



LOW GWP HYDROFLUOROOLEFINS (HFO)

**Reducing the impact on  
climate change**



## The Background Story

|   |    |
|---|----|
| Keeping cool...keeping warm: a fine balance to be managed | 04 |
| The chemistry: yesterday, today, the future               | 05 |
| Technology has indeed come a long way                     | 07 |

## The Honeywell Story

|  |    |
|--|----|
| Honeywell Performance Materials and Technologies               | 08 |
| A history of innovation for safe and energy efficient products | 09 |
| What exactly are HFOs?   | 11 |
| Pioneering innovative hydrofluoroolefin technology             | 12 |

## How can key industries improve their 'green' credentials?

|  |    |
|--|----|
| Mobile air conditioning: automotive                                | 15 |
| Customer insight: Hispacold  | 18 |
| Supermarket and coldstore refrigeration                            | 21 |
| Customer insight: ASDA Supermarkets (UK)                           | 24 |
| Ultra-high efficiency chillers                                     | 27 |
| Customer insight: Waitrose, via Geoclima, Klima-Therm and Frascold | 28 |
| Insulation for construction and appliances                         | 31 |
| High performance solvents and propellants                          | 35 |
| Investing now...investing for the future                           | 39 |

# Think time.

Decades ago, the environmental impact of refrigeration, air conditioning installations, insulation and aerosols on climate change has been primarily attributed to energy consumption and the emissions of chlorofluorocarbons (CFCs). Ozone depletion was one issue to be solved. The new generation of products, the Hydrofluorocarbons (HFCs), had no ozone depletion potential but still had global warming potential. It is easy to make a broad-sweep statement that all refrigerants, aerosols and foams are harmful to the environment, but times – and technologies – have come a long way. Through the usage of a responsible and pragmatic approach towards sustainable practices that respect the safety of people and the environment, Honeywell is making changes that count...

# Keeping cool...keeping warm: a fine balance to be managed.

Love them or hate them, refrigeration, cooling and air conditioning play significant (and irreplaceable) roles in our every day life. Essential ingredients for improving and maintaining our comfort, indoors and out; keeping our food fresh; keeping our IT systems cool; maintaining hygiene in hospitals, particularly in hot countries, it is inconceivable to imagine a world without such installations in place.

Spray-foam, extruded foam insulating panels and refrigerator insulation play equally important – if less obviously visible – roles. Insulating to prevent waste of energy and maximise the value of the energy that IS available is vital in order to conserve precious resources.

But whether as citizens, industrialists or politicians, it is our duty to understand the environmental challenges we face even in the most mundane of everyday items; a supermarket refrigerator, an aerosol can, or the air conditioning in our cars. Only when better informed can we make responsible decisions that will ensure sustainable socio-economic development.

## How does a refrigeration system impact on global climate?

### Through energy use

Refrigeration systems consume electricity which, in the main, is generated through the burning of fossil fuels. In turn, this process releases CO<sub>2</sub> into the atmosphere, the primary contributor to greenhouse gas emissions that are widely considered to lead to global warming and climate change. Thus it follows that any refrigeration system, over its life cycle, will contribute to climate change, an 'indirect' effect that can represent more than 80% of its impact on the climate. Reducing this indirect impact is a key priority when managing such systems.



### Through emissions

Refrigerant systems in general which have not had their refrigerant fluid recovered or recycled can lead to emissions into the atmosphere. Posing a diminishing threat now, the 'direct' effect represents some 20% or less of an impact on the environment.

## Global-warming Potential

Global-warming potential (GWP) is a measure used to describe the relative potency of a greenhouse gas, taking account of how long it remains active in the atmosphere.

The global-warming potentials (GWPs) currently used are those calculated over 100 years, with carbon dioxide taken as the gas of reference with a 100-year GWP of 1: the yardstick against which all other greenhouse gases are evaluated.

Regarding refrigerants the lower the value of the GWP, the less impact on the environment. Substance 'R-134a' for example has a GWP of 1430 and has been the subject of environmental regulation for car air conditioning.

## What is Spray Polyurethane Foam (SPF)?

Spray Polyurethane Foam (SPF) has been used for decades around the world as a high performance insulation system for buildings. Forming a monolithic seal it also prevents leaks, resulting in a fully waterproofed surface over the entire building structure.

SPF can be used as an insulating and air sealing product for commercial, industrial and residential walls and roofs as well as ceiling cavities. The insulation is sprayed, via special equipment, onto the wall or roof and quickly expands to form an even and highly resistant material.

Air infiltrates into and out of homes in many ways; about one-third of this air infiltrates through openings in ceilings, walls, and floors. Controlling and limiting these air leaks can greatly improve the overall energy efficiency of the building. SPF insulates building-systems using polyurethane chemistry, customised for a building. Running costs for buildings are significantly reduced, thanks to energy-savings, longer life expectancy and lower maintenance cost. In addition SPF provides a more comfortable building environment, creating superior occupant experience. SPF helps keep heated buildings warm when the external temperature is cold and also keeps cooled rooms cool during summer, saving energy all year-round.



# The chemistry: yesterday, today, the future.

## Ammonia

The first refrigerant to be used on a large, commercial scale. Efficient, it is also toxic and flammable. Now restricted to use with supervision by skilled personnel.

## Hydrocarbons

Efficient refrigeration fluids, hydrocarbons are extremely flammable. Their use also contributes to urban pollution, triggering the generation of tropospheric ozone in the lower atmosphere.

## Chlorofluorocarbons (CFCs) and Hydrochlorofluorocarbons (HCFCs)

Together with chlorofluorocarbons (CFCs), HCFCs heralded an era of safe, cost-effective and efficient refrigeration. Honeywell introduced HCFC-141b in the

1990s as a low ozone-depleting-potential replacement for CFCs. When the Parties to the Montreal Protocol decided to ban HCFCs, Honeywell again sought a solution through innovation, developing the next generation of fluids, Hydrofluorocarbons (HFCs).

## Hydrofluorocarbons (HFCs)

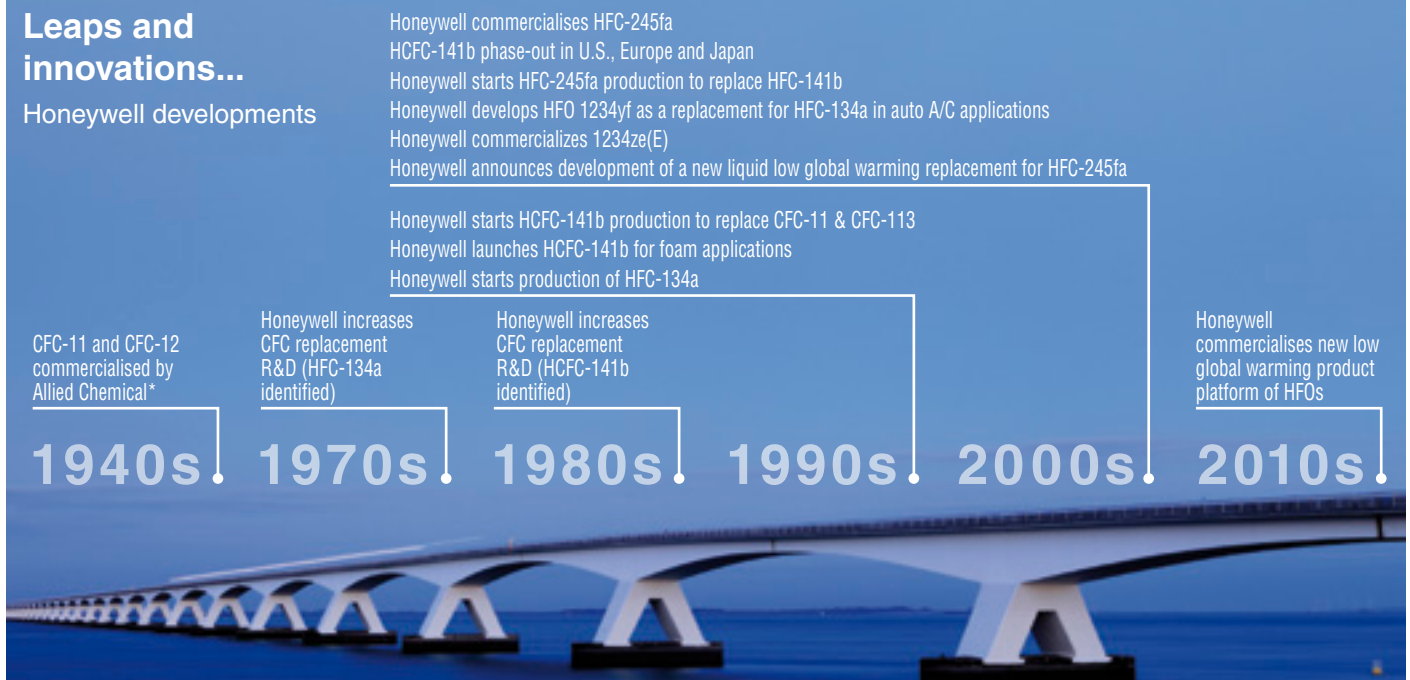
While HFCs do not deplete the ozone layer and have a Global Warming Potential (GWP) a fraction of that of CFCs, there is a desire and a need to further reduce the impact to climate change that HFCs have when released into the atmosphere.

## Hydrofluoroolefins (HFOs)

Utilizing its world-class R&D capabilities, Honeywell next developed Hydrofluoroolefins (HFOs) that have an ultra low GWP and are non-ozone-depleting. Today these HFOs are available for mobile air conditioning, refrigeration, aerosol applications, insulating and one-component foams. Soon, new HFOs will be available to serve the high performance thermal insulation and solvent segments. Blends of HFOs with HFCs are under development to serve the refrigeration market with significantly reduced GWP offerings while maintaining, and in some cases improving, the energy efficiency compared to today's products.

