schedules. Credits may be carried forward, or banked, for five years, or carried back three years to cover a deficit in a previous year. A manufacturer may transfer credits across all vehicles it produces, both cars and light trucks. Trading of credits between companies is also permitted. To facilitate the transition to the increasingly more stringent MYs 2017-2025 standards, EPA is finalizing under its Clean Air Act authority a one-time CO2 credit carry-forward provision beyond 5 years, allowing credits generated from MYs 2010 through 2016 to be used through MY 2021.

Air Conditioning Improvement Credits - As with the MYs 2012-2016 program, manufacturers will be able to generate CO2-equivalent credits to use in complying with the CO2 standards for (1) improvements in air conditioning (A/C) systems that reduce tailpipe CO2 through efficiency improvements, and (2) for reduced refrigerant leakage--through better components and/or use of alternative refrigerants with lower global warming potential. Currently A/C systems use tefrigerants containing hydrofluorocarbons (HEC) which are highly potent greenhouse gases, and EPA's A/C credits will give manufacturers an incentive to accelerate the use of refrigerants with much lower HEC emissions.

Off-Cycle Credits - Off-cycle technologies achieve CO2 reductions that are not reflected in current test procedures. Such off-cycle technologies might include solar panels on hybrids, engine startstop or active aerodynamics. EPA is expanding and streamlining the MYs 2012-2016 off-cycle credit provisions for demonstrating and obtaining these credits. For MYs 2014 and later, EPA is finalizing a pre-approved list of technologies and credit values. Further, manufacturers will be

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able to apply for off-cycle technology credits beyond those listed (or for different credit values for the listed technologies) if they present sufficient data to EPA.

Incentives for Electric Vehicles, Plug-in Hybrid Electric Vehicles, Fuel Cell Vehicles, and Compressed Natural Gas Vehicles - To facilitate market penetration of the most advanced vehicle technologies as rapidly as possible, EPA is finalizing an incentive multiplier for compliance purposes for all electric vehicles (EVs), plug-in hybrid electric vehicles (PHEVs), fuel cell vehicles (FCV) and compressed natural gas (CNG) vehicles sold in MYs 2017 through 2021. This multiplier approach means that each EV/PHEV/FCV/CNGV would count as more than one vehicle in the manufacturer's compliance calculation. EVs and FCVs will start with a multiplier value of 2.0 in MY 2017, phasing down to a value of 1.5 in MY 2021. PHEVs and CNG vehicles will start at a multiplier value of 1.6 in MY 2017 and phase down to a value of 1.3 in MY 2021. There are no multipliers for MYs 2022-2025.

For EVs, PHEVs and FCVs, EPA is setting 0 g/mi as the tailpipe compliance value for EVs, PHEVs (electricity usage) and FCVs for MYs 2017-2021, with no limit on the quantity of vehicles eligible for 0 g/mi tailpipe emissions accounting. For MYs 2022-2025, 0 g/mi will only be allowed up to a pet-company cumulative sales cap:

1) 600,000 vehicles for companies that sell 300,000 EV/PHEV/FCVs in MYs 2019-2021;

2) 200,000 vehicles for all other manufacturers.

For sales above these thresholds, manufacturers will be required to account for the net upstream GHG emissions for the electric portion of operation, using accounting methodologies set out in the rule.

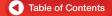
Incentives for Advanced Technologies Including Hybridization for Full-Size Pickup Trucks - EPA is finalizing an additional CO2 per vehicle credit, for mild and strong hybrid electric (HEV) full-size pickup trucks, if this advanced technology is utilized across a designated percentage of a manufacturers' full-size pickup trucks. This incentive further encourages manufacturers to begin to transform the most challenged category of vehicles in terms of the penetration of advanced technologies.

Eligibility for this credit is conditioned on a minimum penetration of the technology in a manufacturer's full size pickup truck fleer. Mild HEVs pickup trucks will be eligible for a per vehicle credit of 10 g/mi during MYs 2017-2021 if the technology is used with at least 20% of a company's MY 2017 full-size pickup production and ramping up to at least 80% in MY 2021. Strong HEV pickup trucks will be eligible for 20 g/mi per vehicle credit during MYs 2017-2025 if the technology is used on at least 10% of the company's full size pickups.

In addition to the specific hybridization credits, because there are other technologies besides mild and strong hybrids which can significantly reduce GHG emissions and fuel consumption in pickup trucks, EPA is also finalizing a performance-based incentive CO2 emissions credit for full-size pickup trucks that achieve a significant CO2 reduction below the applicable target. To avoid double-counting, the same vehicle will not receive credit under both the HEV and performance based approaches.

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Treatment of Compressed Natural Gas (CNG), Plug-in Hybrid Electric Vehicles (PHEVs), and Flexible Fuel Vehicles (FFVs) - EPA is finalizing a methodology for determining CO2 levels for plug-in hybrid electric vehicles (PHEVs) and dual fuel compressed natural gas (CNG) vehicles. This methodology assumes how much of the time these vehicles will operate using the alternative fuel, and how much on gasoline. This methodology (called a "utility factor") assumes that owners of these vehicles will use the cheaper non-gasoline fuel most of the time, since that was a main reason for purchasing the vehicle.

As proposed, EPA is not establishing a utility factor for flexible fueled vehicles (FFVs) using E-85 and gasoline, since there is not a significant cost differential between an FFV and a conventional gasoline vehicle and historically consumers have only fueled these vehicles with E85 a very small percentage of the time. FFVs continue to be treated as they are treated in MY 2016 where emissions are weighted based on actual alternative fuel usage.

Provisions for Intermediate and Small Volume Manufacturers - In the MYs 2012-2016 rule, EPA provided less stringent CO2 standards through MY 2016 to manufacturers with U.S. sales of less than 50,000 vehicles under the Temporary Lead time Allowance Alternative Standards (TLAAS) program. For MYs 2017-2025 standards, EPA is providing additional lead time flexibility to these intermediate volume manufacturers to help ease their transition to the primary program standards. The lead time flexibility is available through MY 2020 and intermediate volume manufacturers are required to meet the primary standards starting in MY 2021.

EPA is allowing small volume manufacturers (SVMs) with U.S. sales of less than 5,000 vehicles to petition EPA for alternative CO2 standards, which will be established for eligible SVMs on a case-by-case basis. These SVMs are exempt under the MYs 2012-2016 CO2 standards. EPA is also allowing manufacturers that are able to demonstrate that they are operationally independent from their parent company and have U.S. sales of less than 5,000 vehicles to be eligible for SVM GHG provisions.

In addition, EPA is continuing to exempt small businesses (companies with less than 1,000 employees, as defined by the Small Business Administration) from all GHG standards and program requirements.

Public Participation

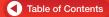
EPA developed this final rule after consideration of extensive public input. EPA and NHTSA heard from nearly 400 testifiers at three public hearings held in Detroit, Philadelphia and San Francisco during January 2012. The agencies received written comments from nearly 300,000 individuals and more than 140 organizations, including auto manufacturers and suppliers, state and local governments and their associations, consumer groups, labor unions, fuels and energy providers, auto dealers, academics, national security experts and veterans, environmental and other non-governmental organizations.

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Background on the MYs 2017-2025 National Program

Following the successful adoption of a National Program for GHG and fuel economy standards for MYs 2012-2016 vehicles, President Obama requested the agencies to continue their efforts to develop a second phase of the National Program, with standards for MYs 2017-2025 light-duty vehicles. In a May 21, 2010, Presidential Memorandum, the President requested that EPA and NHTSA work together to develop a national program that would "...produce a new generation of clean vehicles." The President specifically requested that the agencies develop "...a coordinated national program under the CAA [Clean Air Act] and the EISA [Energy Independence and Security Act of 2007] to improve fuel efficiency and to reduce greenhouse gas emissions of passenger cars and light-duty trucks of model years 2017-2025." The President recognized our country could take a leadership role in addressing the global challenges of improving energy security and reducing greenhouse gas pollution, starting that "America has the opportunity to lead the world in the development of a new generation of clean cars and trucks through innovative technologies and manufacturing that will spur economic growth and create high-quality domestic jobs, enhance our energy security, and improve our environment."

The agencies worked with the State of California to address all elements requested in the May 21, 2010 Presidential Memorandum and completed an initial assessment of the technologies, strategies and underlying analyses that would be considered in setting standards for MYs 2017-2025, in consultation with a wide range of stakeholders. EPA and NHTSA issued an Interim Joint Technical Assessment Report (TAR) and a Notice of Intent (NOI) to conduct a joint rulemaking on September 30, 2010.³ Following an opportunity for public comment, the agencies published a Supplemental NOI (SNOI)² in December 2010 highlighting many of the key comments received in response to the September NOI and the TAR and outlining plans for key technical analyses that would be undertaken in developing the proposed rulemaking.

On July 29, 2011, President Obama announced plans for the MYs 2017-2025 national program and EPA and NHTSA issued another SNOI⁷, outlining plans for the MYs 2017-2025 proposed program. The State of California and thirteen auto manufacturers representing over 90 percent of U.S. vehicle sales provided letters of support for the program concurrent with the SNOI. The joint proposal to extend the National Program to MYs 2017-2025 light-duty vehicles was issued on November 16, 2011 and published in the Federal Register on December 1, 2011.⁴

For More Information

You can access the final rule, regulations and related documents on EPA's Office of Transportation and Air Quality (OTAQ) Web site at:

www.epa.gov/otaq/elimate/regulations.htm

For more information on this rule, please contact the U.S. Environmental Protection Agency, Office of Transportation and Air Quality at: E-mail: OTAQPUBLICWEB@epa.gov

75 FR 62739, October 13, 2010, 75 FR 76337, December 8, 2010, 76 FR 48758, August 9, 2011, 76 FR 74854, December 1, 2011.

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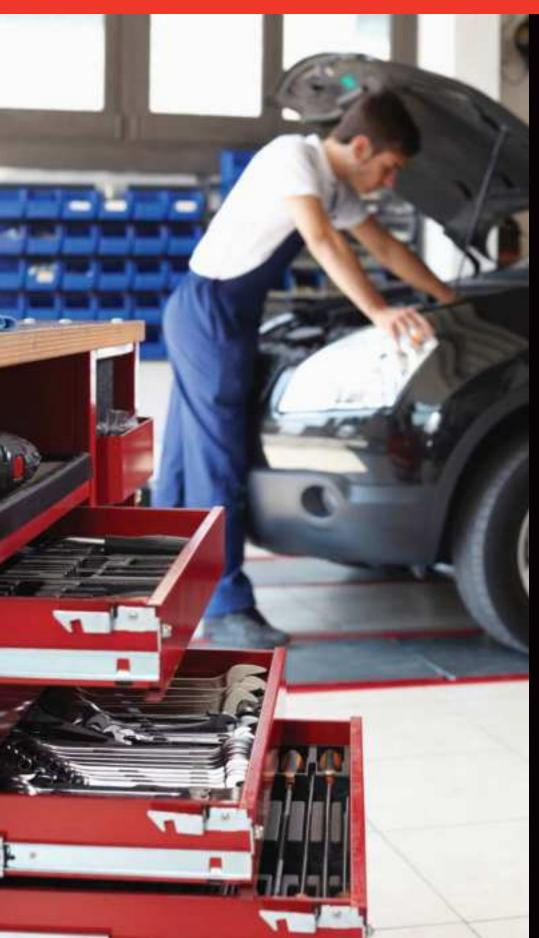
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Part 7 Auxiliary Equipment Providers



The information provided herein is for informational purposes only and Honeywell does not endorse, guarantee, warrant or recommend any of the products or services offered by third parties.

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Auxiliary Equipment and Suppliers

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CATEGORY LISTING

Hoses and Connections

CPS Gauges and Fittings Errecom Hoses Mastercool Gauge Manifold Yellow Jacket (CGA 166 LH Adapter)

Leak Detection

CPS Leak Detector Robinair Leak Detector RTI Leak Detector Techno Tools Leak Detector Yellow Jacket Leak Detector

Pumps

Haskel Pump for Hose Recovery

Recovery, Recycle, Recharge (RRR) Machines

CPS RRR Machine Ecotechnics ECK Twin Launch UK RRR System Robinair Service Equipment RTI Mahle RRR Machine

Refrigerant Identification

Neutronics Refrigerant Identifier

SUPPLIER WEBSITES

This is a partial list of equipment suppliers.

