

American  
Industrial Hygiene  
Association has now  
established for 3M™ TFFE-7100  
a recommended  
exposure guideline of  
**750 ppm**  
for an 8-hour average worker  
exposure per day.

# Still looking for a fluid you can live with?



**3M** *Innovation*

# Try the solvent that's replacing the replacements.

For many, the search for a viable long-term alternative to ozone depleting solvents has been filled with frustration. Finding an acceptable replacement with good cleaning and environmental properties that is also non-flammable and low in toxicity has proven exceedingly difficult. Until now.

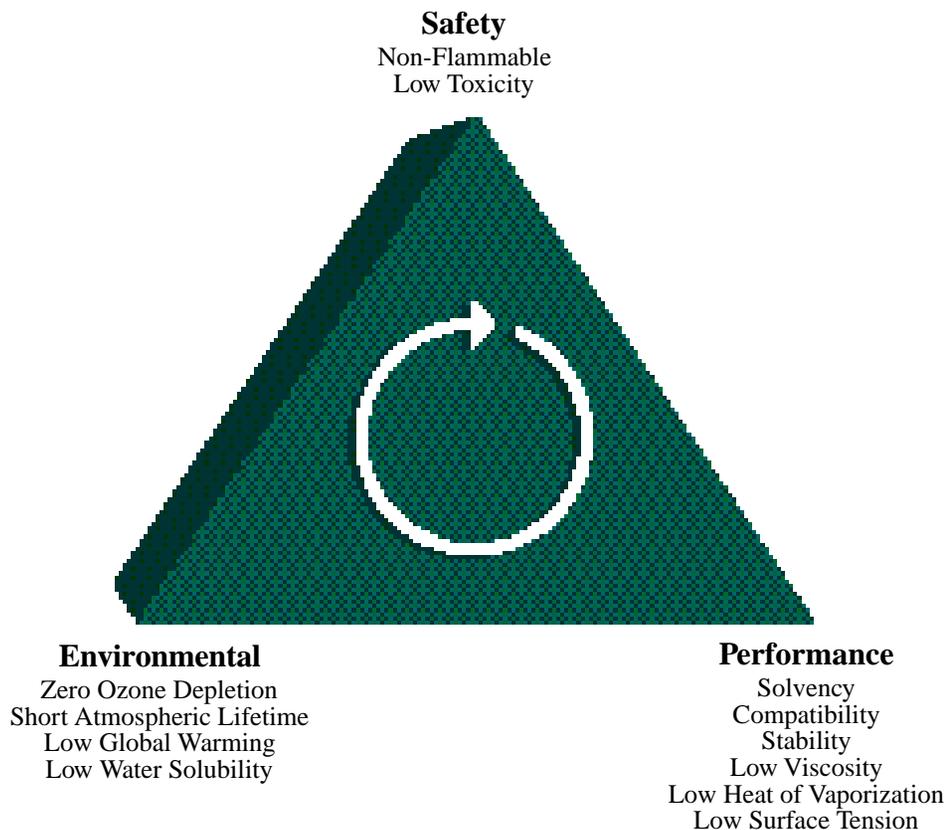
## A Favorable Balance Of Properties.

New 3M™ HFEs (Hydrofluoroethers) represent an important breakthrough in the search for effective replacement solvents. These fluids offer an unmatched balance of cleaning, environmental and safety properties. They are manufactured and supported by one of the leading suppliers of ODS-replacement compounds for worry-free precision cleaning. 3M HFEs are characterized by good cleaning performance, zero ozone depletion potential, low global warming potential and low toxicity.

The favorable balance of 3M HFE properties is due largely to the unique structure of the 3M HFE molecules. The presence of the ether oxygen in the chemical makeup of this compound, combined with the effect of segregating the hydrogens and fluorines around that oxygen, results in an ideal combination of properties.

3M HFEs are non-ozone depleting, are not precursors to photochemical smog—in their neat or unblended state—and have short atmospheric lifetimes. They are non-flammable, and this property does not change with use. They are economical and effective drop-in replacements for CFC and HCFC solvents for a broad spectrum of applications.