## Leaps and innovations...

### Honeywell developments



The chart (above) shows developments from 1940 to 2010 and the steps Honeywell has taken to respond to regulations and to the industry's needs. Throughout, new products have been introduced in line with regulations as previous offerings have been phased out, utilising Honeywell's technology leadership.

**Honeywell Performance Materials and Technologies** serves several industries and segments:

- Mobile and Stationary Air-Conditioning
- Refrigeration
- Insulation Foam for Buildings and Electrical Appliances
- Cleaning Solvents
- Nuclear Power
- Aerosols
- Heat Pumps
- Geothermal and Solar Renewables

\*Formed in 1920 as Allied Chemical & Dye Corporation by the merger of five industrial concerns: Barrett Chemical Company (founded 1858), General Chemical Company (founded 1899), National Aniline & Chemical Company (founded 1917), Somet-Solvay Company (founded 1895) and the affiliated Solvay Process Company (founded 1881). Renamed Allied Chemical Corporation in 1958. It became Allied Corporation in 1981, acquired Bendix in 1983, and merged with Signal Companies in 1985. Operated as Allied-Signal (or AlliedSignal after 1993). AlliedSignal merged with Honeywell in 1999, and the combined entity is now known under that name.



# Technology has indeed come a long way.

Environmental protection is the sum of a lot of small changes and, it has to be said, any move towards sustainable development in the refrigeration, air conditioning, aerosols and foams sectors is the responsible and safe way of driving towards a goal of demonstrating responsibility to our planet. While HFCs continue to have a role in a range of applications, their characteristic of high GWP means that a new generation of fluorocarbons that demonstrate a low GWP would be a step-change improvement. That step-change improvement has resulted in the development of HFOs, which meet – and in most cases exceed – the all important current environmental legislation whilst maintaining the key technical and safety properties of HFCs for many applications.

# Honeywell Performance Materials and Technologies.

Honeywell is a Fortune 100 company that invents and manufactures technologies to address tough challenges linked to global macro trends such as safety, security, and energy. With approximately 122,000 employees worldwide, including more than 19,000 engineers and scientists, Honeywell has an unrelenting focus on quality, delivery and value.

**Honeywell Performance Materials and Technologies** (a business unit of Honeywell) is a global leader in developing and manufacturing high performance specialty materials, including:

- fluorine products such as zero ozone-depleting refrigerants used by top air conditioning and refrigeration makers worldwide
- blowing agents for energy-efficient foam insulation and aerosol applications
- specialty films and additives
- advanced fibres and composites
- intermediates
- specialty chemicals
- electronic materials and chemicals
- technologies and materials for petroleum refining

A diverse portfolio of technologies comprising high-purity, high-quality performance chemicals and materials, these products reduce emissions, stop bullets, enable the production of green diesel and green gasoline, increase oil refinery capacity, speed drug discovery, and protect medicines.

Honeywell Performance Materials and Technologies continues to innovate, developing safe, energy efficient and environmentally friendly offerings for a huge variety of applications.



## Committed to meeting demands via a \$33 million investment in manufacturing

A \$33 million investment in Honeywell's Baton Rouge (Louisiana) facility will allow the Company to increase its output of the LGWP Solstice™ Propellant and Solstice ze Refrigerant, for shipment around the world. Customers are looking for solutions from Honeywell that are energy efficient, safe, economical and better for the environment than existing materials. The investment made in Baton Rouge allows the Company to meet the significant global customer demand for Solstice Propellant and Solstice ze Refrigerant, which has all of these attributes.

In 2011, Solstice Propellant was recognised by the Paris Aerosol Forum as the best new technical product innovation. The prize was awarded by an independent jury of aerosol experts representing brand owners, packaging manufacturers and the media.





# A history of innovation for safe and energy efficient products.

## Innovative refrigeration that allows customers to comply

Honeywell is an established technical leader in the development of the '4th Generation' of fluorine-based refrigerants for the commercial and industrial refrigeration industry worldwide. As you would expect from a world-class supplier, the Company has been at the forefront of the industry's drive to develop these safer, non-ozone depleting alternatives to the older technology (CFC and HCFC refrigerants), in compliance with global legislation for their phase-out.

To ensure that customers are fully supported in this transition, Honeywell has dedicated its research resources to developing a comprehensive range of alternative intermediate and long-term refrigerants. These are not only safe to use but are able to meet or surpass the performance levels of the products they replace, have lower environmental impact, be safe and cost-effective:

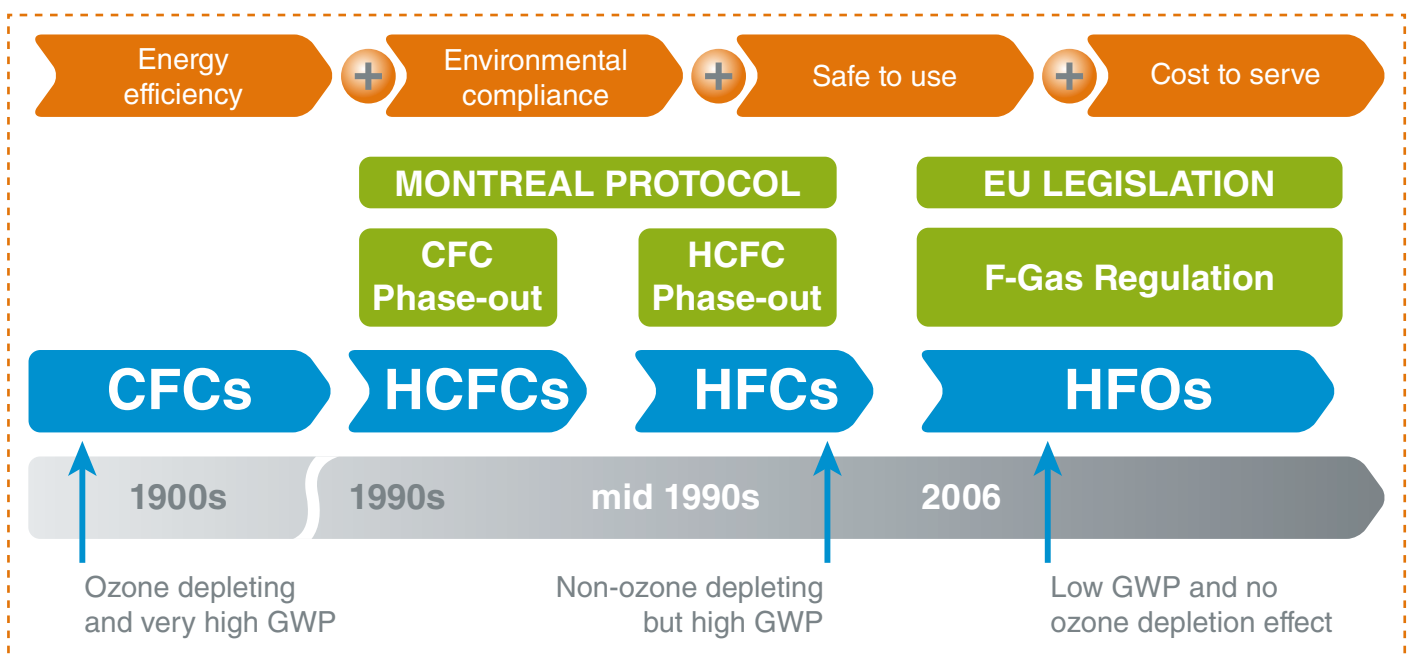
- HFOs are safe to use and, as a supplier of HFOs, Honeywell provides rigorous guidance on safe handling and use

- HFOs have significantly lower GWP than HFCs and also are much lower than all Directives require – the GWP reduction of some Honeywell products can be up to 99.6%
- 4th Generation refrigerants have better performance and are more energy efficient when compared to refrigerants they are intended to replace
- As HFOs use the same technology as HFCs, both implementation and cost to serve are very simple: HFOs need only minor (if any) changes to the technology customers currently use and the differences in implementing and maintenance are minimal
- HFOs are also a global solution, as they are effective in different ambients

The chart below outlines, in simple terms, how developments in refrigeration have kept pace with the strict Directives and Legislation laid down over recent decades.

## Responsible Care

Honeywell Performance Materials and Technologies, as a member of the American Chemistry Council, has adopted Responsible Care® as the foundation of health, safety, and environmental (HS&E) excellence in our business. Responsible Care is the chemical industry's global voluntary initiative under which companies, through their national associations, work together to continuously improve their health, safety and environmental performance, and to communicate with stakeholders about their products and processes.





# What exactly are HFOs?

Hydrofluoroolefins (HFO's) are a family of unique compounds compared to the compounds previously developed for commercial use for heat transfer, blowing agent, solvent and propellant applications. After extensive research and development, some members of this family have been found to offer comparable performance to today's most widely used stationary and mobile refrigerants, blowing agents, solvents and aerosol propellants. These products have short atmospheric lifetimes and have very low global warming potentials.

Honeywell's Solstice™ brand reflects the products' break-through environmental properties, including their insulating capabilities for foam and their cooling capabilities for automotive and stationary air conditioning and refrigerant applications.

# Pioneering innovative hydrofluoroolefin technology.

## LGWP refrigerants, blowing agents and propellant

### Solstice™ yf Refrigerant

Honeywell Solstice yf Refrigerant is specifically tailored for the automotive industry for use as a refrigerant in car air conditioning systems. With a GWP of 4 – a fraction of the global warming impact of R 134a – it provides the same cooling comfort that consumers depend on and surpasses new EU standards.