Beissbarth	www.beissbarth.com/bbcms/cms.php
Brain Bee	www.brainbee.it
CPS	www.cpsproducts.com
Ecotechnics	www.ecotechnics.it
Errecom	www.errecom.it/ENG/
Fral Oksys	www.fral-arm.com
Haskel	www.haskel.com
Hella Nussbaum	www.hella-nussbaum.com
Launch UK	www.launchtech.co.uk
Luvata	www.luvata.com
Mastercool	www.mastercool.com
Motorscan KS electronics	www.motorscan.com
Neutronics	www.neutronicsinc.com
Robinair	www.robinair.com
RTI	www.rtitech.com
Snap On	www.snapon.com
SPX	www.spx.com/en/
Techno Tools	www.techno-tools.com
Tecnomotor	www.tecnomotor.it
TEXA	www.texa.com
Waeco	www.airconservice.eu
WIGAM	www.wigam.it
Yellow Jacket	www.airconservice.eu

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Hoses and Connections



CPS Gauges and Fittings Errecom Hose Mastercool Gauge Manifold Yellow Jacket (CGA 166 LH Adapter)



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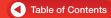
CPS Guages and Fittings

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Errecom Hoses



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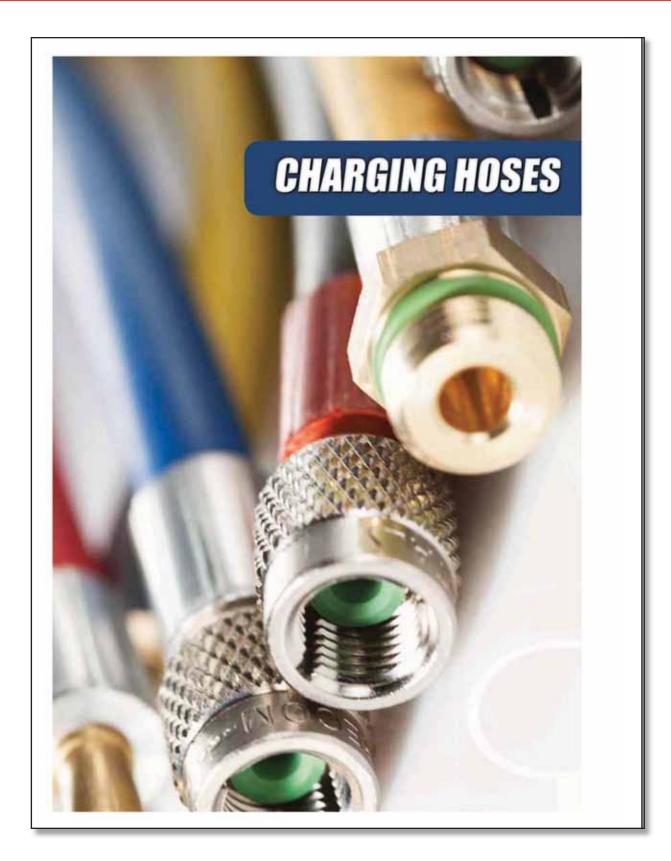
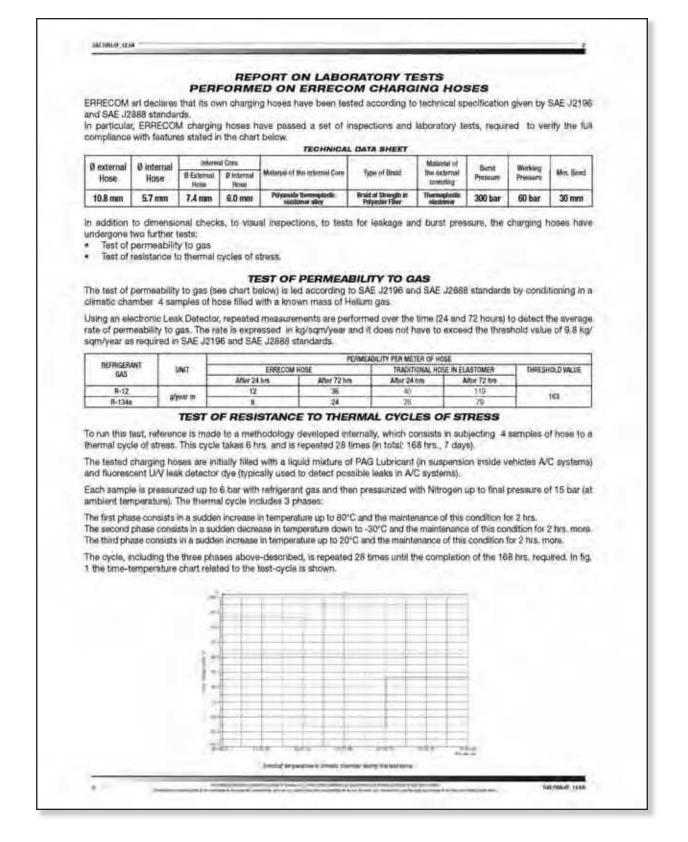




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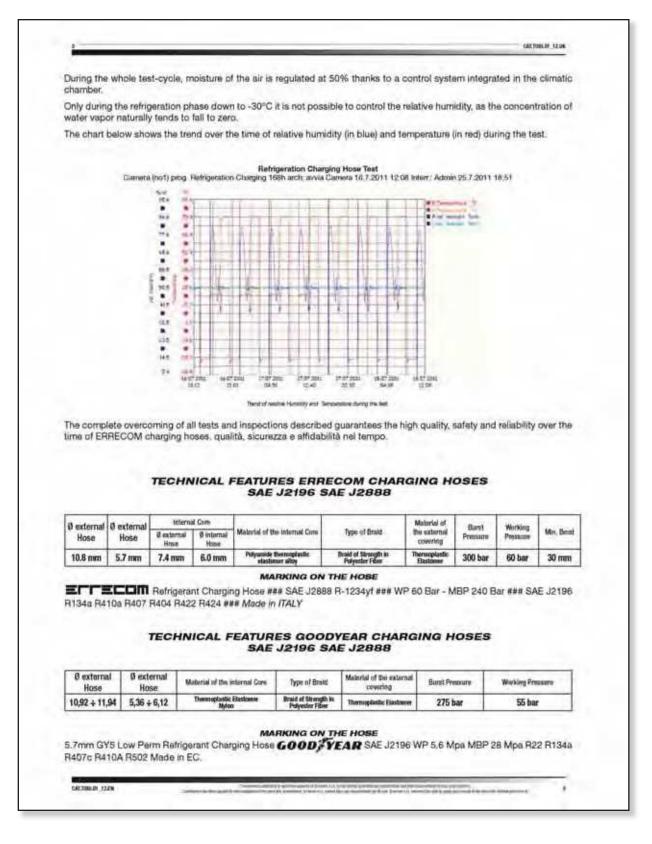
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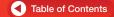
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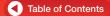


Errecom Hoses



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QUICK	K COUPLERS FOR R134a REFRIGERANT GAS
n n 1	1/4 SAE MADE-IN-CHINA QUICK COUPLERS
	RA1008.01 HIGH PRESSURE 01 PC -
	RA1009.01 LOW PRESSURE 01 PC +
NA RAE	MADE-IN-CHINA 90° QUICK COUPLERS
AT-10 RA1004.01	LESSANTON 🤓 KEKA
RA1005.01	
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And and	3/8 SAE MADE-IN-CHINA 90° QUICK COUPLERS
50150	AR AN CESCHETICIN 💝 Head
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1'-11" 1'-1-#	
M14X1.5	MADE-IN-CHINA 90" QUICK COUPLERS
RA1006.0	LESCRETICN 😂 GEACH
RA1007.0	
HIGH F	PRESSURE SPECIAL ADAPTER FOR R134a
-	FOR BMW 5 - FORD S MAX, GALAXY - VOLVO C30
and the second se	MERCEDES SLK
1000	Art-Art Cristianition
	RA1018.01 HIGH PRESSURE 01 PC -
QUICK C	OUPLERS FOR R-1234yf REFRIGERANT GAS
	OUPLERS FOR R-1234yf REFRIGERANT GAS M12X1,5 ERRECOM QUICK COUPLERS (SAE J2888)
	OUPLERS FOR R-1234yf REFRIGERANT GAS M12X1,5 ERRECOM QUICK COUPLERS (SAE J2888)
	OUPLERS FOR R-1234yf REFRIGERANT GAS M12X1,5 ERRECOM QUICK COUPLERS (SAE J2888) RA1050.01 HIGH PRESSURE 01 PC
	OUPLERS FOR R-1234yf REFRIGERANT GAS
	OUPLERS FOR R-1234yf REFRIGERANT GAS M12X1,5 ERRECOM QUICK COUPLERS (SAE J2888) RA1050.01 HKH PRESSURE 01 PC RA1051.01 LOW PRESSURE 01 PC 2X1,5 PARKER QUICK COUPLERS (SAE J2888)
	OUPLERS FOR R-1234yf REFRIGERANT GAS M12X1,5 ERRECOM QUICK COUPLERS (SAE J2888) RA1050.01 HIGH PRESSURE 01 PC

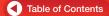


Mastercool Gauge Manifold

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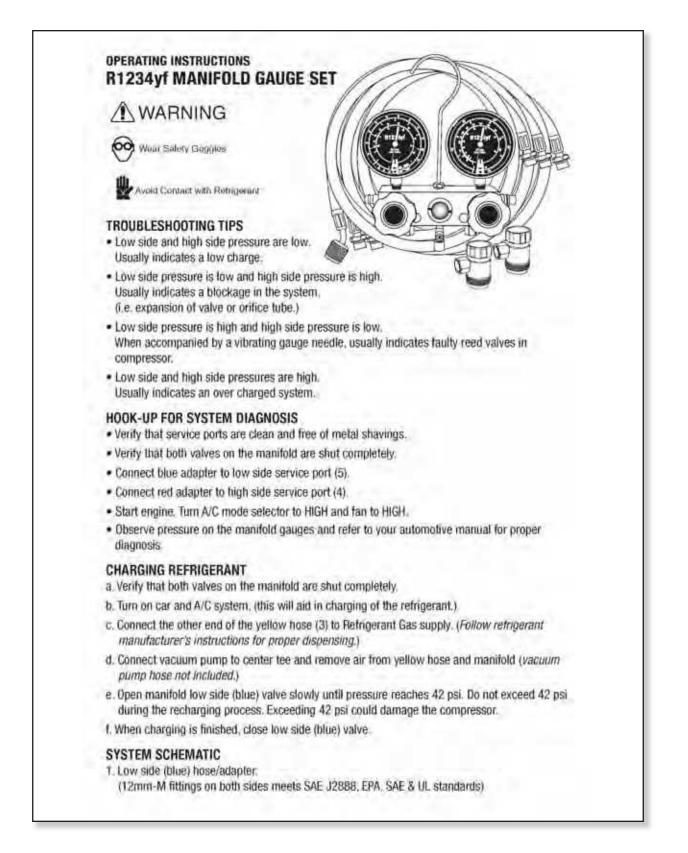


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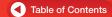


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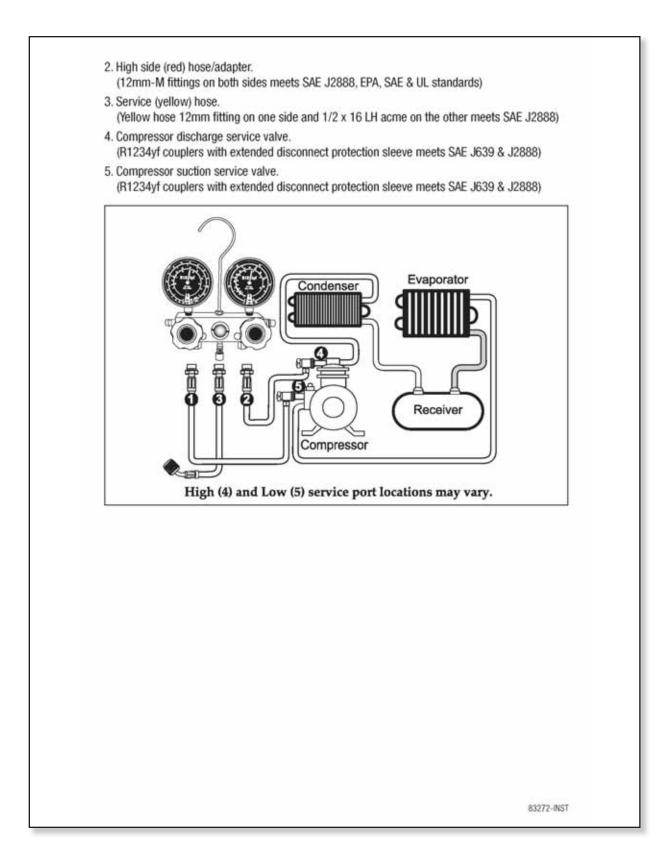


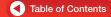
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Mastercool Gauge Manifold

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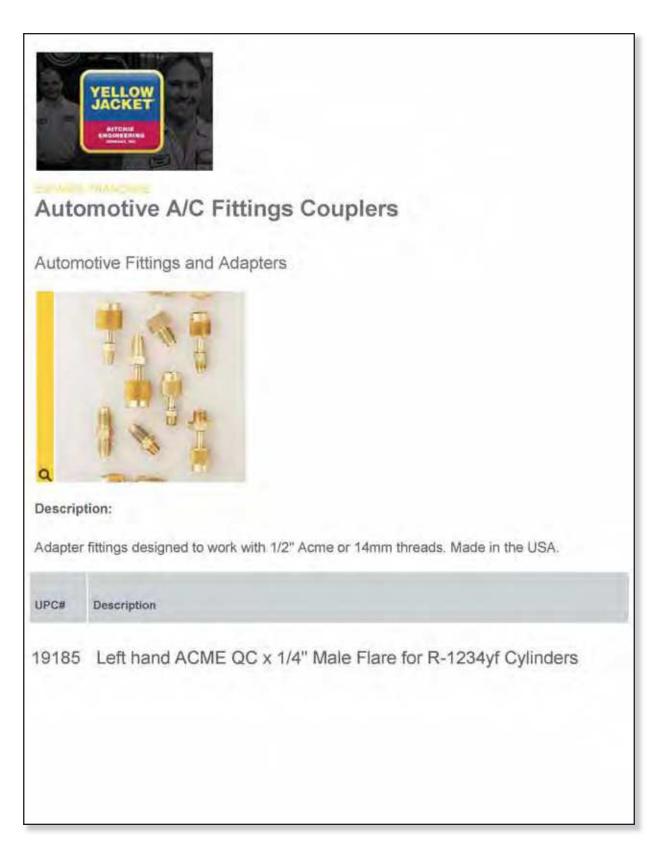




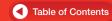


Yellow Jacket (CGA 166 LH Adapter)

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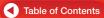




Yellow Jacket (CGA 166 LH Adapter)

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Leak Detection



CPS Leak Detector Robinair Leak Detector RTI Leak Detector Techno Tools Leak Detector Yellow Jacket Leak Detector

CPS Leak Detector



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Robinair Leak Detector



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Product Description

The Robinair No. 22791 uses infrared optics to create a refrigerant leak detector that combines sensitivity, speed, battery life, portability, and ease of use. This unit detects leaks as small as 0.15 oz/year, and meets SAE J1627, J2791, and J2913 standards.