The hydrofluoroether molecules are thermally and hydrolytically stable, allowing them to be refluxed continuously in a cleaning system without degradation, and 3M HFEs have improved hydrocarbon solvency over earlier highly fluorinated solvents such as perfluorocarbons (PFCs) and some hydrofluorocarbons (HFCs).



### Electronics Firm Adopts Co-Solvent Cleaning.

A producer of high performance electronic systems has adopted 3M HFE co-solvent cleaning to satisfy a critical cleaning challenge—removal of RMA flux residues from multi-layer ceramic circuit cards (CCAs). These devices are populated with leadless chip carriers having a typical board-to-device clearance of 0.006" to 0.008". Close spacing traps flux residues that must be removed before coating.

In the past, these boards were cleaned using 1,1,1 trichloroethane vapor degreasing, an ozone depleting process. The supplier now uses 3M HFE co-solvent cleaning with excellent results. Ionograph and chromatograph tests on tested boards confirm that the co-solvent cleaning process meets standards required for these ultra-reliable components.

### The Performance Standard.

3M™ HFE-7100 and 3M HFE-7200 solvent families cover a broad range of cleaning processes to make them effective for cleaning a wide variety of soils. 3M HFEs also demonstrate compatibility with a wide range of metals, plastics and elastomers. The total applied cost of precision cleaning using 3M HFEs can be less than CFC-113 or HCFC-141b, in large part because of dramatically reduced emissive losses. The inherent properties of 3M HFEs result in significantly lower usage rates when compared to traditional solvents, which improves both environmental and economic performance.

Cleaning processes using 3M HFEs can take advantage of the traditional benefits of vapor degreasing, including cleaning, rinsing and drying in one operation—in many cases using existing equipment. These 3M solvents are also very useful for wipe cleaning, flushing and aerosol cleaning applications.

Property	3M™ HFE-7100 <sup>1</sup>	3M™ HFE-7200 <sup>2</sup>	CFC-113 <sup>3</sup>	Vertrel® XF <sup>4</sup>	AK-225 <sup>5</sup>
Boiling Point	61	78	48	55	54
Vapor Pressure mm Hg@25°C	202	109	334	226	285
Liquid Density g/ml@25°C	1.52	1.43	1.56	1.58	1.55
Surface Tension dynes/cm@25°C	14	14	17	14.1	16.2
Heat of Vaporization cal/g@B.P.	30	30	35	31	35
Specific Heat cal/(g°C)@25°C	0.28	0.29	0.22	0.27	0.25
Solubility for Water ppm	95	92	110	490	215
Solubility in Water ppm	12	<20	170	140	330
Freezing Point °C	-135	<-135	<-31	-80	-131
Viscosity cps@25°C	0.6	0.6	0.7	0.67	0.59
Kauri-Butanol Value	10	10	32	9	31

<sup>1</sup>C<sub>4</sub>F<sub>9</sub>OCH<sub>3</sub> <sup>2</sup>C<sub>4</sub>F<sub>9</sub>OC<sub>2</sub>H<sub>5</sub> <sup>3</sup>C<sub>2</sub>F<sub>3</sub>Cl<sub>3</sub> <sup>4</sup>C<sub>5</sub>H<sub>2</sub>F<sub>10</sub> <sup>5</sup>C<sub>3</sub>F<sub>5</sub>HCl<sub>2</sub>

### 3M™ HFE Cleaning Options.

The solvent properties of new 3M HFEs make them suitable for a range of precision cleaning applications. They can be used in traditional vapor degreasing systems with various cleaning processes to remove a wide variety of soils, from light oils and particulate matter, to greases, waxes, flux residues and heavy oils.