Automotive air conditioning systems that use Solstice yf Refrigerant are generally more energy efficient than competing technologies.

### Solstice ze Refrigerant

More energy efficient than hydrocarbons, Solstice ze Refrigerant for chillers is the best low GWP, energy-efficient alternative to traditional refrigerants for air-cooled and water-cooled chillers in supermarkets and commercial buildings. It meets the criteria that are most important to refrigerants customers: Performance, Cost Effectiveness, Environmental Impact and Safety. In addition, this refrigerant can also be used in heat pumps, vending and plug-in units.

### Solstice Gas Blowing Agent

Honeywell Solstice Gas Blowing Agent is a gaseous blowing agent that is being used in extruded polystyrene board and one component foam applications. *Note 1234ze has a different brand name (Solstice*

*Propellant) for aerosol applications.*

The energy efficiency benefits of Solstice Gas Blowing Agent, combined with its LGWP of less than 6, make it the right choice as a replacement for hydrocarbons, carbon dioxide, HCFC-142b, HFC-134a and HFC-152a for use as a foam insulation blowing agent.

### Solstice Liquid Blowing Agent

Honeywell Solstice Liquid Blowing Agent for refrigerator insulation and spray foam insulation scores high marks in the four performance areas that are most important to customers – performance, cost-effectiveness, environmental impact and safety.

The energy efficiency benefits of Solstice Liquid Blowing Agent, combined with its LGWP and safety in use, make it the right choice as a replacement for hydrocarbons, HCFC-141b, HFC-365mfc and HFC-245fa for use as a foam insulation blowing agent.

### Solstice Propellant

Whilst efficient and safe in use, HFC propellants, such as R-134a and 152a, have come under pressure as potential contributors to global warming. Honeywell Solstice Propellant has all the performance benefits of hydrofluorocarbons, but exhibits very favourable environmental properties, delivering across the dimensions that are most important to users: performance, cost effectiveness, sustainability, safety and regulatory compliance.

### Solstice Performance Fluid

Honeywell Solstice Performance Fluid exhibits superior solvency for a wide variety of solutes including hydrocarbon oils, silicone oils, silicone greases, fluorinated oils, mineral oils, acrylics, solder fluxes, hydraulic fluids and others. Solstice Performance Fluid has similar solvency effectiveness to CFC-113, but does not harm most substrates and exhibits low toxicity. It also exhibits very low surface tension, and is both thermally and hydrolytically stable.

With a global warming potential of less than 5 and when substituted for solvents currently in use, Solstice Performance Fluid has the potential to make significant contributions to reductions in global warming.

### Genetron® Performax LT™

A unique blend of HFC refrigerants, and carrying the designation R-407F, Genetron Performax LT delivers the same performance as R-22 with no ODP and is the ideal replacement for R-404A supermarket refrigeration retrofits.

### Solstice – the future

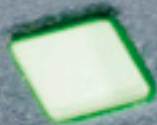
Honeywell is investing in the development of other Solstice products that will be used as solvents, refrigerants, as blowing agents for polyurethane foam insulation and other applications.

Solstice products benefit society through superior energy efficiency performance in cooling and insulating applications. By reducing fuel consumption, fluorocarbons directly reduce greenhouse gas emissions from heating, cooling and electrical power generation, and are cost-effective for the end user compared with fluorocarbon alternatives.

In addition, many Solstice fluorocarbons are non-flammable and have a low order of toxicity, which makes them significantly safer in use than alternatives such as carbon dioxide and ammonia that are either extremely flammable, asphyxiant or highly toxic.







MAX  
AIC

# Mobile air conditioning: automotive.

The power of human innovation has allowed us to advance our standard of living and protect the environment at the same time. When the EU in 2006 called for a more environmentally friendly refrigerant for cars, they did not specify the technology to be used, but rather the benefit to be delivered. In response, Honeywell's team of world-class scientists accelerated their efforts to bring to the market the next generation of refrigerants for mobile air conditioning (MAC).

The result? A product that not only exceeded the goals set politically, but one that represents a long-term, global and energy efficient solution.



## The energy efficiency of Solstice™ yf Refrigerant

As explained earlier, the major part of a refrigerant's global warming potential is due to indirect emissions: CO<sub>2</sub> emissions, caused by increased fuel consumption needed to power the air conditioning system. Tests by the Japanese Automobile Manufacturers Association JAMA showed that ACs equipped with Solstice yf Refrigerant produce markedly less CO<sub>2</sub> emissions than those running with CO<sub>2</sub> in hot climate zones. This is proof that Solstice yf Refrigerant provides a global solution as required by the automobile air conditioning industry for energy efficient vehicle air conditioning.

The EU MAC directive 2006/40 was put in place in 2006. It mandates that all new car types have a refrigerant with a global warming potential (GWP) of less than 150 as of January 2011.

Starting with the 1989 Montreal Protocol, which bound the signing parties to phase out ozone depleting substances, the Kyoto Protocol in 1997 set specific goals. The industrialised countries agreed upon defined threshold values for greenhouse gases, which are one of the main causes of global warming.

When the EU Commission implemented the Kyoto Protocol in 2000 it also addressed automotive air conditioning. The objective

was to minimise negative impact on climate through innovative refrigerants. The EU MAC directive 2006/40 was put in place in 2006. It mandates that all new car types have a refrigerant with a global warming potential (GWP) of less than 150 as of January 2011. From 2017 on, this standard will apply to all new cars.

Honeywell has provided a solution to this challenge: a refrigerant that fulfills all the requirements – environmentally friendly,

efficient, safe and globally applicable – and is cost-effective for both the car industry and the individual car owner. Solstice yf Refrigerant achieves the climate goals set by the EU directive 2006/40, the 'Mobile Air Conditioning' Directive (MAC), in a timely, cost effective, energy efficient, and safe way.

### An innovation to improve the world step by step

Honeywell's Solstice yf Refrigerant is a key element in achieving the EU's climate goals. With a GWP of only 4, it is 97 percent lower than the mandate of less than 150. It is also 99.7 percent better than the refrigerant currently in use, R-134a, which has a GWP of 1430. Solstice yf Refrigerant is safe and efficient in all climates across the world.

To achieve optimal results, Honeywell has worked closely with the car manufacturers. In 2008, following years of discussions with stakeholders in the automotive industry, Solstice yf Refrigerant was identified as the refrigerant that delivered all the requirements – environmental benefits, energy and cost efficiency and safety. It has also been subjected to worldwide testing by independent institutes under the supervision of the Society of Automotive Engineers (SAE). They agreed: Solstice yf Refrigerant is a satisfactory solution.

## Solstice yf Refrigerant – the facts

**Climate Protection** • Solstice yf Refrigerant has a GWP (Global Warming Potential) of 4, exceeding the climate protection goals of the EU (GWP 150) many times over. Compared to alternative refrigerants, Honeywell Solstice yf Refrigerant has the most favorable climate footprint over its entire life cycle.

**Global Solution** • Solstice yf Refrigerant meets the regulations of different countries and region for mobile air conditioning.

**Fast Implementation** • Solstice yf Refrigerant is compatible with most current air conditioning systems. Changes will need to be made, but it is not an entirely new technology.

**Energy Efficiency** • Solstice yf Refrigerant is more efficient in hot regions than competitive IGWP alternatives meeting the GWP 150 requirement of the EU MAC directive. The new refrigerant provides efficient cooling in all global climate zones as required by the auto air conditioning industry and has been found suitable for global implementation.

**Safety** • Solstice yf Refrigerant is safe and can be used as the refrigerant in automotive air conditioning. Extensive, long-running studies have proven that Solstice yf Refrigerant is safe for use in motor vehicles.



“Use of the refrigerant is safe for car passengers and rescue workers.”

**German Fire Services Association (DFV), 2011**

DFV assessed Solstice™ yf Refrigerant in close cooperation with the German Association of the Automotive Industry VDA – including specifically designed tests according to requirements by DFV.

“Used in ACs, this refrigerant shows the least risk potential in comparison to alternative agents and fulfils best all environmental and customer requirements.”

**\*SAE International, 2010**

With a GWP of only 4, Solstice yf Refrigerant is 97% lower than the mandate of less than 150. It is also 99.7% better than the refrigerant currently in use, R-134a, which has a GWP of 1430.

Visit [www.1234facts.com](http://www.1234facts.com) for more information

## The impact on vehicle manufacturers

In today's economic climate, playing catch-up is not an option; the companies that stay ahead of changing environmental regulations while continuing to deliver cost effective vehicles that exceed consumer requirements are the ones that will prosper and grow in the future. Right now, the global automotive industry is being pressured to reduce the environmental impact of its products and a myriad of technological challenges are being put in front of the car industry as governments attempt to reduce emissions from cars and trucks.

Automotive refrigerants like Solstice yf Refrigerant are one way that manufacturers can work toward achieving this objective. It's a simple change the industry can make with very little system modification, saving time, cost and environmental impact for years to come.

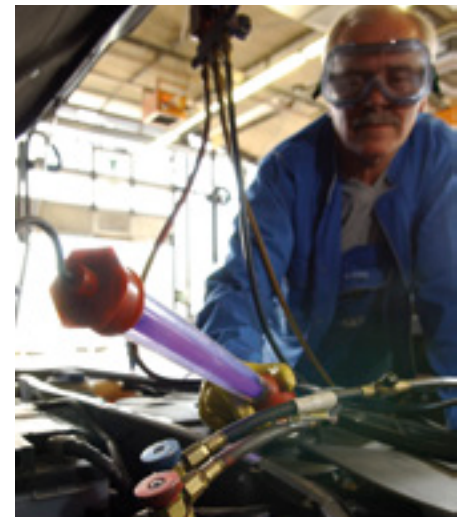
### A near-drop-in solution

Implementation of Solstice yf Refrigerant will require few changes to manufacturers' existing air conditioning systems. Contrary to that, CO<sub>2</sub> air conditioning system solutions require a complete overhaul of manufacturing technologies that would require significant investment in resources to implement.