No. 22791 comes with a wall charger and a car charger for its compact lithium-ion battery—which can power the leak detector for up to eight hours of continuous operation before needing to recharge. A choice of three sensitivity settings keep false alarms to a minimum while allowing detection of even the smallest leak in a refrigerant contaminated environment. A 30-second, self-calibration test occurs whenever the unit is powered on to ensure optimal performance. A built-in replaceable filter blocks moisture and particulates, preventing damage to the sensor.

Specifications

Sensing element: enhanced infrared photo optics Refrigerants: HFC, CFC, HCFC, blends, and HFO-1234yf Sensitivity level (per SAE J2791 and J2913):

> HIGH: 0.15 oz/year and higher MED: 0.25 oz/year and higher LOW: 0.5 oz/year and higher

Response time: less than one second

Battery life: up to 8 hours continuous use before recharge

Auto OFF: 10 minutes of inactivity

Battery: 3.7V, 1880 mAH rechargeable, lithium-ion (No. 74364)

Low battery LED: illuminates when 1 hour of battery life remains

Charge time: less than 4 hours @ 500 mA

Operating environment: 32°F (0°C) to 122°F (50°C) at <75% RH **Storage environment:** <80% RH for detector and battery **For 80% battery recovery:**

-4°F (-20°C) to 140°F (60°C) less than 1 month

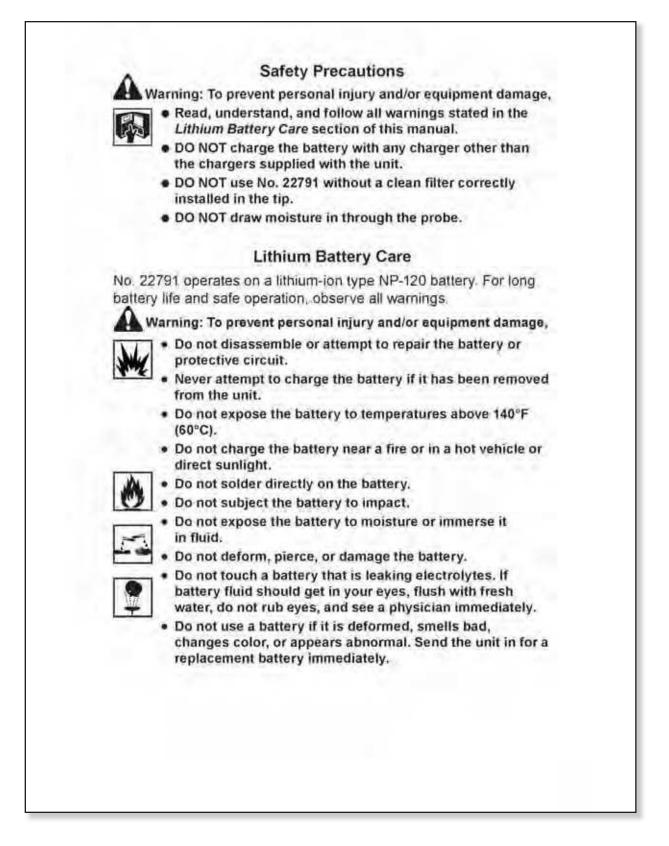
- -4°F (-20°C) to 113°F (45°C) less than 3 months
- -4°F (-20°C) to 68°F (20°C) less than 1 year

Accessories included: wall charger, car charger, storage case, battery (installed), and operator's manual.

Robinair Leak Detector

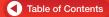


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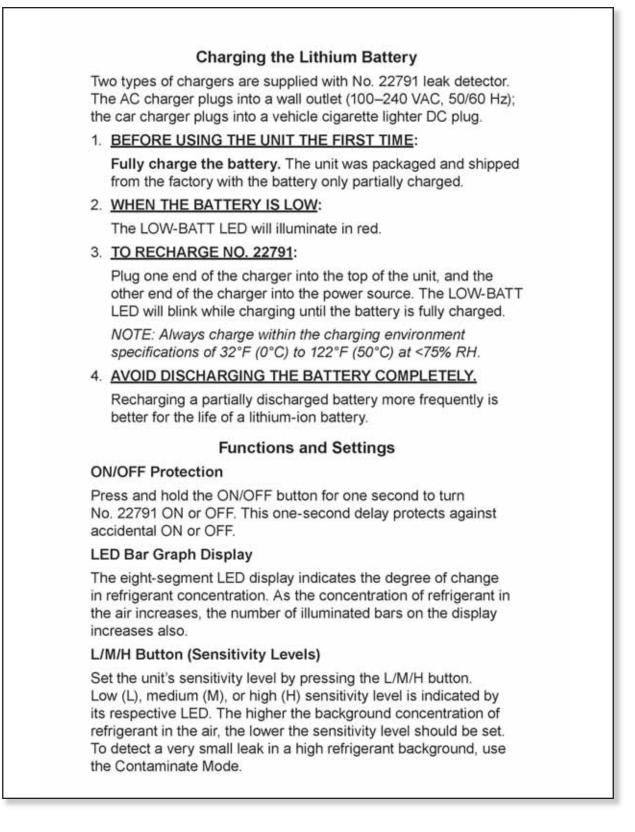




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Robinair Leak Detector

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Mute Button

Press the MUTE button to toggle the audio portion of No. 22791 ON or OFF.

Peak Button

The PEAK function stores the highest change in refrigerant concentration achieved while continuing to detect leaks. Press the PEAK button to toggle this function ON and OFF. The PEAK LED illuminates when this function is turned on. Turning the PEAK function off clears the peak information.

Contaminate Mode

To detect even the smallest leak in refrigerant-contaminated environments, press the PEAK button rapidly four times. The green LED will flash rapidly to show contamination mode is on. Press the PEAK button rapidly four times again to turn contamination mode off.

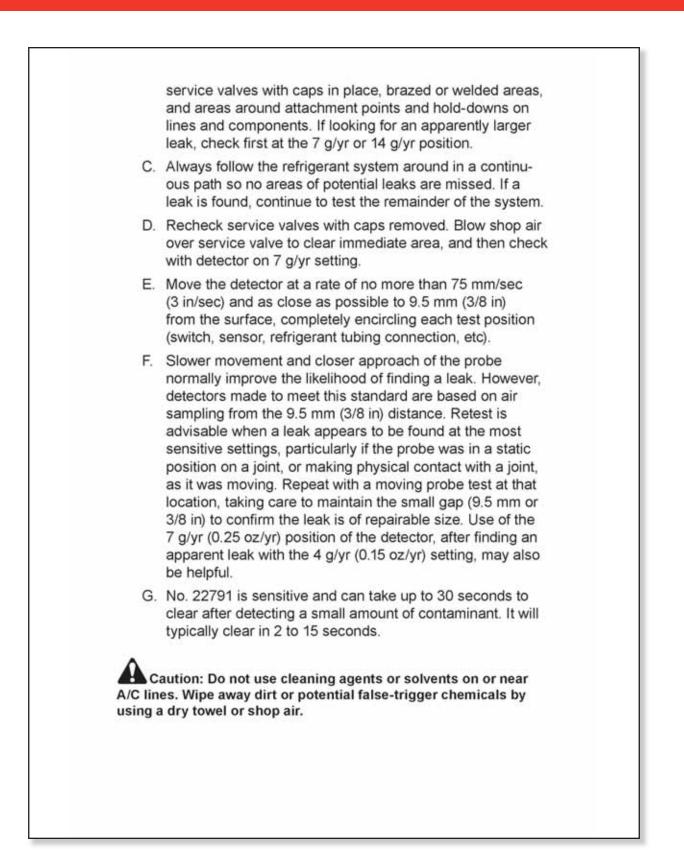
Leak Detection Procedure

- Press and hold the ON/OFF button for one second. The warmup and calibration sequence takes approximately 30 seconds. The sensitivity level defaults to HIGH at startup.
- 2. The most likely place for a refrigerant leak is at soldered joints in refrigerant lines and changes in cross section or direction of these lines. No. 22791 detects changes in concentration of refrigerant, not the absolute concentration of refrigerant. This allows the detection of leaks in locations that may have refrigerant in the air. Use the following "double pass" method to find leaks from the detection of change in refrigerant concentration. Leak test with the engine off.
 - A. Charge the system with sufficient refrigerant to have a gauge pressure of at least 340 kPa (50 psi) with the system off. At ambient temperatures below 15°C, leaks may not be measurable because the pressure may not be reached.
 - B. Visually trace the entire refrigerant system, and look for signs of air conditioning lubricant leakage, damage, and corrosion on all lines, hoses, and components. Check each questionable area with the detector probe, as well as all fittings, hose-to-line couplings, refrigerant controls,

Robinair Leak Detector

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Robinair Leak Detector

Doc Number: # Part 7 - Page 259

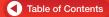
If the 22791 does false trigger on a chemical listed below, allow the leak detector to clear for a minimum time listed in the table.

Chemical	Detection	Time to Clear (seconds)
Windshield washer solvent	Yes	6
Ford spot and stain remover	No	-
Ford rust penetrant and inhibitor	Yes	5
Ford gasket and trim adhesive	Yes	6
Permatex Natural Blue cleaner and degreaser	No	
Ford brake parts cleaner	Yes	6
Ford clear silicone rubber	No	-
Motorcraft G-05 antifreeze / coolant	No	-
Gunk Liquid Wrench	Yes	4
Ford pumice / lotion hand cleaner	No	-
Ford Motorcraft DOT-3 brake fluid	No	2
Ford spray carburetor tune-up cleaner	Yes	5
Ford silicone lubricant	No	-
Dexron automatic transmission fluid	No	5
Mineral engine oil	No	-

SAE J2791 False-Trigger Test Results



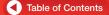
Robinair Leak Detector



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Accessories and Replacement Parts
Optional Accessories Order No.
Extension Probe (9 inch) 74367
Rigid Extension Probe
Replacement Parts Order No.
100-240 VAC Charger
Std. Europe Plug Adapter 74115
Great Britain Plug Adapter 74116
12V DC Charger
Filters (5) and O-rings (3) 74363
Lithium-ion Battery
Sensor Tip
Filter Replacement
A filter, located in the tip of the wand, blocks moisture and other
contaminants from the sensor. When this filter becomes wet, it
restricts the flow of air and must be replaced.
To replace the filter:
1. Unscrew and remove the tip of the sensor to expose the white
filter.
2. Remove and discard the filter.
3. Position a new filter in the tip so the round end of the filter is
closest to the tip of the wand.
NOTE: Use only Robinair supplied replacement filters.
Storage
The battery should have a 40%-50% charge during prolonged
storage of a month or longer. The correct storage environment is
critical to battery life.
Storage environment: <80% RH for detector and battery.
For 80% botton recovery
For 80% battery recovery:
-4°F (-20°C) to 140°F (60°C) less than 1 month
-4°F (-20°C) to 113°F (45°C) less than 3 months
-4°F (-20°C) to 68°F (20°C) less than 1 year
NOTE: Battery life will be reduced significantly if the battery is
stored with a full charge and/or at high temperatures.
- 1982년 - 2019년 1월 1997년 1월 1997년 1월 1997년 1월 1997년 1월 1997년 1997년 1997년 1997년 1997년 1997년 1997년 1997년 1997년 1 1997년 - 1997년 1 1997년 - 1997년 1

Robinair Leak Detector



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Arctic PRO

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RTI Leak Detector



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ξ.



A Bosch Group Company

Dual Mode Refrigerant Gas Leak Detector

Featuring Two Leak Detection Modes: • Solid Electrolyte Gas Sensor and • Patented UV System Detects both R-134a and R-1234yf Refrigerants

Pinpoint Refrigerant Leaks Quickly and Efficiently

The RTI model LD-2 features two detection modes, a solid electrolyte gas sensor, and a Patented UV dye detection system. It has a long life solid electrolyte sensor technology that is designed to detect the more difficult HFC refrigerants such as R-134a and the new HFO refrigerant R-1234yf. The instrument's unique digital leak size indicator takes the guesswork out of determining leak size. The digital display is independent from the audio alarm and sensitivity level, allowing the precise pinpointing of the leak source. The LD-2 is powered by (4) AA Alkaline batteries.