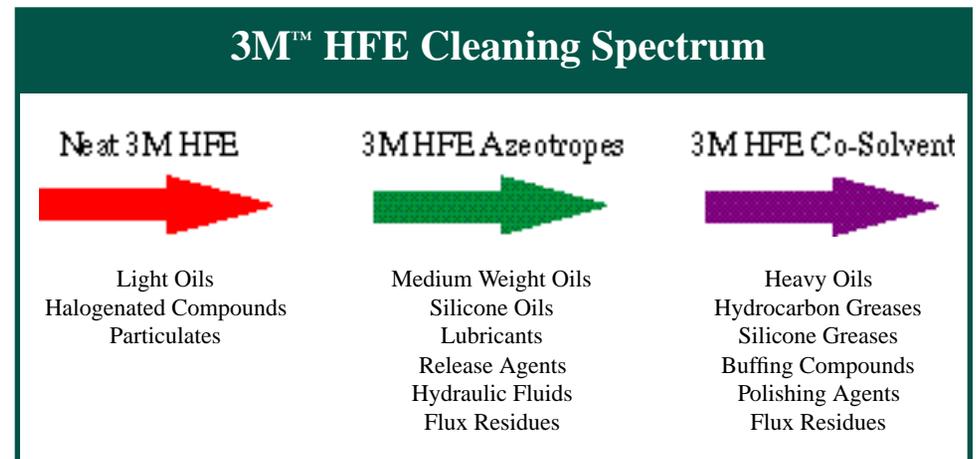
**Neat 3M HFE.** Pure 3M HFE solvent can be used to remove light hydrocarbon and silicone oils. As highly fluorinated compounds, 3M HFEs are ideally suited for cleaning halogenated oils and greases. With their high density and good wetting characteristics, these solvents function effectively in removal of particulate from final assemblies. Pure 3M HFEs alone can remove a number of lighter oils as effectively as CFC-113.

**3M HFE Azeotrope Cleaning.** Medium weight soils can be removed using an azeotropic mixture of a 3M HFE and an organic solvent. These mixtures have much higher solvency than pure 3M HFE-7100, and are useful on soils ranging from hydrocarbon and silicone oils to greases and even flux residues and low melting point waxes. 3M HFE azeotropes have desirable physical properties for precision cleaning applications, with fairly high density, low viscosity and surface tension values, and acceptable environmental properties. They are also low in toxicity and have zero ozone depletion potential.

**3M HFE Co-Solvent Cleaning.** Removal of the most challenging soils, such as heavy oils and greases, waxes, polishing agents, buffing compounds and flux, can be accomplished with the 3M HFE co-solvent process.

This cleaning process combines two fluids: a low volatility organic solvent that dissolves soils from part surfaces; and 3M HFE-7100, which functions as an effective rinsing agent to flush solvating agent and soils from part surfaces. A variety of low volatility, high solvency organic solvents are available for use in a co-solvent process, with the optimum choice depending on the application. Co-solvent cleaning is simple to use, and has the same non-VOC and zero ODP benefits as neat 3M HFEs processes.

3M has several formulators that utilize 3M HFEs and business associates that participate in application development and effective use of 3M HFEs, including equipment issues, co-solvent options and process testing.



# Upon closer scrutiny, the benefits of cheap cleaning fluids vaporize.



Comparing fluids simply on a cost per pound basis can be deceiving. Although 3M™ HFEs are priced higher than many other solvents, they may cost no more to use in your cleaning operation. That's because other fluids have hidden costs that can easily drive up your operating expense. When you factor in reduced emissive and drag-out losses, energy savings and more, you may cover that 3M HFEs offer the best cleaning for your dollar.

**Emissive Losses.**

The evaporative loss of 3M™ HFE solvents in a cleaning system is measurably lower than most other solvents for two important reasons: higher molecular weight; and relatively low vapor pressure. As a consequence, diffusive loss of 3M HFEs is a substantially less than traditional CFCs or many replacement solvents in a given system.

**Drag-out Losses.**

The low surface tension, low viscosity, high density and low heat of vaporization of 3M HFEs results in reduced drag-out losses compared to other solvents. Alternate solvents tend to cling to complex surfaces after cleaning and rinsing due to surface tension forces, and are drawn out of the cleaning system before they can drip off or evaporate. 3M HFEs drip away quickly, and the net result is reduced solvent consumption and lower fluid replacement costs over time compared to solvents with less favorable physical properties.