Solstice yf Refrigerant is an organic fluorinated compound and has performance properties similar to those of the refrigerant R-134a, currently used in cars in many parts of the world. The operating system pressures of Solstice yf Refrigerant are similar to the current refrigerant, R-134a. This allows for reuse of the recent manufacturing technology advancements that will continue to make AC systems affordable into the next generation of Solstice yf Refrigerant systems.

Worldwide, car owners can actively contribute to climate protection without foregoing the safety and convenience of air conditioning.

**Right: Refilling refrigerant in vehicle air conditioning.**



# Hispacold: climate systems for buses and coaches

## Spirit of innovation drives eco-friendly refrigerant application.

Hispacold had been working to develop a climate system solution for buses and coaches far ahead of the potential transposition of the MAC Directive to road transport in order to affirm its strong position in their sector.

Although competition is intense, Hispacold is the only company responsible for end-to-end climate control unit production, giving the company unrivalled whole-system knowledge and know-how.

The spirit of innovation that has defined Hispacold for over 30 years was applied to its research into a new refrigerant that would meet both the future potential MAC Directive targets and the company's broader commitment to sustainable development – a key driving force behind their innovation strategy. Hispacold's pursuit of being best-in-class in climate controls, blowers and compressors is

extended now to include refrigerants in this strategy view.

As the automotive industry seeks solutions both for ever-tightening emissions standards and to meet the demands of consumers for more fuel efficient and eco-friendly technology, Honeywell's Solstice™ yf Refrigerant is proving its credentials as a drop-in replacement for R-134a. Honeywell Solstice yf Refrigerant is a technology that provides a compelling proposition to the automotive sector as a result of its energy efficiency, environmental benefits, safety, performance, ease of usage and overall effectiveness.

Solstice yf Refrigerant has a GWP of just 4 – a figure 97% lower than the MAC Directive requires for Automotive and 99.7% lower than R-134a. Moreover, Solstice yf Refrigerant has an atmospheric lifetime of only 11 days, compared to

13 years for R-134a and more than 500 years for CO<sub>2</sub>. And, unlike HFCs and CFCs, which take decades to decompose, Solstice yf Refrigerant does not persist in the atmosphere.

These impressive features attracted the attention of Hispacold, which was seeking an alternative to R-134a and decided to conduct an extensive research exercise to compare the new Honeywell refrigerant and other alternative refrigerants, like CO<sub>2</sub>, with an R-134a-based system.

### Finding the coolest environmental solution

In order to find a replacement for R-134a – one that would meet the company's energy-efficiency and sustainability objectives as well as its future potential regulatory commitments – Hispacold conducted laboratory research involving a rooftop unit with condenser and evaporator (model 12S) to assess the relative performance of both Solstice yf Refrigerant and CO<sub>2</sub> with the original R-134a-based system.

## Testing with Hispacold's 12S roof top unit

### System description

- Compact system
- Condenser in the middle, evaporators at the sides
- Compressor: Ecoice (Hispacold) 660cc
- Refrigerant charge: 4.8kg for R-134a versus 3.9 kg for Solstice yf
- Same pipes, hoses and fittings as for R-134a (compatible with Solstice yf)
- Same equipment feed as for the R-134a refrigerant system: no differences and no issues

### Test Description

The bench test of the complete rooftop unit compared the performance of Honeywell's new Solstice yf Refrigerant refrigerant against R-134a. The test used R-134a with the unit's existing expansion valves, repeated the test with Honeywell Solstice yf Refrigerant with the same set-up, and then tested Honeywell Solstice yf Refrigerant with a new expansion valve supplied by Honeywell Cooling Solutions.

Two compressor speeds were run – 1500 and 2000 rpm – with multi ambient temperature / evaporating temperature settings: 40°C/25°C; 35°C/23°C; 45°C/27°C; 42°C/23°C.



Both fluids had previously undergone risk assessment (life, endurance, crash...) in the automotive sector, which had proven them to be safe in terms of toxicity and flammability.

However, following initial bench tests by Hispacold with the CO<sub>2</sub> system, it was discarded, because performance was confirmed not to be acceptable above 30°C and overall system cost was higher.



**Carbon footprint reduction**

The switch from R-134a to Solstice™ yf Refrigerant resulted in a reduction of close to 20% in refrigerant gas, along with lower direct emissions of almost 100% (99.77%) – the equivalent of 14,000 tones of CO<sub>2</sub>eq. for a typical fleet of 2,000 buses.

|                         | GWP  | Charge (kg) | CO <sub>2</sub> eq. |
|-------------------------|------|-------------|---------------------|
| R-134a                  | 1430 | 4.8         | 6,864               |
| Solstice yf Refrigerant | 4    | 3.9         | 16                  |
| Difference              |      | 0.9         | 6,848               |
| %                       |      | 81%         | 99.77%              |

“We have evaluated CO<sub>2</sub>-based systems. However performance is drastically reduced above 30°C ambient temperature, which significantly reduces market potential at this moment. We have thus focused our efforts on Solstice yf Refrigerant, which is a proven and supported technology selected by several automotive manufacturers to replace R-134a.”



**An eco-friendly innovation for Hispacold**

“We conducted thorough studies and extensive testing of Solstice yf Refrigerant. These studies showed it is a technically viable environmental alternative to R-134a in our climate systems for buses and coaches. It also is an essential drop in to R-134a systems with similar efficiency to R-134a. Our results are supported by CDTI (Centre for the Industrial Technological Development, from the Spanish Ministry of Science and Innovation). We look forward to extensively using this new refrigerant in our products in the market, so we can reduce our carbon footprint.”

**Jacobo Gutiérrez García**  
Market Manager, R&D Engineer (Hispacold)

**Juan Bernal Cantón**  
R&D Manager (Hispacold)

**Fuel efficiency, energy and emissions benefits of Solstice yf Refrigerant**

**Solstice yf Refrigerant**

- is a near drop-in replacement refrigerant for current A/C systems
- offers close to 20 % reduction in gas charge compared with R-134a
- delivers direct emissions reduction of 99.77 %, equating to 14,000 tonnes of CO<sub>2</sub>eq. for a fleet of 2,000 buses (typical fleet size of a medium-to-large city)



# Supermarket and coldstore refrigeration.

Supermarkets around the world are coming under intense scrutiny to prove their credentials when it comes to environmental impact and sustainability. The cooling gases used in their refrigeration systems accounts for around one quarter of their carbon footprint – and that is before energy for powering equipment is taken into account.

Honeywell has responded by developing a new refrigerant blend – Genetron® Performax LT™ – which is delivering outstanding results across key metrics linked to energy efficiency, carbon footprint reduction, running costs and safety.



“Tesco Poland decided to use Genetron® Performax LT™ refrigerant to help us meet our aggressive carbon footprint reduction targets.”

**Robert Hurley, Group Engineering Standards & Energy Manager for Tesco Group Property**

According to the industry testing, systems using Genetron Performax LT, also known as R-407F, consume up to 15% less energy than systems using R-404A. Use of Genetron Performax LT can also reduce carbon dioxide emissions by up to 40%.

Environmental agencies the world over face an uphill struggle to raise awareness of the issues with emissions from supermarket fridges. Supermarkets are the biggest industrial emitters of HFCs, which were introduced in the 1990s as safer alternatives to ozone-depleting chemicals such as CFCs. While HFCs do not damage the ozone layer, the GWP is significant: one tonne of the widely used gas called R-404A has a warming effect equal to 3,900 tonnes of CO<sub>2</sub> over a 100-year period. The level of leakage of the chemicals is equivalent to 1 billion car journeys to the average local supermarket...

#### **The challenges facing supermarkets today**

Concerns about replacement costs, disruption to store opening times – particularly in this day and age of 24/7 shopping – and loss of profits as a result, means that many large corporations are reticent to change.

Supermarket refrigeration as an environmental threat is not getting the front line, on the street exposure of, for example, plastic carrier bags, in recent years challenged by public groups and governments worldwide as the number one supermarket-related threat to the environment. Now, while many of the major high street names have indeed addressed the problem of carrier bags in different ways, in reality, their refrigeration systems

are continuing to inflict far more damage on the environment.

Pressure from shareholders, rising costs in just about every area and a price-savvy customer base all threaten to impact on a supermarket's bottom line. While much of this may be beyond their control, with escalating energy costs, supermarkets are, quite rightly, looking at their energy consumption levels very closely to determine where savings can be made in order to minimise that impact.

It may be that educating supermarkets about more energy efficient systems might just be the catalyst to persuade them to change old habits sooner rather than later.

#### **Creating a sustainable future**

Honeywell's Genetron Performax LT is a highly efficient and innovative mixture of conventional hydrofluorocarbon refrigerants (R-32, R-125 and R-134a). It can be used for new commercial installations and to retrofit existing R-404A, R-407A and R-22 installations with only minor adaptations.

Paul Sanders, Managing Director for Honeywell Fluorine Products in Europe, Middle East, Africa and India, said, “Genetron Performax LT can help supermarkets' bottom line because it is more energy efficient and requires minimal changes to the equipment supermarkets are currently using.”

Sanders also noted that Honeywell Genetron Performax LT is a class A1 refrigerant, meaning that it has low toxicity and is non flammable.