Features and Benefits:

- Patented 3 LED UV Light 395-415 nm wavelength for optimum air conditioning dye fluorescence US Patent 7, 145, 649
- · No UV enhancement eyeglasses needed
- · Unique digital alarm with numeric leak size indicator
- · Long life, stable sensor
- · Automatic calibration and reset to ambient levels
- · 3 adjustable sensitivity levels
- · True mechanical pump
- Low battery indicator
- SAE J2791 Certified, EN14624 Certified and CE Certified
- · Mute feature
- · Super durable, garage tough
- · Carrying case included
- Visual LED leak alarm near sensor
- Two year warranty on Betector, including sensor
- Made in USA

www.rtitech.com • 800-468-2321

Solstice[®] yf Refrigerant User Guide

RTI Leak Detector

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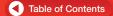


Techno Tools Leak Detector

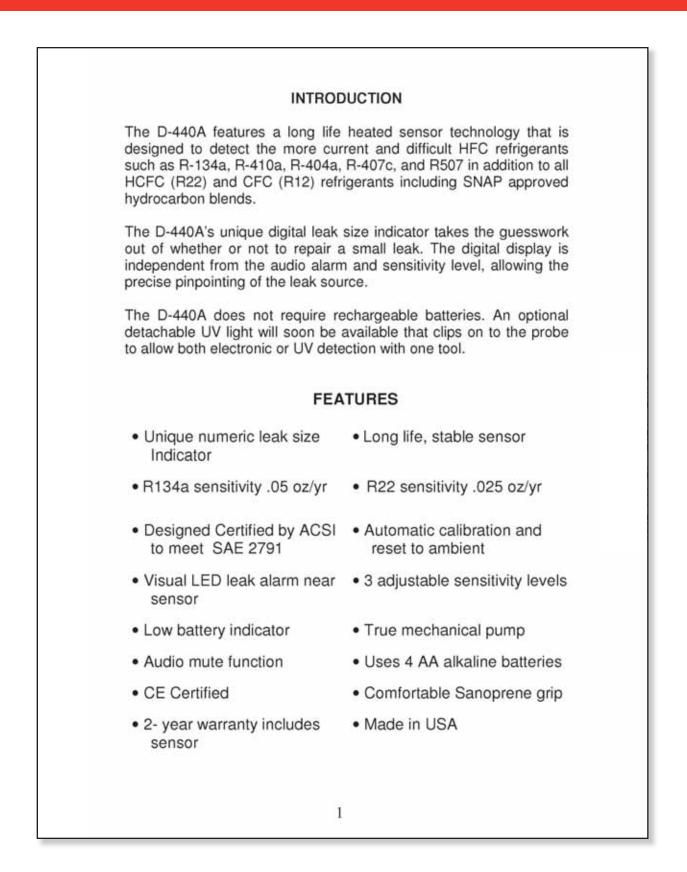
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Model #	D-440A
Name	
Name	Leak Detector, Refrigerant Gas
Sensitivity	.05 oz/yr R134a
0	.025 oz/yr R22
Sensor Life	> 300 hours
Response Time	Instantaneous
Power Supply	4 AA Alkaline batteries
Battery Life	8 hours continuous
Warm up time	< 20 seconds
Probe length	17 inches
Numerical Display	7 segment digital display (1 to 9)
Weight, Ibs	1.5 lbs
Warranty	2 years (includes sensor)
EN14624/2005	Test Specifications
Minimum/Maximum Sensistivity Threshold (fixed)	1 gm/yr minimum, >50 gm/yr maximum
Minimum/Maximum Sensitivity Threshold (moving)	3 gm/yr minimum, > 50 gm/yr maximur
Minimum Detection Time (1gm/yr)	Approx 1 sec
Clearing Time	Approx 9 seconds after exposure to >5
	gm/yr
Minimum Threshold after Maximum Exposure	1 gm/yr
Sensitivity Threshold in Polluted Atmosphere	1 gm/yr
Calibration Frequency Cross Sensitivity to Aut	
Calibration Frequency Cross Sensitivity to Aut Some automotive solvents hydrocarbon properties as R response (<30 seconds) from t clean up any chemicals in the response.	omotive Chemicals and chemicals have similar 134a and may elicit a positive the D440A. Before leak checking, e list below that elicit a positive
Calibration Frequency Cross Sensitivity to Aut Some automotive solvents hydrocarbon properties as R response (<30 seconds) from t clean up any chemicals in the response. Chemical Name	and chemicals have similar 134a and may elicit a positive the D440A. Before leak checking, e list below that elicit a positive e/Brand Response
Calibration Frequency Cross Sensitivity to Aut Some automotive solvents hydrocarbon properties as R response (<30 seconds) from t clean up any chemicals in the response. Chemical Name Rain-X Windshield Wash Fluid	omotive Chemicals and chemicals have similar 134a and may elicit a positive the D440A. Before leak checking, e list below that elicit a positive e/Brand Response Y
Calibration Frequency Cross Sensitivity to Aut Some automotive solvents hydrocarbon properties as R response (<30 seconds) from t clean up any chemicals in the response. Chemical Name	and chemicals have similar 134a and may elicit a positive the D440A. Before leak checking, e list below that elicit a positive e/Brand Response
Calibration Frequency Cross Sensitivity to Aut Some automotive solvents hydrocarbon properties as R response (<30 seconds) from t clean up any chemicals in the response. Chemical Name Rain-X Windshield Wash Fluid Ford Spot Remover (Wet) Ford Rust Inhibitor Ford Gasket Adhesive (Wet)	comotive Chemicals and chemicals have similar 134a and may elicit a positive the D440A. Before leak checking, e list below that elicit a positive e/Brand Response Y Y Y Y Y Y
Calibration Frequency Cross Sensitivity to Aut Some automotive solvents hydrocarbon properties as R response (<30 seconds) from t clean up any chemicals in the response. Chemical Name Rain-X Windshield Wash Fluid Ford Spot Remover (Wet) Ford Rust Inhibitor Ford Gasket Adhesive (Wet) Loctite Natural Blue degreaser (omotive Chemicals and chemicals have similar 134a and may elicit a positive the D440A. Before leak checking, e list below that elicit a positive e/Brand Response Y Y Y Y Y Y diluted) Y Y Y
Calibration Frequency Cross Sensitivity to Aut Some automotive solvents hydrocarbon properties as R response (<30 seconds) from t clean up any chemicals in the response. Chemical Name Rain-X Windshield Wash Fluid Ford Spot Remover (Wet) Ford Rust Inhibitor Ford Gasket Adhesive (Wet) Loctite Natural Blue degreaser (Ford Brake Parts Cleaner	comotive Chemicals and chemicals have similar 134a and may elicit a positive 134a and may elicit a positive the D440A. Before leak checking, e list below that elicit a positive e/Brand Response Y Y Y Y Y Y diluted) Y Y Y
Calibration Frequency Cross Sensitivity to Aut Some automotive solvents hydrocarbon properties as R response (<30 seconds) from t clean up any chemicals in the response. Chemical Name Rain-X Windshield Wash Fluid Ford Spot Remover (Wet) Ford Rust Inhibitor Ford Gasket Adhesive (Wet) Loctite Natural Blue degreaser (Ford Brake Parts Cleaner Ford Silicone Rubber (uncured)	comotive Chemicals and chemicals have similar 134a and may elicit a positive 134a and may elicit a positive the D440A. Before leak checking, e list below that elicit a positive e/Brand Response Y Y Y Y Y Y diluted) Y Y Y
Calibration Frequency Cross Sensitivity to Aut Some automotive solvents hydrocarbon properties as R response (<30 seconds) from t clean up any chemicals in the response. Chemical Name Rain-X Windshield Wash Fluid Ford Spot Remover (Wet) Ford Rust Inhibitor Ford Gasket Adhesive (Wet) Loctite Natural Blue degreaser (Ford Brake Parts Cleaner Ford Silicone Rubber (uncured) Motorcraft Antifreeze heated to	omotive Chemicals and chemicals have similar 134a and may elicit a positive the D440A. Before leak checking, e list below that elicit a positive e/Brand Response Y Y Y Y Heliuted) Y Y </td
Calibration Frequency Cross Sensitivity to Aut Some automotive solvents hydrocarbon properties as R response (<30 seconds) from t clean up any chemicals in the response. Chemical Name Rain-X Windshield Wash Fluid Ford Spot Remover (Wet) Ford Rust Inhibitor Ford Gasket Adhesive (Wet) Loctite Natural Blue degreaser (Ford Brake Parts Cleaner Ford Silicone Rubber (uncured)	comotive Chemicals and chemicals have similar 134a and may elicit a positive 134a and may elicit a positive the D440A. Before leak checking, e list below that elicit a positive e/Brand Response Y Y Y Y Y Y diluted) Y Y Y
Calibration Frequency Cross Sensitivity to Aut Some automotive solvents hydrocarbon properties as R response (<30 seconds) from t clean up any chemicals in the response. Chemical Name Rain-X Windshield Wash Fluid Ford Spot Remover (Wet) Ford Rust Inhibitor Ford Gasket Adhesive (Wet) Loctite Natural Blue degreaser (Ford Brake Parts Cleaner Ford Silicone Rubber (uncured) Motorcraft Antifreeze heated to Gunk liquid wrench Ford Pumice lotion (with solvent	comotive Chemicals and chemicals have similar 134a and may elicit a positive 134a and may elicit a positive the D440A. Before leak checking, e list below that elicit a positive e/Brand Response Y Y Y e/Brand Y Y Y Y diluted) Y Y Y Y 160 deg F Y (partial) Y N Y y N Y Y Y Y
Calibration Frequency Cross Sensitivity to Aut Some automotive solvents hydrocarbon properties as R response (<30 seconds) from t clean up any chemicals in the response. Chemical Name Rain-X Windshield Wash Fluid Ford Spot Remover (Wet) Ford Rust Inhibitor Ford Gasket Adhesive (Wet) Loctite Natural Blue degreaser (Ford Brake Parts Cleaner Ford Silicone Rubber (uncured) Motorcraft Antifreeze heated to Gunk liquid wrench Ford Silicone lubricant Ford Pumice lotion (with solvent Ford Motorcraft brake fluid	comotive Chemicals and chemicals have similar 134a and may elicit a positive 134a and may elicit a positive the D440A. Before leak checking, e list below that elicit a positive e/Brand Response Y Y Y V Y Holdeg F Y N Y
Calibration Frequency Cross Sensitivity to Aut Some automotive solvents hydrocarbon properties as R response (<30 seconds) from t clean up any chemicals in the response. Chemical Name Rain-X Windshield Wash Fluid Ford Spot Remover (Wet) Ford Rust Inhibitor Ford Gasket Adhesive (Wet) Loctite Natural Blue degreaser (Ford Brake Parts Cleaner Ford Silicone Rubber (uncured) Motorcraft Antifreeze heated to Gunk liquid wrench Ford Pumice lotion (with solvent	comotive Chemicals and chemicals have similar 134a and may elicit a positive 134a and may elicit a positive the D440A. Before leak checking, e list below that elicit a positive e/Brand Response Y Y V Y diluted) Y Y 160 deg F Y (partial) Y N Y Y Y Y Y





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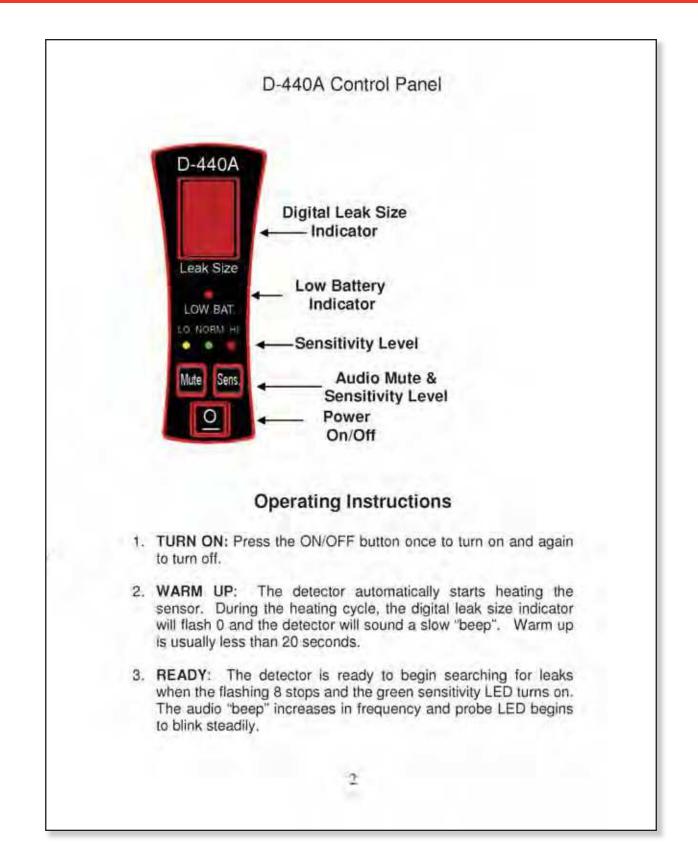


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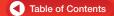
Techno Tools Leak Detector

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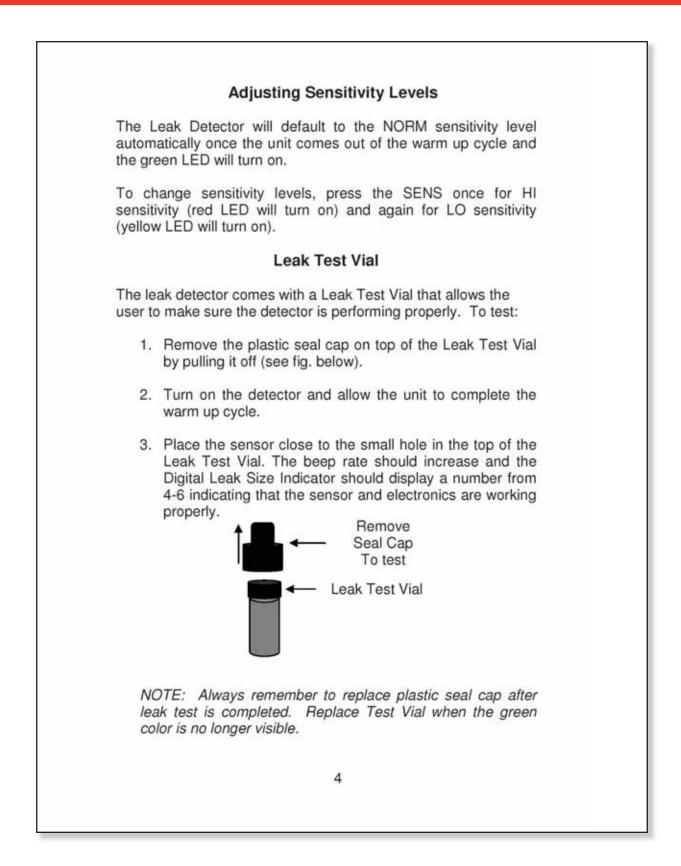


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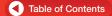
Leak Size Indicator The digital leak size indicator remains off normally but once a leak is detected, a number from 1-9 will be displayed for all HFC and HCFC refrigerants regardless of the sensitivity setting. The number will continue to increase or decrease depending on the amount of refrigerant sensed. The maximum value will be displayed once the leak source has been located. The table below can be used to approximate the size of leak: Maximum # displayed Leak Size (oz/yr) 1 -3 < 0.1 4-6 0.1 to 0.5 7-9 >0.5 Low Battery Indicator Replace the 4 AA Alkaline batteries when the red LED on the control panel is lit. Follow battery installation instructions under Maintenance section. Audio Mute Function To silence or mute the audio beep and alarm signal, press the MUTE button. To restore the audio sound, press the MUTE button again. (Note: a few seconds is required to restore sound if the mute button is pressed in rapid succession.) 3