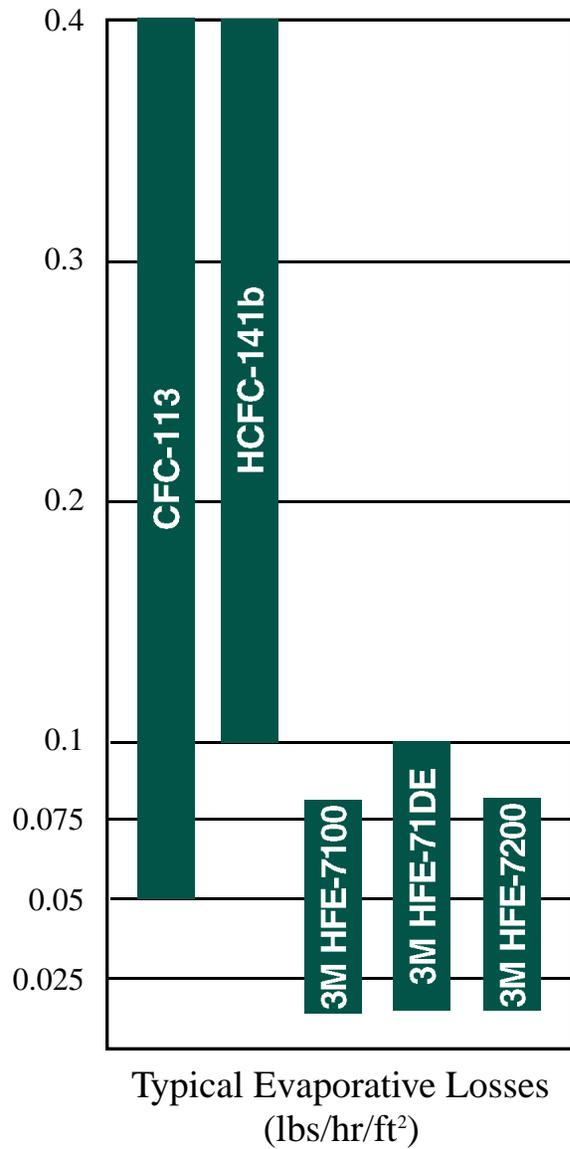
**Cardiac Control Systems Cleans Medical Components.**

A 3M HFE vapor degreasing process has been adopted by Cardiac Control Systems, Inc., a medical device manufacturer, to replace traditional CFC solvent cleaning. This process uses 3M HFE-7100 to remove light fingerprints and soils from component parts and packaging material.

This Palm Coast, Florida, company finds that the cost of cleaning with the single-fluid 3M HFE process is comparable to their earlier ODS process, and performance is as good or better. Parts cleaned in the new system are free of contaminants and residue, and meet stringent medical device manufacturing requirements for cardiac pacing system components. Maintenance of Cardiac Control Systems' new 3M HFE cleaning process is minimal, and fluid disposal is no longer an issue.

Property	3M™ HFE-7100	3M™ HFE-7200	CFC-113	1,1,1 TCA	HCFC-141b	HCFC-123	n-Propyl Bromide
Liquid Density <sup>1</sup> @25°C	1.52	1.43	1.56	1.30	1.23	1.46	1.35
Viscosity <sup>2</sup> @25°C	0.6	0.6	0.7	0.77	0.43	0.45	0.49
Surface Tension <sup>3</sup> @25°C	14	14	17	25.1	19.3	16.0	25.9
Heat of Vaporization <sup>4</sup> @B.P.	30	30	35	58	53.3	41.6	58.8
Specific Heat <sup>5</sup> @25°C	0.28	0.29	0.22	0.25	0.30	0.26	0.27

<sup>1</sup>g/ml <sup>2</sup>cps <sup>3</sup>dynes/cm <sup>4</sup>cal/g <sup>5</sup>cal/g/°C



Drag-out solvent losses in a cleaning system are substantially less with 3M™ HFEs because of low surface tension, low viscosity, high density and low heat of vaporization compared to other fluids. This chart shows typical ranges of emissive losses in pounds per hour per square foot of cleaning system surface area for various solvents. Because of their physical properties, 3M HFEs have dramatically lower loss rates than other solvents.

#### Precision Aircraft Bearings Cleaned in Co-Solvent Process.

The Aurora Bearing Company, a producer of precision rod end and spherical bearings, has adopted 3M HFE co-solvent cleaning for bearings, which must be absolutely free of the oils, greases, particulate material and metal fines deposited during the manufacturing process.

The 3M HFE co-solvent process replaced aqueous cleaning, which presented rust and additive residue problems. Co-solvent cleaning uses an organic solvating agent with low volatility and high solvency to lift soils from part surfaces. 3M HFE-7100 fluid functions as a rinsing agent to effectively remove the solvating agent along with suspended soils.