#### **Did you know...?**

...that refrigeration systems make up 50% of a typical supermarket's total energy consumption? Fluorinated gases in those systems help keep those systems energy efficient...

...and that in developing countries, one quarter of the perishable foods production is lost due to a lack of or an incomplete cold chain (namely poor cold storage and refrigerated transport systems), representing almost 400 million tons per year.





## Genetron® Performax LT™ – it's cool for new build and retrofit alike

Sixty of the Tesco stores using Genetron Performax LT are newly built. The remaining 15 stores were retrofit applications, where Genetron Performax LT replaced R-404A, an older refrigerant that has higher global warming potential. Tesco installed Genetron Performax LT mainly in small format stores of up to 1,000 square metres, as well as some supermarkets (2,000 to 3,000 m<sup>2</sup>) and large hypermarkets of more than 4,000 m<sup>2</sup>. The total of 75 stores has been implemented between June and November 2011 whilst Tesco will continue with the roll-out plan in Poland.

Genetron Performax LT is the best performing, cost saving and lowest GWP refrigerant for supermarket installations.

Visit [www.genetronperformaxlt.co.uk](http://www.genetronperformaxlt.co.uk) for more information

### Running out of time – switching away from dominant refrigerant R-404A\*

**Ray Gluckman, External Consultant on F-Gas Regulation Implementation for DEFRA (UK Department for Environment, Food and Rural Affairs) & Director, Climate Change, SKM Enviros**

Across Europe, tough policies to reduce greenhouse gas (GHG) emissions in refrigeration systems are being introduced. The EU Energy Strategy 2020 strategy makes direct references to the urgency of curbing CO<sub>2</sub> emissions from refrigerants. Predominantly in supermarkets, an opportunity for short-term GHG reductions could be missed if the retail industry doesn't apply the right strategy to eliminate the use of R-404A, the dominant refrigerant across Europe for chilled and frozen food refrigeration. This is essential because R-404A is a poor energy efficiency refrigerant with a significantly high global warming potential (GWP) – at 3,922, it is the highest of all commonly used refrigerants.

The most effective strategy in terms of delivering significant GHG reductions and saving costs combines a short- and long-term perspective. Since most supermarket refrigeration systems have a life span of 15 to 20 years, existing R-404A equipment should be converted to R-407A or R-407F over a four-year period and all old plants reaching end of life should be replaced with a very low GWP system. Compared to a scenario where R-404A is present in all refrigeration systems for the period 2011-2020, this strategy achieves 23% GHG reduction through huge benefits of retrofitting existing equipments. As R-407A or R-407F have a GWP less than half of R-404A, direct global warming impact can be reduced by as much as 55% and indirect electricity-related CO<sub>2</sub> emissions by a further 10-15%. This is clearly a win-win situation where environmental and cost-effectiveness concerns are seamlessly met.



\*Extracted from: <http://www51.honeywell.com/sm/chemicals/refrigerants/eu/en/news-n2/f-gas-regulation-review.html>

# ASDA Supermarkets (UK)

## Innovative refrigerant reduces emissions, enhances energy efficiency and supports sustainability.

In the latest field test – completed with ASDA, one of the foremost supermarket chains in the UK – the new Honeywell refrigerant was assessed against the commonly-used R-404A and R-407A.

The results proved Genetron® Performax™ LT to be the best performing refrigerant currently available for supermarket installations.

Unlike R-407A, Genetron Performax LT can be used in both low temperature and medium temperature applications. The refrigerant delivered impressive results due to its higher capacity and efficiency and a GWP that is nearly 50% lower than R-404A and 15% lower than R-407A.

The Honeywell Genetron Performax LT advantage created for ASDA included:

- Up to 15 % saving in system energy bills
- Up to 40 % reduction in system CO<sub>2</sub> emissions
- Up to 10 % improvement in system running costs

### Background: contributing to ASDA's carbon reduction goals

ASDA has made a public commitment through its Sustainability 2.0 agenda to reduce the environmental impact both of its own operations and those of its supply chain.

The ambitious goals for 2015 (compared to 2005 levels) include:

- Reducing energy consumption in existing stores by 35%
- Reducing new store carbon emissions by 60%
- Reducing overall carbon footprint by 10%
- Removing 20 million metric tons of CO<sub>2</sub> from its global supply chain
- Reducing 60% of emissions from its transport fleet

A key contributor to these targets for ASDA is the identification and application of eco-friendly refrigerants used to preserve meat and dairy products, with a particular

focus on reducing energy consumption (and cost) and lowering carbon emissions through improved GWP.

Following a successful laboratory test of Genetron Performax LT, ASDA embarked on a full-scale field test of the Honeywell refrigerant at its new Hunts Cross store in Liverpool (UK).

### Field test implementation: monitoring and assessing data

To ensure the robustness of the project, a dedicated team of professionals was set up to run the trial. In addition to the involvement of ASDA's Head of Refrigeration and Energy Manager, the team included representatives from Honeywell Refrigerants Technical Management, Emerson Climate Technologies (Copeland scroll compressors), AGas, BJA Consulting, CBES Constructive Solutions and City Holdings.

The Hunts Cross store was chosen because it had two identical MT (medium temperature) systems, which would allow for accurate comparisons of Genetron Performax LT alongside R-404A and R-407A (see Fig.1 ).

The MT systems comprised:

- Identical connected loads
- Identical pipe work design and layout
- 8 compressors pack ZB45 (Copeland scroll)

### Field test results

A thorough evaluation of the results by the entire project team for the Hunts-Cross store confirmed the power consumption:

- The R-404A system consumed 5% more energy vs. the R-407A system.
- The Honeywell Genetron Performax LT system consumed 13% less power than the R-407A system and around 20% less than the original R-404A system.

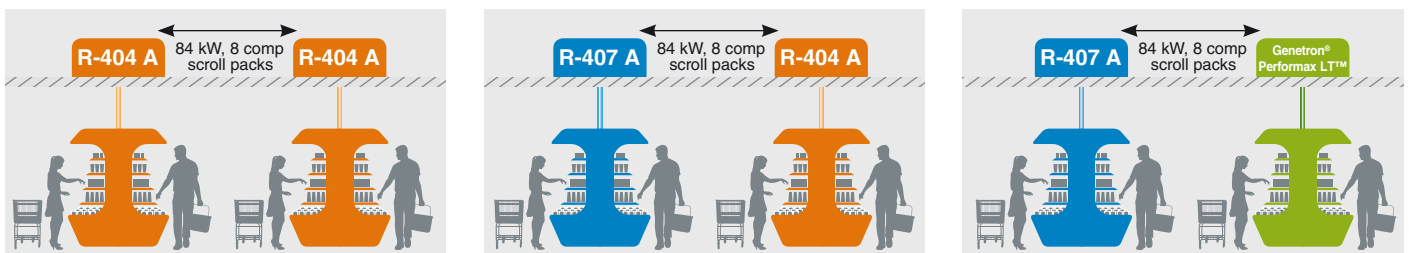


Figure 1: Original system and two-steps transformation





“I feel the most important aspect of this conversion to Genetron Performax LT will be its unparalleled efficiency and lower GWP versus R-404A, which will enable us to reduce both direct and indirect emissions. I am impressed by the energy improvement.”

**Brian Churchyard, Head of Refrigeration at ASDA.**

In order to ensure like-for-like comparisons between all three refrigerants, System 1 was converted from R-404A to R-407A and performance and energy consumption measured over a 12 months period. System 2 was then converted from R-404A to Genetron® Performax™ LT and operated over an extended period to ensure that the results for each refrigerant could be compared, verified and validated.

Brian Churchyard, Head of Refrigeration at Asda: “ASDA will extend this programme to the rest of refrigeration packs (MT and LT) in Hunts-Cross and use this experience for the further roll-out of conversion to Performax in other stores in the UK”.

### Carbon footprint and operating costs

The results demonstrate significant emissions and cost advantages (excluding the cost of retrofitting) in using Honeywell Genetron Performax LT over R-404A and R-407A across a range of operating conditions.

| Emissions savings (life time)                       |       |
|---|-------|
| Direct emissions tons CO <sub>2</sub> eq.           | 1.930 |
| Indirect emissions tons CO <sub>2</sub> eq.         | 264   |
| Total reduction emissions; tons CO <sub>2</sub> eq. | 2.194 |

### Feedback: a win-win result for ASDA

“The benefits we are seeing are very much a combination of ASDA system optimisation and favourable properties of the refrigerant. I feel the most important aspect of this conversion to Performax will be its unparalleled efficiency and lower GWP versus R-404A, which will enable us to reduce both direct and indirect emissions. We have killed two birds with one stone; I am impressed by the energy improvement; this will bring us great opportunities when rolling-out this conversion also to LT packages and other stores”.



### Rolling out the benefits of Genetron Performax LT globally

The ASDA Field Test confirms the excellent performance and energy efficiency of Genetron Performax LT and the potential for significant energy savings and carbon footprint reductions among supermarket operators.

Genetron Performax LT outperforms alternative refrigerants across all ambient conditions – a benefit confirmed by subsequent retro-fit projects in the supermarket sector – creating potential for extended application into storage and packaging areas. The efficiency of the Honeywell refrigerant also provides potential for enhancing overall profitability – a true win-win situation when emissions reduction is factored in. Industry-indicative results confirm the ASDA experience, with Genetron Performax contributing up to 15% savings in energy bills, a 40% reduction in CO<sub>2</sub> emissions and 10% lower running costs.