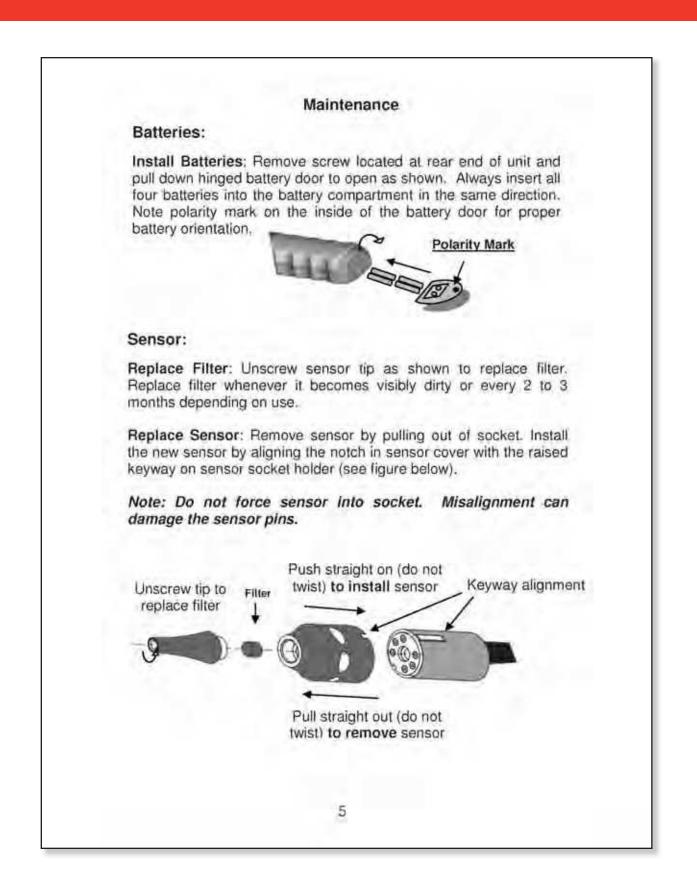
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Replacement Parts

Item	Part Number
Sensor with Filter	AC-SEN0009A
Sensor filters (5 pack)	AC-FIL0001A
Leak Test Vial	AC-LSA0001A
Parts Kit (includes sensor, test vial, & filter kit)	AC-KIT0004A
Carrying Case	AC-CAS0001A

RETURN FOR REPAIR POLICY

Every effort has been made to provide reliable, superior quality products. However, in the event your instrument requires repair, forward unit to Service Center freight prepaid to the address below with return address, phone number and/or email address.

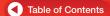
SERVICE CENTER 2651 W 81st Street Hialeah, FL 33016

WARRANTY POLICY

The D-440A Refrigerant Gas Leak Detector is warranted to be free of defects in materials and workmanship for a period of two years from the date of purchase. This warranty applies to all repairable instruments that have not been tampered with or damaged through improper use including unauthorized opening of the unit. Please ship warranty units that require repair freight prepaid to Service Center along with proof of purchase, return address, phone number and/or email address.

Call Toll Free: 800-222-0956 Fax: 786-235-1202

Solstice[®] yf Refrigerant User Guide



Yellow Jacket Leak Detector

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YELLOW JACKET®

ACCUPROBET UV Leak Detector with Solid Electrolyte Sonsor



Use the electrolyte sensor or UV technology (or both at the same time) to detect HFC, HCFC and CFC refrigerants, including SNAP approved hydrocarbon blends

The ultra-sensitive sensor of the YELLOW JACKET= ACCUPROBE[®] UV Handheld Leak Detector allows it to detect even the most difficult to detect R-134a, R-404A, R-407C and R-410A refrigerants. Our exclusive solid electrolyte sensor technology reduces heat and gives the sensor longer life than traditional heated anode or heated diode detectors.

The ACCUPROBE UV features low, normal and high sensitivity levels with visual and audible signals, and a 3 LED UV light system that works with 395-415nm wavelength leak tracing dyes. The audible alert, which can also be muted, and the flashing visual alarm indicator at the probe end increase in frequency and duration as concentration increases. The ACCUPROBE UV is equipped with the advanced digital SmartAlarm^{**} LED display. This feature takes the guesswork out of whether or not to repair a small leak. Unlike the more traditional LED bar graphs that copy or mimic the audio alarm signal, the SmartAlarm digital leak size indicator measures, registers and displays the leak size independently from both the audio alarm and the sensitivity level.

Features

- Improved, robust, ergonomic design easy to use in close areas and extendable into hard-to-reach areas
- Long life, stable sensor
- · Instantaneous response time
- · Quick clearing from large amounts of refrigerant
- · Automatic calibration and reset to environment
- · Low battery indicator
- · Microcontroller technology
- Temperature range of 24° to 125°F (-4° to + 52°C)
- · Humidity 0 to 95% RH non-condensing
- SAE J2791Certified
- CE Marked
- 18 month limited warranty
- Made in USA

Specifications

Sensitivity: Detects 0.06 oz (1.7g)/yr. of R-134a and 0.03 oz (0.9g)/yr. of R-22 Power: AA alkaline batteries

Battery Life: 4.5 hours continuous Probe Length 17 inches (430mm) Length (body): 10.5 inches (270mm) Weight: 17 onnces (480g) Calibration: Automatic Sensor Life: >300 hours

Response Time: Instantaneous

UPC	Description
69336	AccuProbe UV
69337	AccuProbe UV - Euro/UK plug
69338	AccuProbe UV - Japanese plug
69339	AccuProbe UV - AU/NZ plug

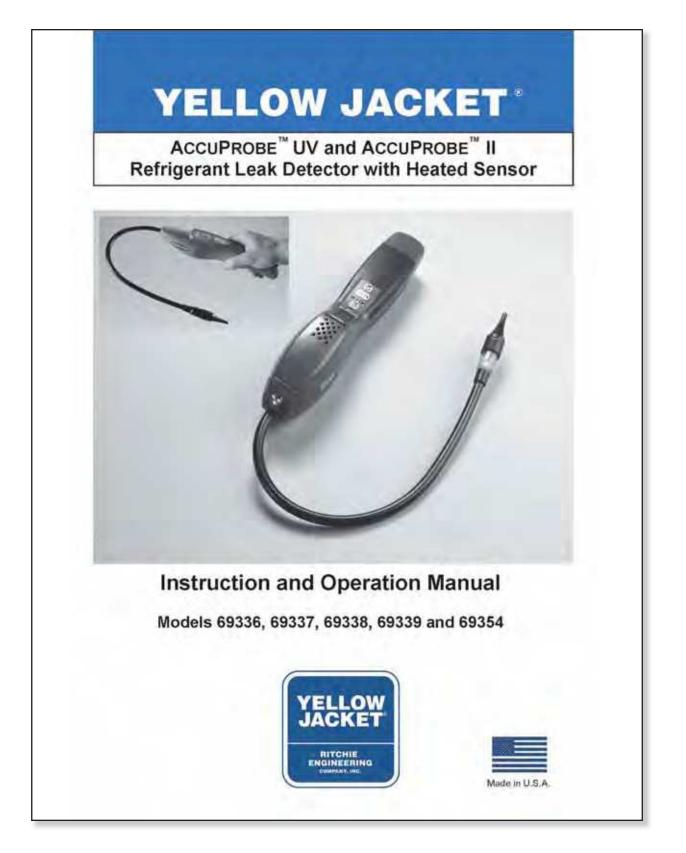
loomington, MN USA 35438-2623 www.yellowiacket.com

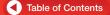


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Yellow Jacket Leak Detector

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Introduction

The YELLOW JACKET® AccuProbe¹⁶ UV and AccuProbe¹⁶ II Hand-held Leak Detectors detect all HCFC refrigerants such as R-22 and R-124. The ultra-sensitive long life sensor with Solid Electrolyte Sensor Technology also detects the more current, difficult-to-detect refrigerants such as R-134a, R-1234y f, R-404A, R-407C and R-410A (see page 7 for a more complete chart of detectable refrigerants)

The ACCUPROBE UV is equipped with the unique digital SmartAlarm⁷⁶ LED display the first digital leak size indicator in a handheld heated sensor leak detector. This feature takes the guesswork out of whether or not to repair a small leak. Unlike the more traditional LED bar graphs that copy or mimic the audio alarm signal, the SmartAlarm digital leak size indicator measures, registers and displays the leak size independently from both the audio alarm and the sensitivity level.

The ACCUPROBE UV also features a 3 LED UV light system that works with 395–415nm wavelength leak tracing dyes. The sleek, ergonomic design of these YELLOW JACKET leak detectors makes them easy to use in close areas and extendable into hard-to-reach areas.

When finding leaks, it is important to note that the AccuProbe responds to changes in concentration of refrigerant. For this reason, the detector will stop alarming even though it is held at or near the source of the leak and will not alarm again until the detector senses a change in concentration. To verify the exact location of the source of the leak, always move the probe away from the area of the leak briefly to allow the sensor to reset at a lower concentration, and then bring it back again until the exact location of the leak source has been verified.

Features

2

- Advanced digital SmartAlann[™] leak size indicator (AccuProbe UV)
- Flashing visual alarm indicator at probe end (AccuProbe UV)
- Audio mute button (AccuProbe UV)
- Operates on 4 AA alkaline batteries (AccuProbe UV can also use AC power)
- 3 LED UV light system that works with 395-415mm wavelength leak tracing dyes (AccuProbe UV)
- · Microcontroller technology
- Ultra-high sensitivity to detect leaks as small as 0.06 oz (1.7g)/yr. of R-134a/ R-1234yf and 0.03 oz (0.9g)/yr. of R-22. See insert sheet for certified ratings.

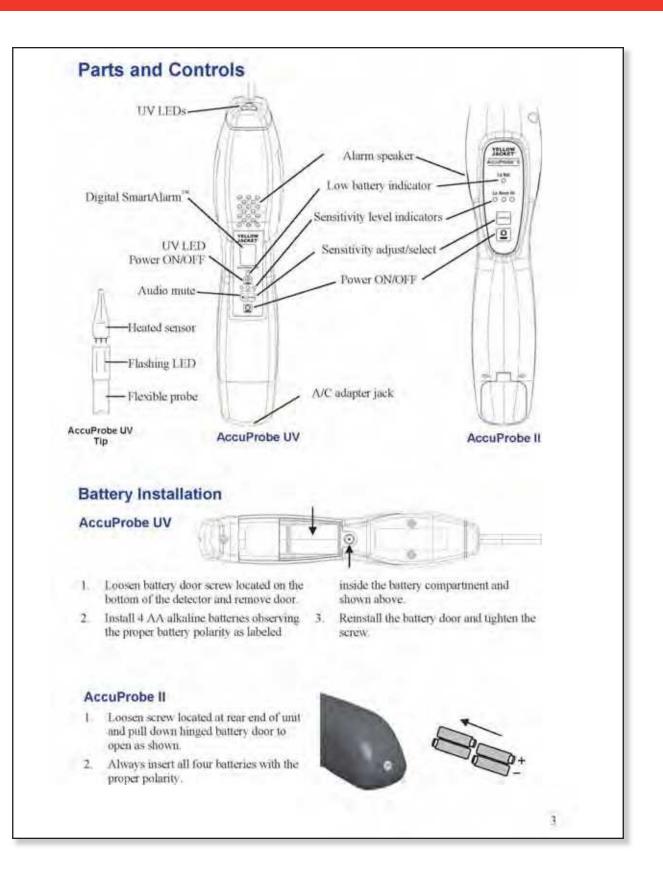
- · Automatic calibration and reset to ambient
- Detects HFC, HCFC, CFC and HFO refrigerants (see page 7)
- Long life stable sensor utilizing Solid Electrolyte Sensor technology
- 3 selectable sensitivity level settings
- Sleek ergonomic design
- · Low battery indicator
- Temp Range 24^e to 125°F (-4° to + 52°C)
- Humidity 0 to 95% RH noncondensing
- · CE Marked
- True mechanical pump





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Operating Instructions

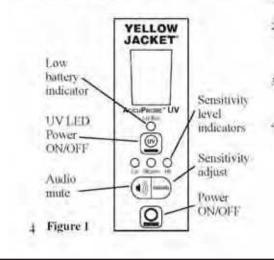
AccuProbe UV

- POWER ON: The detector is turned ON and OFF by pressing the POWER button (see figure 1 below).
- WARM-UP: The detector automatically starts heating the sensor to condition it for use. While in this WARM UP phase – and until ready – the instrument will signal audibly by beeping slowly and visually by flashing the sensitivity LEDs and the zero (0) in the SmartAlarmTM display window. Warm up time is usually about 20 SECONDS or less. For maximum sensitivity, wait an additional two minutes after normal warm-up.
- 3 SEARCH: The delector is ready for leak searching when the sensitivity LEDs stop flashing and the beep rule increases. At this time the zero in the display window stops flashing. When a leak is detected, the beeping sound and flashing LED in the probe will increase in frequency, and the SmartAlarm digital LED display will turn on indicating the leak size. If no leak is detected go to HI sensitivity and continue searching.

SmartAlarmTM Display

The SmartAlarm LED Display is a digital leak size indicator that numerically displays the leak size on a scale of 1 to 9 for all HEC and HCFC refrigerants – regardless of the sensitivity setting. This value helps you decide whether or not the leak is large enough to require repair.

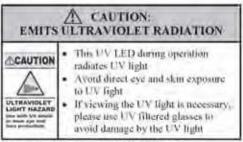
For example, when in the HI sensitivity mode, the detector may sound a full audio alarm but the SmartAlarm Display may show a low number – indicating that the leak is very small. In contrast, when in the L() sensitivity mode, a full audio alarm may not sound but the SmartAlarm may alow a high number, indicating that the leak is large.