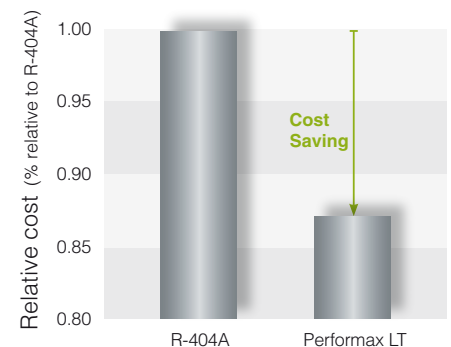
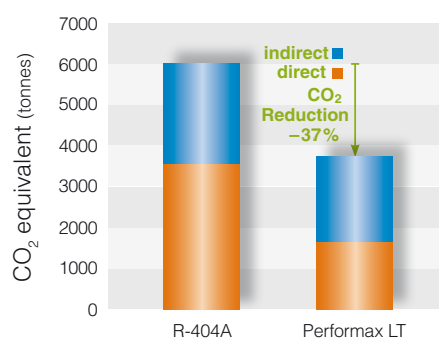
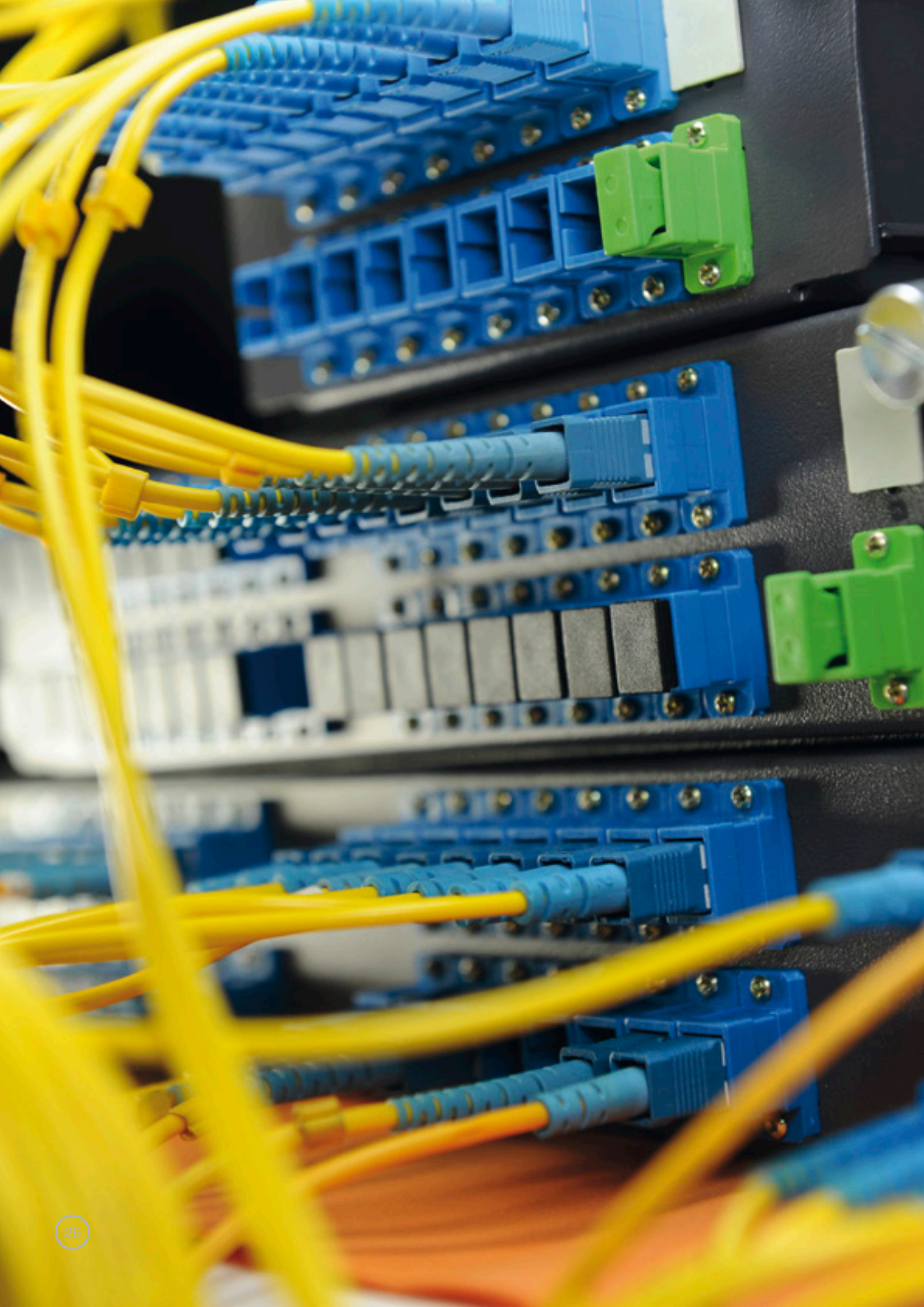


Figure 2: Carbon footprint (left) and relative operating costs (right).



# Ultra-high efficiency chillers.

Chiller technology is fundamental to the day-to-day operation of not only supermarkets but also hotels, coldstores, offices, hospitals and data centres – and it is an area that is increasingly the focus of innovation as organisations seek solutions to both energy and climate change challenges. It is this drive for change that has led Honeywell to respond by developing Solstice™ ze Refrigerant...

# Waitrose, via Geoclima Professional Air Conditioning

## Waitrose welcomes a world-first application with an HFO solution that shows great promise.

Solstice™ ze Refrigerant offers low GWP (Global Warming Potential) and enhanced energy efficiency. The technology was specified for the world's first HFO chiller trial when Geoclima units were installed by Klima-Therm in the Bromley store of leading UK supermarket chain Waitrose. At the same time, laboratory research confirmed the significant carbon footprint and energy efficiency advantages offered by Solstice ze Refrigerant.

It is anticipated that Solstice ze Refrigerant for chillers will become the energy-efficient alternative to traditional refrigerants.

- 20% lower energy consumption than propane
- Near drop-in solution for R-134a
- GWP of 6
- 100% non-ozone depleting
- Low toxicity and non-flammable at ambient temperature

### Background: a commitment to carbon reduction

Waitrose had made a public commitment to halve the impact of its refrigeration and cooling direct emissions (CO<sub>2</sub>eq. emissions tonnes) by 2012/13 (compared with its 2008/09 baseline), having reduced emissions by 18% in 2010/11, and by 20% since 2008/09. This is largely the result of fitting new refrigeration systems and establishing an extensive leak prevention programme. It is a position that has won the supermarket chain widespread approval and several cooling industry awards. In line with this overarching position, Waitrose agreed to participate in the world's first field trial of an HFO chiller, manufactured by Geoclima, in order to compare performance – and carbon footprint – with its current range of hydrocarbon units.

Geoclima is a major chiller manufacturer, based in Italy, offering customers around the world a wide range of refrigeration and air conditioning products and systems.

The Company is engaged in continuous research and development focused on exploiting technological advances to help customers meet key criteria linked to performance, energy efficiency and environmental impact. This commitment to innovation made the Company the ideal partner for the Waitrose field trial.

### Field and laboratory test: implementation and results

To ensure the validity of the test results, two identical refrigeration systems were compared – one using Solstice ze Refrigerant and the other, at the nearby Waitrose Canterbury store, using R-290 (propane).

The trial, run by refrigeration expert company, Klima-Therm comprised two air-cooled 180kW Geoclima machines using a combination of advanced adiabatic technology, liquid pump amplification, micro-channel condensers and a Frascold reciprocating compressor. HFO usage did not require any change in chiller or component design.

The field test results showed a 22% reduction in energy consumption for the Solstice ze Refrigerant system compared with the R-290 system.

The outcomes confirmed the findings of laboratory tests undertaken by Frascold, which compared the new HFO with R-134a. In this analysis, Solstice ze Refrigerant cut energy consumption by almost 27% and, despite some loss of capacity, the overall Coefficient of Performance (CoP) was better than R-134a across a range of applications and conditions. According to compressors experts, performance with HFOs could be further improved through system optimisation.



## Sector perspective

There are both environmental and financial benefits in adopting Solstice™ ze Refrigerant as a sustainable approach to chillers. It is an important enabler for energy efficiency gains of up to 27% compared with HFCs such as R-134a, contributing both to wider sustainability goals and financially-driven incentives, such as the UK Carbon Reduction Commitment.

Moreover, implementation of Solstice ze Refrigerant is cost-effective and fast because only minor system adaptation is required to achieve results similar to medium-pressure refrigerants like R-134a. In addition, Solstice ze Refrigerant provides a global solution as a result of its efficient cooling performance in all climate zones.

From an environmental perspective, Solstice ze Refrigerant has a GWP of 6, thereby contributing positively to eco-design directives by both reducing direct CO<sub>2</sub> emissions (by 99.6%) and improving indirect CO<sub>2</sub> emissions as a result of lower energy consumption. Solstice ze Refrigerant:

- Is 100% non-ozone depleting
- Benefits from low toxicity (ASHRAE class A)
- Is nonflammable at ambient temperature (ASHRAE class 2L).

It is significantly safer in use than alternatives such as hydrocarbons and ammonia, which are either extremely flammable or highly toxic.

Ongoing field tests are also delivering promising preliminary results in vending machines and plug-in units.

“The HFO solution shows great promise as it combines good efficiency with very low global warming potential. If the ongoing monitoring of energy continues to prove successful, we plan to include HFO-based chillers in our choice of refrigeration platforms for stores in the future.”

**Jim Burnett, Waitrose.**

### Feedback: a positive result for low carbon technology

“This HFO offers excellent performance, efficiency, serviceability and safety, but with a dramatically reduced carbon footprint that will permit its usage in the place of non-fluorinated refrigerants, while avoiding

flammability risks,” commented Paolo Ferraris, Managing Director, Geoclima.

Waitrose’s monitoring of energy use is still ongoing but, if test results are anything to go by, Solstice ze Refrigerant has already set a new precedent. To quote Roberto Mallozzi, Managing Director, Klima-Therm:

“The Waitrose trial system is operating very well, particularly when one remembers that it is not optimised for HFOs. The higher efficiency of HFOs, their low GWP and lower running costs make a compelling case for the future.”



### Waitrose world-first Solstice ze Refrigerant chillers in South London store land national award for Klima-Therm and Frascold

A world-first in refrigeration technology, which harnesses the latest generation low global warming Solstice ze Refrigerant in a working store in London, has won Klima-Therm and Frascold a national UK award.

The companies were presented with the prestigious Award for Refrigeration Product of the Year 2012 in the glittering finals of the ACR News Award.

The Italian-made Geoclima chillers are based on Frascold reciprocating compressors and were tested on the HFO refrigerant in Frascold’s research and development centre at Rescaldina, near Milan, before being supplied to chiller manufacturer Geoclima, and then onto Klima-Therm for installation and commissioning at Waitrose’ store in Bromley, south-east London.

The judges praised the companies’ bold, innovative and pioneering approach – which enabled them to beat larger, global manufacturers in the race to develop low Global Warming Potential (GWP) refrigeration systems, that are safe, efficient and operate at normal pressures. Roberto Mallozzi of Klima-Therm said: “On behalf of the project team, we are delighted to have won this award: It shows what can be achieved with a can-do approach, technical creativity and responsiveness to market needs.”





# High performance, energy efficient blowing agents.

## What is a blowing agent?

A blowing agent is a substance which is capable of producing a cellular structure via a foaming process in a variety of materials that undergo hardening or phase transition, such as polymers. Blowing agents are typically applied when the blown material is in a liquid stage. The cellular structure in a matrix reduces density, increasing thermal and acoustic



insulation, while increasing relative stiffness of the original polymer until it reaches a desired state.

As such, a blowing agent plays an intrinsic role during the processing stage and is the key component that determines the insulation capacity, but once the polymer has been formed its role is virtually redundant. The blowing agent – and therefore the gas in the foam – only really needs consideration again when it is time to recycle or dispose of the foam item it helped to create.

Blowing agents are used to make a vast selection of foams used in a broad range of end products – from insulated panels used in construction, to vehicle components, office chairs, furniture, training shoes and packaging...the list is endless.

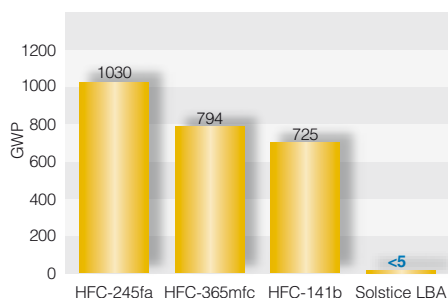
## Over seventy years of technical expertise

The first blowing agents were invented in the 1940s, and Honeywell has been at the forefront of every major improvement in blowing agent technology since then. Honeywell's Solstice™ HFO blowing agents provide an environmentally superior and energy efficient solution for the construction industry, and propellants for aerosols. The Honeywell HFOs offer similar performance properties as its predecessors, but offer global warming potential that is significantly below the limit set by the EU – lowering an organisation's carbon footprint while maximising the end-product performance.



## What does a blowing agent do to foam?

Polyurethane foam is primarily used as a cost-effective and highly energy-efficient insulation for appliances and homes, as well as for commercial roofing systems. Blowing agents allow foam to expand and provide many of the foam's key performance characteristics, including its high R-value, which is the measure of insulating capability. Fluorinated blowing agents provide the highest degree of thermal insulation for polyurethane foams.



## The sums add up...

When substituted for HCFC-141b, HFC-245fa and HFC-365mfc, the use of Solstice Liquid Blowing Agent can yield substantial improvements in the environmental impact of foam blowing agents right away. With a global warming potential (GWP) of less than 5, its worldwide use could save about 60 million metric tonnes per year of CO<sub>2</sub> equivalent, comparable to eliminating carbon dioxide emissions from more than 11.8 million cars every year.



# The latest technical advances with ultra low GWP.

## Solstice™ Liquid Blowing Agent

Honeywell Solstice Liquid Blowing Agent excels in the four dimensions that are most important to blowing agent users: energy efficiency performance, environmental impact, safety in use, and cost-effectiveness. It has an extremely short atmospheric lifetime of approximately 26 days. It has an ultra-low global warming potential (GWP) of less than 5 and has no impact on ozone layer depletion. And because Solstice liquid blowing agent is non-flammable, it does not require expensive explosion-proof equipment and handling, unlike hydrocarbon alternatives. It is also a near drop-in replacement for today's most commonly used blowing agents.

## Solstice™ Gas Blowing Agent

Honeywell Solstice Gas Blowing Agent has been developed for extruded polystyrene, and pressurized one- and two-component PUR foams. It is a replacement for HFC-134a, HFC-152a, HCFC 142b and other fluorocarbon and non-fluorocarbon blowing agents. Solstice Gas Blowing Agent is non-flammable having a boiling point of

-19 °C. It has a very low GWP of less than 6, a low MIR, low POCP and low contribution to ground level smog formation.

Solstice Gas Blowing Agent allows extrusion of thick, dimensionally stable foam and is a near drop-in replacement for many extrusion processes currently using fluorocarbon and non-fluorocarbon blowing agents.

## Other applications for blowing agents

Honeywell is a recognised innovator in high-performance blowing agent technology for closed-cell foam insulation and advanced energy-efficiency refrigerants for heating, ventilation and air conditioning, as well as other heat transfer fluid applications. Honeywell has consistently helped manufacturers replace ozone-depleting and global warming substances, improving the energy efficiency of systems and has ongoing research and development efforts to develop environmentally superior solutions for customers around the world.

## Did you know...?

... Spray-applied foam insulation (regardless of which blowing agent technology is used) can make homes 20-40% more energy-efficient than those using traditional insulation materials such as fibreglass or mineral wool...

...and that Honeywell Solstice Liquid Blowing Agent has been demonstrated to increase the thermal insulation value of highly energy efficient spray-applied insulation foams by an additional 5%.

## VOCs...

The measure that characterizes whether a chemical is a VOC is the Maximum Incremental Reactivity (MIR). This measure (MIR) at which chemicals are generally considered to be a VOC, by US regulation, is that of ethane. The MIR of both Solstice™ Propellant and Solstice Blowing Agent has been measured at less than the value for ethane, hence are classified as VOC-exempt in the U.S. The European Union uses a somewhat different measure to characterize propensity for ground level ozone formation – photochemical ozone creation potential (POCP) which is reported, and compared to ethane, which has a POCP of 12.3. Solstice Propellant and Solstice Blowing Agent both have measured POCP of 6.4, well below that of ethane, so they can be considered Low Impact VOCs.

|                |   | HFC 152a | CO <sub>2</sub> | HFC 134a | Solstice Blowing Agents |
|----------------|---|----------|-----------------|----------|-------------------------|
| Performance    | Energy Efficiency                           | ●        | ●               | ●        | ●                       |
|                | Ability to extrude thick panels             | ●        | ●               | ●        | ●                       |
| Cost effective | Adoption Cost/Ease                          | ●        | ●               | ●        | ●                       |
|                | Lower Cost/Unit                             | ●        | ●               | ●        | ●                       |
| Environment    | Global Warming Impact (direct and indirect) | ●        | ●               | ●        | ●                       |
|                | Volatile Organics                           | ●        | ●               | ●        | ●                       |
| Safety         | Flammability                                | ●        | ●               | ●        | ●                       |
|                | Toxicity                                    | ●        | ●               | ●        | ●                       |



# High performance solvents and propellants.

Propellants for aerosols have many technical applications – from the dispersion of consumer products such as deodorants and medical treatment of respiratory illnesses, to high performance cleaning solvents for the aviation sector and air blowers and freezing sprays for the electronics industry. Honeywell is a long-time supplier of non-ozone-depleting propellants and solvents to the aerosol industry, particularly for industrial aerosol formulations where nonflammability is desirable or essential.

# Super-critical cleaning with a clean conscience.

The super-critical cleaning of precision metal and plastic parts covers a broad range of industries – from aerospace and electronics to pharmaceutical and medical applications. But while cleaning solvents are effective at removing grease and residues from a wide range of substrates, potentially they also carry a number of hazards, ranging from threat of fire or explosion to environmental problems if not handled properly.