SmartAlarm ¹³⁴ DISPLAY	LEAK SIZE DISPLAY (OZ/YR.)*
1 10 3	- 0.1 (2.8g)
4 10 6	0.1 to 0.5 (2.8-14g)
7 10 9	= 0.5 (14.1g)

The maximum value displayed, once the source of the leak is located, indicates the leak size. This value helps you decide whether or not a leak is large enough to require repair. The table above shows the leak rates corresponding to the SmartAlarm mamerical display.

UV LIGHT OPERATION



Before leak checking with the UV light:

- (n) Make sure the A/C system is properly charged with sufficient dye (see manufacturer's specifications for proper dye charge.)
- (b) Run the A/C system long enough to thoroughly mix and enculate the dye with the refrigerant and lubricating oil.
- Turn on UV light by pressing the UV light ON/OFF button (see diagram on left).
- Holding the leak detoctor approximately 10" to 14" away, shine the UV light beam slowly over the components, hoses, and metal lines that make up the A/C system.
- When the UV light shines on the Borescent dye that has escaped from the system, the dye will glow a bright yellow green.
- The UV LEDs will automatically furn off after five minutes.

3 UV LED Lights



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Yellow Jacket Leak Detector

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Using the SmartAlarm Display

- The SmartAlarm will not display a number (1 through 9) until a leak is sensed. Once a leak is sensed, the numbers on the display will gradually increase.
- Use the SmartAlarm display to "zero in" on the leak source by watching the numbers climb higher as the leak source is approached.
- Once the leak source has been located, always wait for the maximum number to be displayed to determine the size of the leak.
- 4. Lower numbers (approximately 1 to 3) indicate that the leak size is less than 0 1 oz/yr, and may not require repairing at this time – depending on the amount of gas in system. NOTE: Multiple small leaks in a system are cumulative and may require that all system leaks should be repaired.

AccuProbe II

- TURN ON: Press the ON/OFF button once to turn on and again to turn off.
- WARM UP: The detector automatically starts 3 heating the sensor. During the heating cycle, the detector will sound a slow "heep." Warm up time is usually about 20 SECONDS or less. For maximum sensitivity, wait an additional two minutes after normal warm-up.
- READY: The detector is ready to begin searching for leaks when the green sensitivity LED turns on. The audio "beep" increases in frequency.

Sensitivity level to Bai indicators 0 0 0 Fower ON/OFF ON/OFF ON/OFF ON/OFF ON/OFF ON/OFF ON/OFF

Adjusting the sensitivity levels

To choose another sensitivity level, press the Sensitivity button. The LED below each level will change indicating the new setting.

The leak detector will default to the NORM sensitivity level automatically once the unit comes out of the warm-up cycle and the green LED turns on.

Using the Leak Standard

Use the leak standard to determine that the leak detector performs to specifications.

- Lift off the plastic scaling cap on the top of the LEAK STANDARD.
- 2. POWER ON the unit After WARM UP and when READY expose the sensor directly to the small hole in the top of the bottle cap. The beep rate should increase to an alarm. For the AccuProbe, the SmartAlarm should display a number greater than 2. If the SmartAlarm fails to display 2 or above, leave the detector on for approximately 15 to 30 seconds longer and retest. This indicates that the sensor and electronic circuit are functioning properly
 - Replace plastic cap seaf after leak test. Note: Replace the leak standard when the green color is no longer visible.



5

Yellow Jacket Leak Detector

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Low battery indication

Important: Replace the batteries immediately when the red low battery LED comes on (see page 3) Follow instructions under section titled "BATTERY INSTALLA-TION" on page 3

Audio alarm mute (AccuProbe UV)

To silence the audio alarm, press the MUTE button Press the MUTE button again to restore the audio alarm.



Sensor failure mode

If the sensor is not working correctly, the AccuProbe Leak Detector will not come out of the warm-up mode. (Some competitive units without this function will not alert you that the sensor is malfunctioning or has failed.)

If the AccuProbe detector does not come out of warm-up, first be sure the sensor is plugged in all the way. If that does not correct the situation, replace the sensor.

Maintenance

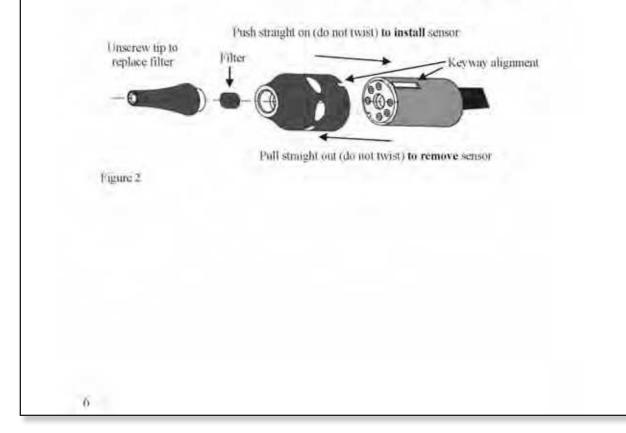
Batteries: Replace the batteries when the red low battery LED turns on. See "BATTERY INSTALLATION" on page 3.

Sensor filter replacement: Unscrew the sensor tip as shown to replace the filter. For optimum performance, replace filter whenever it becomes visibly dirty with grease or oil or every 2-3 months (depending on use)

Note: Never clean dirty filters with a solvent or soap and water. Always replace with a new filter supplied with the leak detector or they can be re-ordered from your supplier or distributor.

Sensor replacement: Remove sensor by pulling out of socket. Install the new sensor by aligning the notch in the sensor cover with the raised key way on the sensor socket holder (see Figure 2).

Note: Do not force sensor into socket.





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Yellow Jacket Leak Detector

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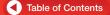
7

Const Constant Constant	Parts	69383
AccuProbe UV and AccuProbe II	Parts kit (sensor, filters and leak standard bottle)	69383
	Sensor and filter	69384
	Sensor filters (package of 5)	69385
	Leak standard bottle	69386
AccuProbe UV	A/C Adapter Input: 113V-60Hz UL listed	69380
	A/C Adapter - EU/U/K Plog Input: 230/V 5011z CE & TEV Approved.	69381
	A/C Adapter AU/NZ Plug Input: 230V 50Hz CE & TÜV Approved	69378
	Battery cover and screw	69388
	Carrying case - blow molded with inserts	69387
AccuProbe II	Carrying pouch	69361

PROBLEM CHECK REPAIR OR REPLACE		
PROBLEM	CHECK	REPAIR OR REPLACE
No power	 Check for weak or reversed batteries 	Replace batteries
Stays in "wanni up" mode	 Sensor not plugged into socket correctly Sensor open/defective 	 Make sure sensor is pushed all the way down into socket Replace sensor
No detection	 Check sensor with leak standard bottle Check if the filter is dirty or sensor opening is plugged 	 Replace sensor Replace filter or clean out opening
Slow recovery after detection	 Check if fifter is dirty or sensor opening is plugged 	Replace filter or clean out opening
No beeping	Nothing	 Press mute button (if equipped) to turn speaker back on

R-12 ALTERNATIVES	R-22 ALTERNATIVES
R-134i, E-1234y1, R-40) A (ME-39), R-401E (ME-66), R-401C (ME-52), R-406A (GHG)	R-407C, R-410A, R-410B, R-507
R-414A (GH0-X4), R-414B (Hot Short, R-416A (Fog (_ FR-12)	R-113, R-13B & R-503 ALTERNATIVES
R-409A (FX-56), Preeze 12, Free Zone, OHG-XS, OHG-HP, IKON 12.	R-40311, R-508A, R-50841
R-502, R-500 ALTERNATIVES	HC REFRIGERANTS (not SNAP approved)
R-402A&B, R-404A, R-407A, R-408A, R-411A&B, R-507	R-290, R-600A, R-170/R-290, R-600A/R-290

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Yellow Jacket Leak Detector

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24 MONTH LIMITED WARRANTY

Ritchie Engineering guarantees YELLOW JACKET AccuProbe Leak Detectors to be free of date of manufacture serial number located on the defective material and workmanship that would affect the life of the product under normal use for the purpose for which it was designed. This warranty does not cover items that have been altered, abused, misused, improperly maintained or returned solely in need of field service maintenance. This warranty excludes the sensor, which is warranted for one year.

If found defective, we will upon compliance with the following instructions, credit, replace or repair at our option, the defective leak detector provided it is returned within 24 months of the

date of sale. ACCUPROBE leak detectors have a label on the bottom of the unit.

Correction in the manner provided above shall constitute a fulfillment of all liabilities with respect to the quality, material and workmanship of the product.

THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES OF QUALITY, WHETHER WRITTEN, ORAL OR IMPLIED.

For tips on searching for leaks, visit www.yellowjacket.com VELLOW JACKET Products Diversion Ritchie Engineering Cu., Inc. 10950 Hampihire Avenue South Bloomington, MN 55438-2623

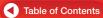
Lelephone 100-769-8370 or 952-043-1333 Pigs. 800-322-8684 or 932-043-1605 E-mail matserv@vellowsacket.com Web. www.yellowjacket.com



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Pumps



Haskel Pump for Hose Recovery

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Haskel Pump for Hose Recovery

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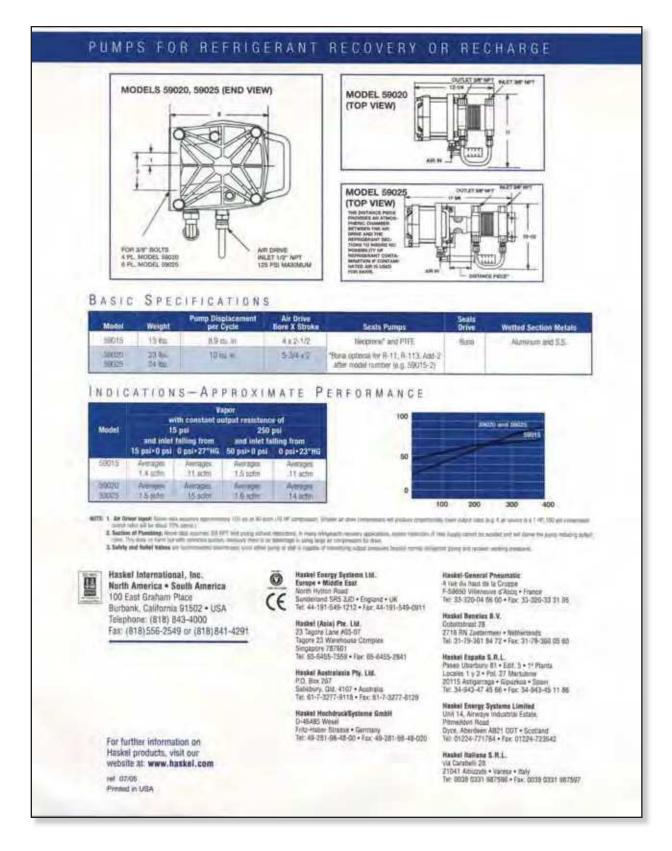


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Haskel Pump for Hose Recovery

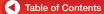
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Recovery, Recycle, Recharge (RRR) Machines



CPS RRR Machine Ecotechnics ECK Twin Launch UK RRR System Robinair Service Equipment RTI Mahle RRR Machine



CPS RRR Machine

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CPS RRR Machine

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CONVERT-ABLE MULTI REFRIGERANT RECOVER / RECYCLE / RECHARGE FULLY AUTOMAT The FA1234 is a patented, multi refrigerant Convert-able R / R / R machine that can be converted for use with any of the following refrigerants in 5 minutes or luss: R-134a, HFO-1234y1, R22 and R407C. This R / R / R convert-able unit is the only machine in the world to recover without fear of cross contamination Whith converted back and forth. Designed to meet the following SAE standards. **SAEJ2788** R-134a SAEJ2810 R-134a Recovery only **SAEJ2843** ACH7 HE0-1234yf SAEJ2843 HFO-1234yf Recovery only TIS FA1234 INTRODUCING Innovations in Design"

FEATURES:

- Standard equipment includes a CPS patented high speed 2-cylinder oil-less compressor for fast and complete recovery
- Featuring CPS patented motorized ball valve flow control system, the FA1234 eliminates the worry of working on systems that have been contaminated with sealants, burn outs, etc.
- · High capacity, 50 micron 6 CFM vacuum pump
- Equipped with 50 lb recovery tank as standard equipment. Can be easily programmed for 90 lb recovery tanks, or any standard international tank on the market
- Standard equipment includes 8 foot hoses, R-134a couplers, HFO-1234yf couplers, R-134a tank refill adaptors, and HFO1234yf tank refill adaptor.
- The digital display screen features multiple languages – English, French, German, Spanish, and Chinese
- Powder coated steel cabinet built on top of a 1° steel tubular frame for durability in the shop with spare filter storage drawer.
- The FA1234 can be programmed for HI side, L0 side or both HI & L0 side charges
- Microprocessor controlled mass flow monitoring system keeps track of and displays remaining filter life on screen enabling maximum filter life to be achieved, eliminating unnecessary filter changes. The integrated pressure transducer automatically controls air purge, leak testing, and self calibrates every time the machine is turned on.
- The FA1234 features an International Mode for fast and efficient operation in parts of the world where SAE standards do not apply

GLOBAL HEADQUARTERS 1010 East 31st Street Hialeah, Florida 33013, USA Tel: 305-687-4121 1-800-277-3808

Fax: 305-687-3743 Email: Info@cpsproducts.com www.cpsproducts.com



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Ecotechnics ECK Twin

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Ecotechnics ECK Twin

Introducing the advanced, fully automatic refrigerant management station for R134a now and HFO-1234yf in the future



Ecotechnics ECK Twin

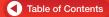
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Ecotechnics ECK Twin A solution for the future, past and present of AC servicing Quick, easy and automatic the temperature slightly delivering a faster recharge of refrigerant into the cuttomers. The ECK Twin is a reliable, effective and whicle masy-to-use refrigerant management station for servicing both R134a and HFC-1234yl Need a helping hand? refrigerant systems. It automatically controls the recovery, recycling, vacuum and It is important to ensure your refrigerant recharging processes of allo servicing. With management station is well maintained a number of peterited designs including and serviced regularly to ensure best hemetic dye oil camoges and eutometic performance and maximum Wespan. discharge of non-condensable games via Autoclimate has the answer: a network of splenoid valves. This machine delivers both erigineers covering the UK that carry out high performance and excellent operational servicing to the manufacturers standards. reliability. Servicing includes performance checks of the machine, changing the vacuum pump **Guick** switch - quick money oil and filter and carrying out a calibration It is easy to switch he ECK twin between of the scales. There is no need to send R134a or HFO-1234yf, meaning any type your machine away, out engineer will come of vehicle is quickly serviced, no waiting for to your sits, minimising downtime of the the machine to reset. The ECK Twin can machine. also work on hybrid vehicles as standard. **Technical support** As standard the ECK Twin has an internal refrigerant tank heater. The machine Autoclimate offers helpdesk technical will automatically monitor and manage support and engineering services/repairs the temperature of the tank and when for all refrigerant management stations that recharging is about to occur, will increase they supply.



Ecotechnics ECK Twin



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Ecotechnics ECK Twin

Fully automatic station for recovering, recycling, and recharging either R134a or HFO-1234yf





ECK TWIN features

- Work on sittier R134a or HPO-1234yl vehicles
- Fast changeover from one rehigecant to another
- Work on hybrid vehicles
- Automatic functionality prevents error-prone manual processes
- High precision recovery and recharging
- Automatic vecuum leak test facility
- + Automatic UV dye injection time-controlled release
- + Flush-prepared capability
- + Built in writicle database
- · 2 compressors (one for R134a and one for HFO-1234yr)
- Built-in printer to aid upsetting and record keeping
- ··· Hasted reingerant tank
- Polrigerant lank temperature and pressure sensore
- · Automatic taps for simpler use
- Autometic discharge of non-condemtable gases via solanoid velves.
- Large and readable class 1 gauges to check A/C system pressure
- Large masy to follow touch ecreen display

For more information (C) 0345 50 50 900

Ecotechnics ECK Twin

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Ecotechnics ECK Twin



technical summary

Power supply	220-240v AC, 50Hz	
Weight.	110kg	
Dimensions	67 x 62 x 107 cm	
Vacuum pump.	100 litres/min	
Refrigerant tank	12kg (x2)	
Hermatic compressor	1/4hp 12cc (x2)	
Hours	3.0m standard (2 pairs)	
Rechwging scale precision	+/-10gm	



Ecotechnics ECK Twin



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servicing P(134e and HFC and recharging processe refrigerant. The ECK Twi charging, integrated vehi	es for oil. UV dyn and refrigeran i has a buill in refrigerant tarik i ide database and an integral pr ystemis in the workshop and is	gement station dasigned for ely controls the recovery, vacuum as well as recycling the recovered leater for speeding up refrigerent inten. The ECK 2500 Two offers easily changed quackly between
CAR AND	Prineir nupply	229-3404 AC: 50Hz
	Postrigenaat Verigtri	HEO1034yF and H134e HEO10
	Diceinsions	67om x (Sasm x 107 cm
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6	104	cactodges
	High performance dry litter Hermitik: compremuir	2 Warn for humbley 1/4hp totac (x2)
10	Tioters	iBh standard (x2)
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	integral printee	Ves Colour graphic touchischem
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	National Real and South	Automátic
	UV dye injection	Automatik
	Fluid-proposed Molity	Teni
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ECK 2900-HFO

FULLY AUTOMATIC SINGLE-GAS STATION FOR RECOVERING, RECYCLING, AND RECHARGING HF01234YF REFRIGERANT.



01752 344 989 enquiries@launchtech.co.uk

www.launchtech.co.uk



Launch UK RRR System

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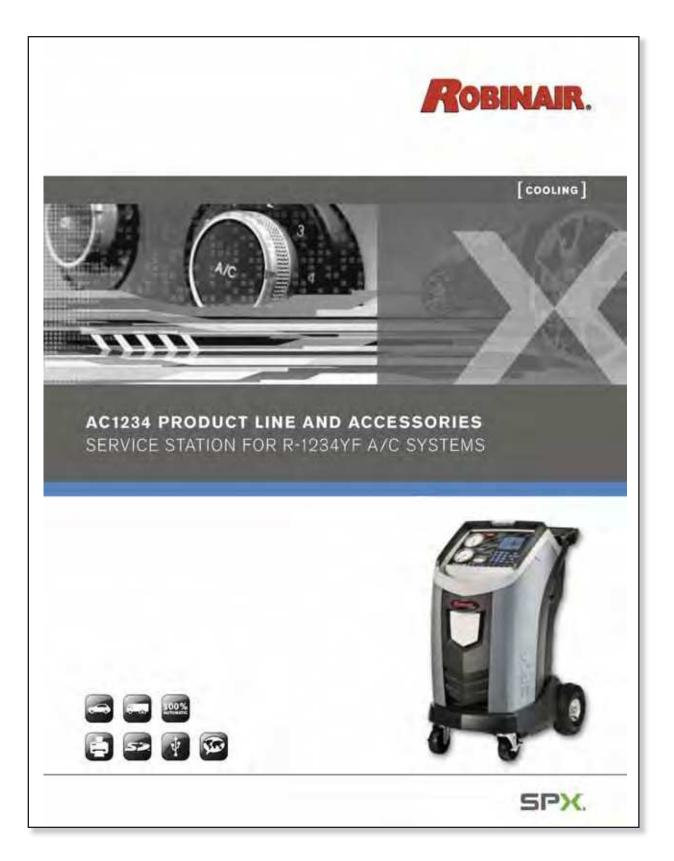


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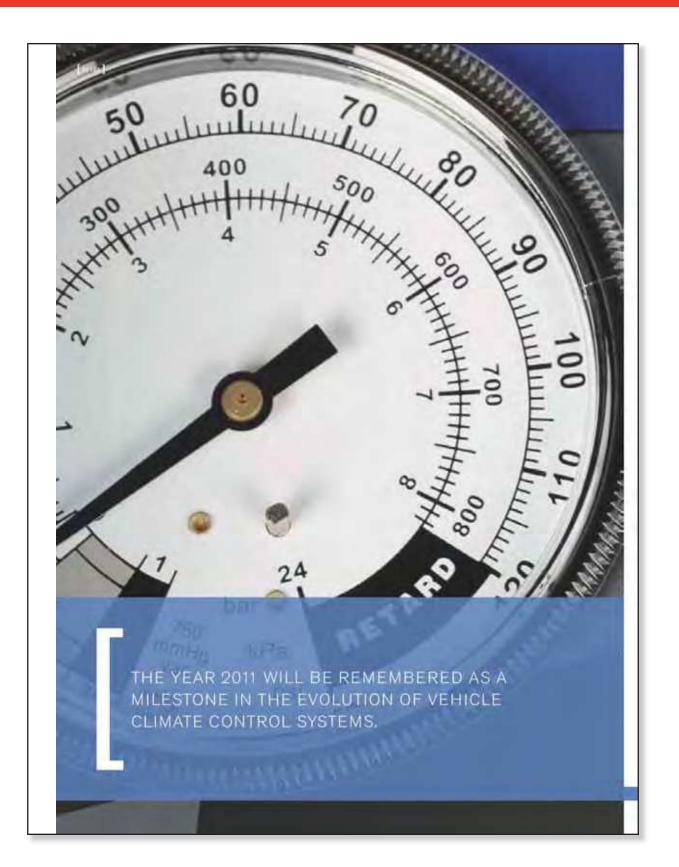


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UCING R-1234YF ID GAS	06 - 07
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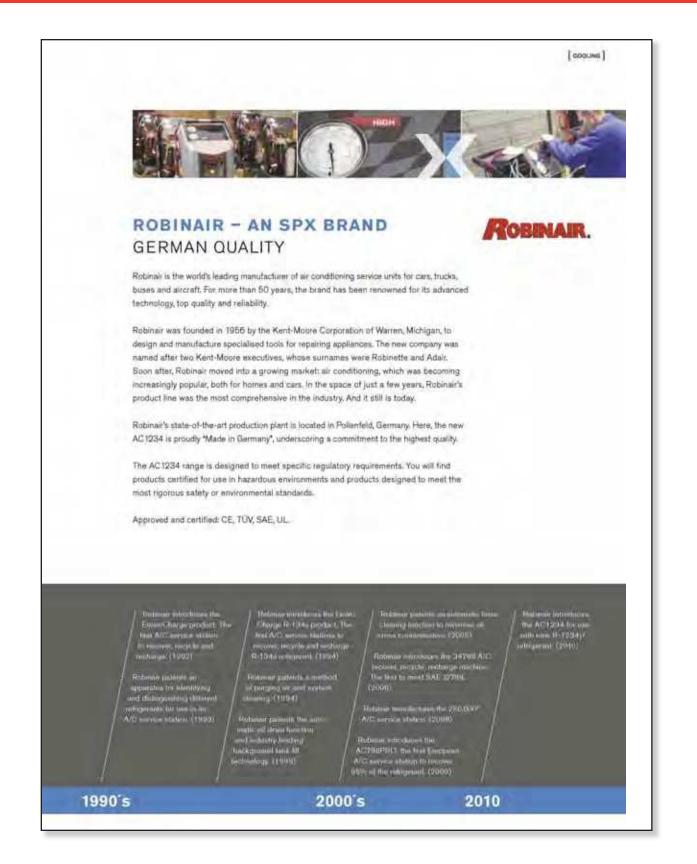
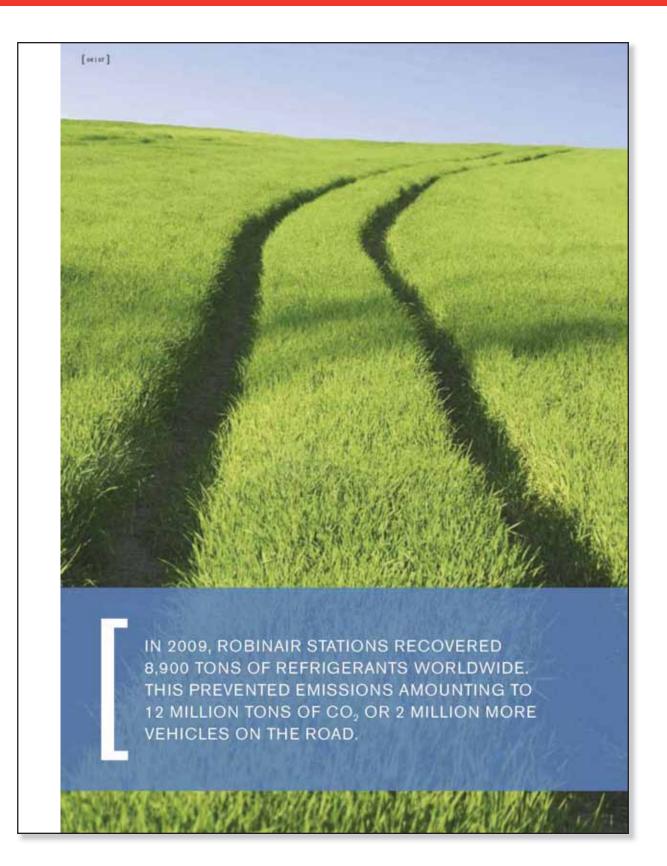




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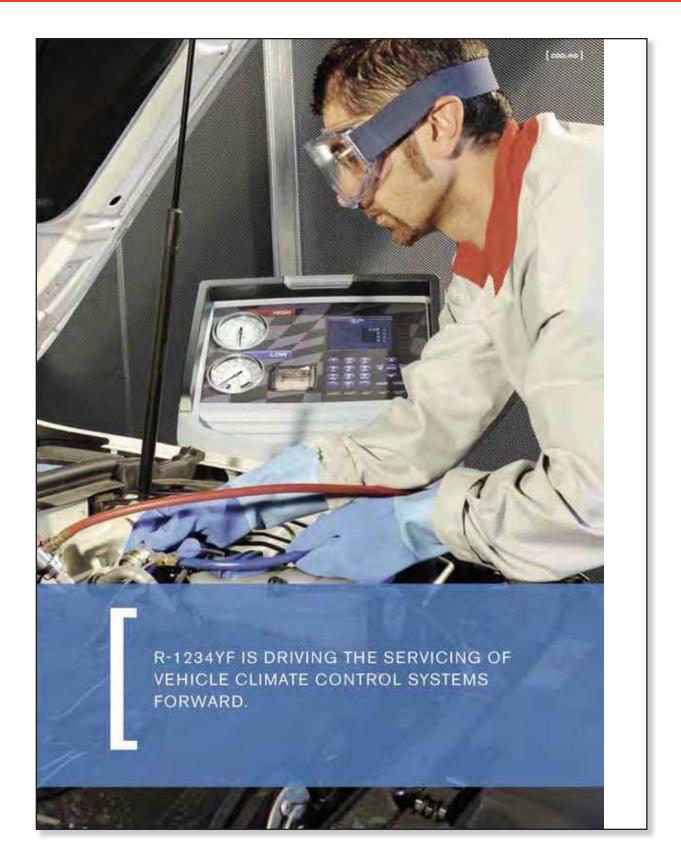
WHAT DOES THIS MEAN FOR YOUR WORKSHOP? Starting in 2011, a range of vehicles with air conditioning systems running on the new R-1234yf gas will enter the European market. However, the great majority of vehicles on the roads will still be using the older R-134a refrigerant - and these will continue to require servicing for the next 15 years or so. This means that your workshop will need equipment that can handle both the old and new vehicles. As noted before, R-1234yl is slightly flammable. So it is essential to use equipment that is specifically designed for the new refrigerant and that has been properly cartified. WHAT YOUR WORKSHOP NEEDS: 1. Avoiding contamination between the two refrigerants is imperative. Accordingly, using two distinct circuits for the recovery and recharging process represents the best solution. In reality, this translates into a dedicated machine for each of the two systems. From a purely technical perspective, a "dual use" unit or a retrofit of an older R-134a service machine is possible. But major auto manufacturers have not endorsed either dual use or retrotit solutions for their networks. 2. In addition, major automotive manufacturers are recommending the use of refrigerant identifiers that will allow the workshop to monitor the type, quality and purity of a given refrigerant. 2. Finally, the professional workshop will also require a new leak detector capable of identifying leaks of the new refrigerant in the vehicle's air conditioning system.