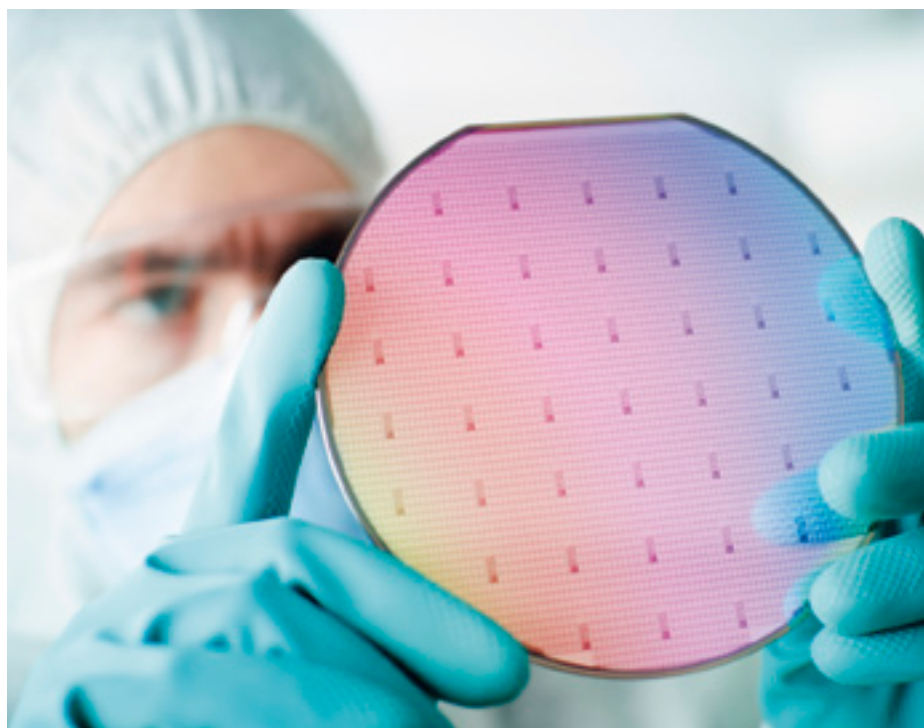
Excellent cleaning performance; safety in use; ultra-low carbon dioxide emissions; ultra low surface tension; and cost effectiveness are the most important demands of specialist cleaners and solvent users worldwide.

## How does Solstice™ Performance Fluid meet these demands?

Honeywell's Solstice Performance Fluid offers superior performance with significantly lower global warming impact, exhibiting superior solvency for a wide variety of solutes including hydrocarbon oils, silicone oils, silicone greases, acrylics, fluorinated oils, mineral oils, solder fluxes and hydraulic fluids.

It is compatible with many commonly used plastics and elastomers, and metals such as stainless steel, aluminum, cold rolled steel, copper, galvanized steel and tinplate. Because Solstice Performance Fluid is non-flammable, it does not require expensive explosion-proof equipment and handling, unlike certain other solvents.

It is also more cost-effective compared to other currently available cleaning solutions because of its reduced solvent loss, reduced energy requirement for processing and drying, its lack of post-process non-volatile residue and its potential as a drop-in alternative in aerosol cleaners.



## Propellants that are low on impact and high on performance

Honeywell Solstice™ Propellant is a promising replacement for liquefied gas propellants currently in use, with the potential to make significant reductions in greenhouse gas emissions and ground level ozone creation.

When substituted for R-134a in aerosol products, the use of Solstice Propellant can substantially reduce greenhouse gas emissions. With a global warming potential (GWP) of less than 6, its widespread use could save more than 14 million tonnes per year of CO<sub>2</sub> equivalent emissions, comparable to eliminating carbon dioxide emissions from more than 2.5 million cars every year.\*

Solstice Propellant also has very low photochemical reactivity and does not contribute in any significant way to tropospheric ozone generation, one of the components of photochemical smog.

Overall, Solstice Propellant provides the best solution from an environmental standpoint.



# Low environmental impact, high performance.

“Environmental responsibility is at the core of the HK Wentworth way of working and so when the opportunity came to utilize a low-global-warming-potential propellant in some of our key products, we quickly recognized the benefit this would create for our customers...without any compromise in performance,” said Jade Bridges, European Technical Support Specialist, HK Wentworth Ltd.



The HK Wentworth Group of companies develops and manufactures innovative electro-chemicals and cleaning products for use across a wide range of industry sectors.

Among the most popular products are air-dusters and freezer sprays sold through the Electrolube and AF International brands.

Air-dusters are used in a variety of applications to remove dust and debris

from hard to reach places, often in electronic assemblies and devices such as computers. Freezer sprays are used within the electronics industry for fault finding; helping to identify and to cool overheating electrical components.

In both cases it is vital that the products supplied for these purposes are non-flammable, because they are often used when equipment is switched on and ‘live’.

HK Wentworth technicians had been seeking a replacement for the HFC-134a propellant used in these product ranges, because while it provided excellent non-flammable performance, it also exhibited high Global Warming Potential (GWP).

“We looked at hydrocarbon alternatives, but these were flammable and therefore posed a high risk to health and safety in the working environment,” says Jade Bridges. “So when Honeywell introduced us to Solstice Propellant, with its very low GWP, zero ODP and non-flammable qualities, it provided a viable alternative.”

Electrolube's FREH Freezer refrigerant and its EADH Air Duster now benefit from Solstice Propellant – offering the electronics industry the benefits of low environmental impact combined with high performance. Likewise, Solstice Propellant is now present in the AF International SDUH range of air-dusters, which are widely used to clean computers, keyboards, printers, timing devices, cash machines, fax machines, photocopiers, audio/video equipment,

“Moreover, the ability to reduce equivalent CO<sub>2</sub> emissions by more than 99.5% over the predecessor technology also meant [Solstice Propellant] was a perfect fit for our environmental policy.”

**Jade Bridges, HK Wentworth.**

photo equipment, VCRs, CDs and delicate lab equipment.

## Opening up global markets

The ability to harness the benefits of Solstice Propellant means that both Electrolube and AF International can now extend their marketing activities into territories where the use of HFC-134a was not authorized.

“Not only does this present us with new growth opportunities for our products, it also underlines our commitment to protecting the environment, which is such an important part of the whole business ethos within the Group,” says Jade Bridges.

## Solstice Aerosol Propellant tested successfully for onboard insecticide

“In an airplane, safety is a paramount. Using flammable substances on board or when cleaning the interior or exterior of the plane can be tricky. Therefore we conducted thorough tests to explore how to replace currently used HFCs. Our trials proved Honeywell Solstice Propellant behaves similarly to R-134a, yet offers a unique combination of non-flammability and low global warming potential of only 6, which is 99,6% lower.”

**Joel Rivet**  
General Manager of Produits Sanitaires Aeronefs





# Investing now... investing for the future.

The safety and performance of Honeywell's HFO products, along with their favourable environmental properties, promise to improve the 'green' performance of air-conditioning, refrigeration and propellant systems, as well as solvent and blowing agent applications, over the long term. In developing countries in particular, who now are having to play catch-up and have only just begun an accelerated phase-out of HCFCs, Honeywell's HFO products offer an opportunity to use low GWP products now. This is thanks in part to the early proactive efforts of Honeywell in bringing innovative products to the market that, through extensive testing and installation, have now proven themselves in regards to the environmental, safety, performance and cost-effective aspects. But while Honeywell's HFO products are recognised globally as a step-change improvement as they offer many of the key properties of existing HFCs, but with very low GWPs, they are not expected to be the only technology considered for the future. Honeywell is convinced: innovation is the best path to finding solutions for the environmental challenges that lie ahead.

Honeywell International is a global diversified technology and manufacturing leader, serving customers worldwide with aerospace products and services; control technologies for buildings, homes and industry; automotive products; turbochargers; and specialty materials.



**RESPONSIBLE CARE®**  
OUR COMMITMENT TO SUSTAINABILITY

#### RESPONSIBLE CARE

Honeywell Performance Materials and Technologies, as a member of the American Chemistry Council, has adopted Responsible Care® as the foundation of health, safety, and environmental (HS&E) excellence in our business. Responsible Care is the chemical industry's global voluntary initiative under which companies, through their national associations, work together to continuously improve their health, safety and environmental performance, and to communicate with stakeholders about their products and processes.

#### 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

#### Honeywell Fluorine Products Europe B.V.

Laarderhoogweg 18  
NL-1101 EA Amsterdam  
Netherlands

#### Honeywell Belgium N.V.

Haasrode Research Park  
Grauwmeer 1  
3001 Heverlee, Belgium  
Tel: +32 16 391 211  
Fax: +32 16 391 371

#### Honeywell Refrigerants

101 Columbia Road  
Morristown, NJ 07962-1053  
Tel: 1-800-631-8138  
www.1234facts.com  
www.honeywell-refrigerants.com

#### SOURCES

<http://www.honeywellrefrigerants.com>  
<http://www.honeywell-solstice-propellants.com/>  
<http://www.honeywell-solsticeba.com/>  
<http://www51.honeywell.com/sm/chemicals/refrigerants/eu/en/news-n2/f-gas-regulation-review.html>  
<http://www.honeywell-solsticeba.com/wp-content/uploads/2011/09/low-GWP-blowing-agent-Honeywell-next-generation-paper-2011.pdf>  
<http://www51.honeywell.com/sm/chemicals/refrigerants/eu/en/products-n2/refrigeration.html>  
[http://www51.honeywell.com/sm/genesolv/newsevents-sub/newsreleases-details/10\\_20\\_11\\_](http://www51.honeywell.com/sm/genesolv/newsevents-sub/newsreleases-details/10_20_11_)  
[www.polymerlibrary.com](http://www.polymerlibrary.com)  
<http://www.nndb.com/company/569/000122203/>  
[http://epp.eurostat.ec.europa.eu/statistics\\_explained/index.php/Glossary:Global-warming\\_potential\\_%28GWP%29](http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Glossary:Global-warming_potential_%28GWP%29)

#### TRADEMARKS

Honeywell Solstice™ yf Refrigerant  
Honeywell Solstice™ ze Refrigerant  
Honeywell Solstice™ Liquid Blowing Agent  
Honeywell Solstice™ Gas Blowing Agent  
Honeywell Solstice™ Performance Fluid  
Honeywell Solstice™ Propellant  
Honeywell Genetron® Performax™ LT

Notice: All statements, information and data given herein are believed to be accurate and reliable, but are presented without guaranty, warranty or responsibility of any kind, expressed or implied. Statements or suggestions concerning our products are made without representation or warranty that any such use is free of patent infringement and are not recommendations to infringe any patent. The use should not assume that all safety measures are indicated, or that other measures may not be required.

**Honeywell**