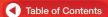


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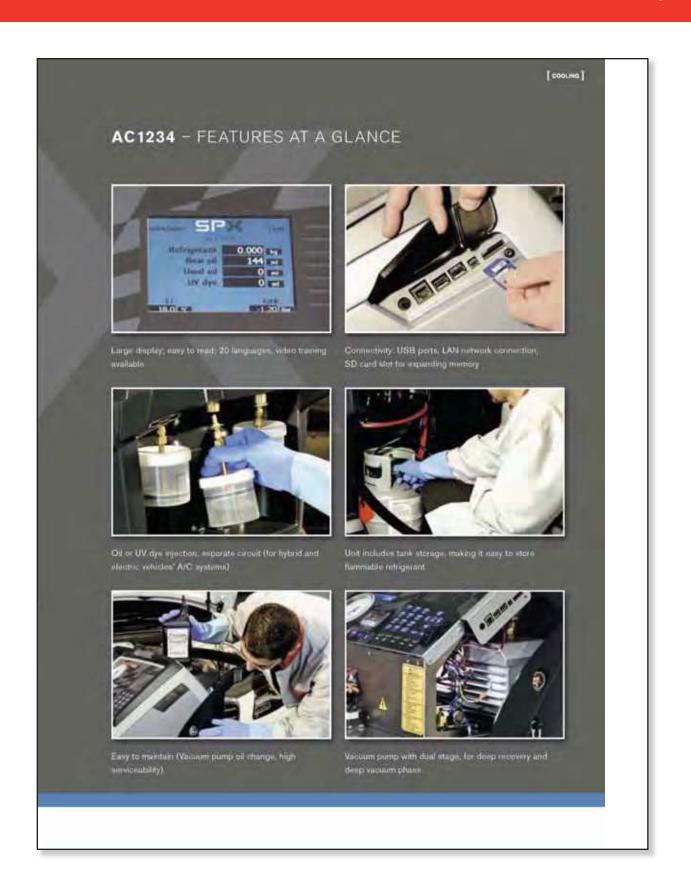
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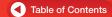
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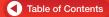
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Emm

TECHNICAL DATA, PRIMARY FUNCTIONS

terrigerant.	R-1234/	R-1234yl	R-1234vF
Automatic Tunction	Sens - automatic	Automatic	Fully automatic
ingle processing mode selection Recovery, viscian, sharpe functions)	Yes	Yes	Nes
Recovery function	Automatic	Automatic	Automátic
ubricant cil drain function	Automatie – vanial (bothe graduations)	Actomatic - visual (bottle graduations)	Automotic with electronic scale control
facuum function	Automatic	Automatic	Automatic
esk lest	Automatic	Automatic	Automatic:
ubricant oil injection	Manual	Automatic with electronic scale control: 1 tanks	Automatic with electronic scale control; 2 tanks
JV dye injection	Net available	feot sysilable	Automatic with electronic scale control
ielingerant charge function	Automatic	Automatic	Automatic:
lushing kinetion	Yes	Yes	Vies
themai storage wesel refil function	Manual	Automatic	Automatic
Vir purge function	Manual	Automatic with electronic control	Automatic with electronic control
toos dearing function	Yes	Yes	Ves
iðer replacement sountei	Ven	Ves	Yes
Bectronic database	Optional - using amut key	Yes	Yes
Separt printout function	Optional	Optional	Ves
Raphay	Monochrome graphical display (190, x190)	340 x 290 CD	Color W VEA
Seypad	Function and alpha-numeric keypad	Function and alpha-numeric keypad	Function and alpha-numeric keyped
Sauges manameters	EN837-1, 63 mm	EN827-1, 100 mm	EN837-1, 900 mm
Atmaal valves	10 (H# & LP)	No	No



Robinair Service Equipment

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Printee Optional Optional Optional Wes USB connection No Mile_1 Mile_2 SD card alof No Mile_1 Mile_2 SD card alof Yes Nils Mile_1 Internal air Row control Yes Nils Mile_1 Hermitik: compressor 1/3 HP 1/3 HP 1/3 HP Vecoursprintip 3 chm (T1 L/min) 3 chm (T1 L/min) TO Virinit (S0 Hz) 198 i/min (80 Hz) Hermitik storage setoel 10 Kg (22 LB) 10 Kg (22 LB) 10 Kg (22 LB) Filter dyret 300 kc 700 koc 700 kc Veloce lubriczint of separator Double chamber Double chamber Double chamber		AC1234-3	AC1234-5	AC1234-7" / AC1324-8"
No No.	Service houes & Couplers	2.50 mil 5AE 32888	2.50 mt SAE J2888	250 mt 5AE J2988
SD card ald Yes Yes Yes Hermitika compressor 1/3 HP 1/2 HP 1/3 HP Hermitika compressor 1/3 HP 1/2 HP 1/3 HP Vacuum plump 3 chn (71 L/min) 3 chn (71 L/min) 1/3 HP Vacuum plump 3 chn (71 L/min) 3 chn (71 L/min) 1/3 HP Hermitika dorage sensel 10 Kg (22 LB) 10 Kg (22 LB) 100 Kg (22 LB) Filler dyse 300 cc 700 oc 750 cc Velscle lubricant of separator Double chamber Double chamber Double chamber Compresses hancant separator Single chamber with solenoid Sengle chamber with solenoid Sengle chamber with solenoid Compresses hancant separator Yes Yes Yes Yes SAE J29843 Ne Yes Yes Yes	Prinder	Optional	Optional	Ves
Hermatikan Row control Yes Yes Hermatikan Row control 1/3 HP 1/2 HP 1/3 HP Vacuum pump 3 chm (Y1 L/min) 3 chm (Y1 L/min) 700 Vmin (50 Hz) Hermatik storage veccel 10 Kg (22 LB) 10 Kg (22 LB) 100 Kg (22 LB) Hiller dryne 300 kc 700 co 150 cc Hiller dryne 300 kc 700 co 150 cc Veckens kunschaft separator Double chamber Double chamber Double chamber Compresses kunschaft separator Single chamber with solenoid control for ol return Win SAE J29843 Nic Yes Yes Yes	JSB connection	No	Vac. T	Yen, 2
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Vacuum pump 3 chn (71 L/min) 3 chn (71 L/min) 770 V/min (50 Hz) 198 i/min (80 Hz) Internal storage vessel 10 Kg (22 LB) 10 Kg (22 LB) 10 Kg (22 LB) Filter dyse 300 cc 700 cc 700 cc Weide lubricant of separator Double chamber Double chamber Double chamber Concerns set lubricant separator Single chamber with solenoid control for oil return CE Yes Yes Yes Yes SAE J2843 Ne Yes Yes	Hannail an Row control	Yes	Wes	Yes
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Filler dyser 300 cc 700 cc 700 cc Vehicle lubricant of separator Double chamber Double chamber Double chamber Compresses lubricant separator Single chamber with solenoid control for oil return CE Yes Wei Wei TUV Yes Wei Wei SAE J2099 No Yes Wei	бомтрите	3 chn (71 L/min)	3 ctm (71 L/mm)	
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Single chamber with solenoid Single chamber with solenoid control for oil return Single chamber with solenoid control for oil return Single chamber with solenoid control for oil return CE Yes Yes Yes Yes TUV Yes Yes Yes Yes SAE 2009 No Yes Yes Yes SAE 2019 No Yes Yes Yes	Filter drywr	300 Le	700 ac	#06 æ
Compression Number Control for oil return Control for oil return Control for oil return CE Yes Yes Yes Yes TUV Yes Yes Yes Yes SAE-2009 No Yes Yes Yes SAE-2014 Ne Yes Yes Yes	Vehicle Subricant of expansion	Double chambles	Osuble chamber	Double charatier
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SAE J2099 No Yes Yes SAE J2943 No Yes Yes	Æ	Viel	We	Yim
SAE 20843 No. Yes Yes	nuv	Yes	We	Vers
	SAE . 12099	No	Vits	Yes
UL 1962 No. Ves Ves	SAE 22943	Na	Ves	Wea-
	л. 1962	No	Ves	Vita
ANSU/ASA 12/12/01 No. Yes Wes	NASUASA 12.12.01	No	Yes	Wa
RoHS View View View	RoHS	Ves	West	Viez
WEEE Ves Ves Ves	NEEE	Ves	Yes	Yes
Batteries and accumulator directive Yes Yes Yes	Satternes and accumulator directive	Yes	Ves	Viez



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HIGH-TECH PRODUCTION -FOR QUALITY YOU CAN TRUST

Why are Robinair A/C units such exceptional quality? A lot of that has to do with how they're made.

Our state-of-the-art A/C production line in Pollenfeld, Germany, reflects the latest Lean Manufacturing, SoSigma and Kanban standards, At ergonomically-designed workstations, highly-skilled workers assemble Robinair products around the clock. In fact, the facility was recently upgraded to produce increased volumes of Robinair A/C machines, following strong demand from the European market.

Multiple quality checks are built into the production process to ensure every unit is 100 per cent safe to operate. These include high-pressure checks in line with the European Pressure Equipment Directive (97/23/EC) (also known as PED) and VDA (German Automotive Industry Association) requirements, which ensure that all components have the necessary strength and stability. Vacuum tests simulate the functionality of the recovery process while leakage tests ensure all connections are completely leak-proof. We also conduct high voltage and insulation tests, and check all electric and electronic functions and interfaces.

Just-In-time processes ensure that our products are available in the right place at the right time – meeting global demand. Because outstanding quality means that our A/C units are durable, reliable and efficient – aomething that's appreciated worldwide.

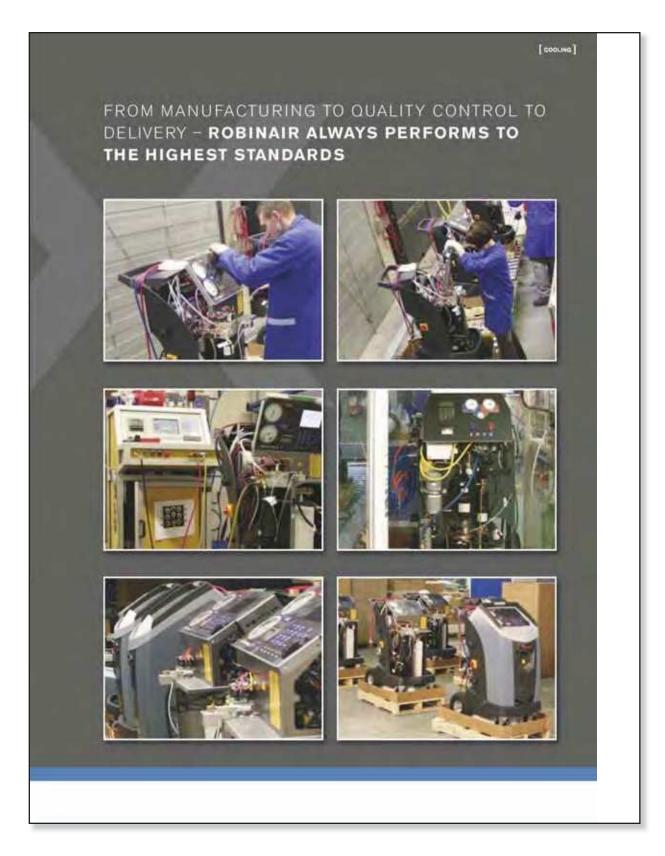


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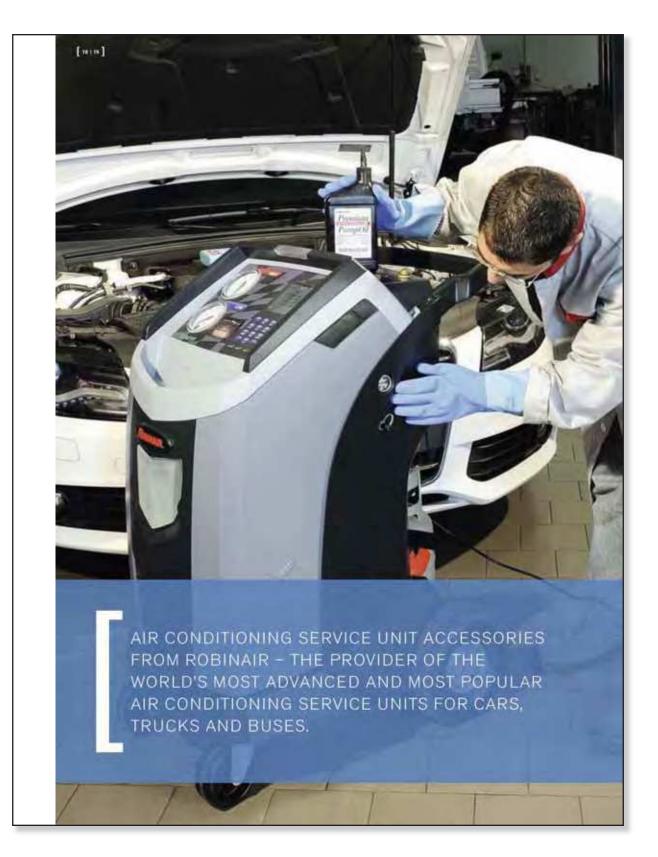


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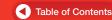


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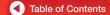


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RTI Mahle RRR Machine

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RTI Mahle RRR Machine

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Refrigerant Identification



Neutronics Refrigerant Identifier





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