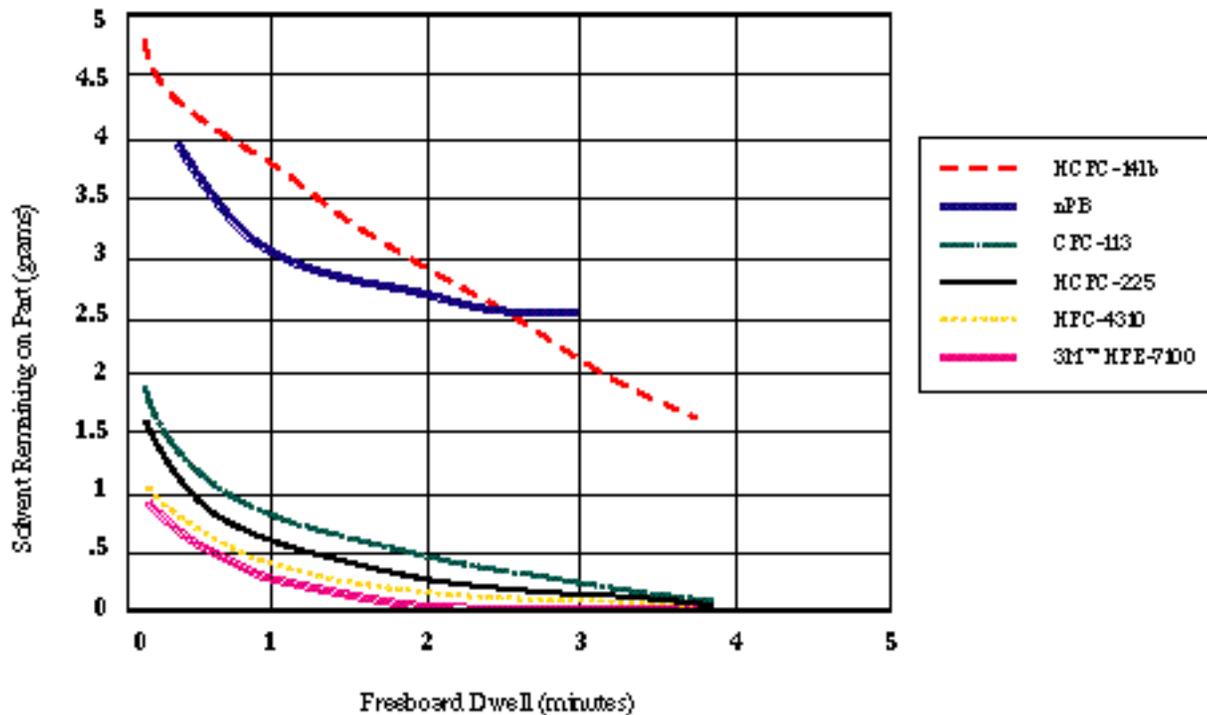
Aurora Bearing finds that the non-ODS 3M HFE rinse agent drains effectively from mechanically complex bearings. Its very low heat of vaporization aids in rapid drying, and minimizes liquid drag-out for minimal overall fluid consumption.

### Other Cost Benefits.

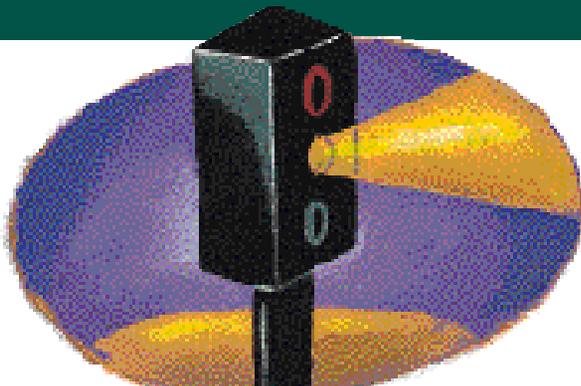
3M™ HFEs can provide cost savings in a number of areas. Due to their low heat of vaporization, these fluids reduce the electrical costs associated with boiling the liquid. From an environmental perspective, there is no need for special abatement systems. 3M's nationwide Used Fluid Return Program can help to reduce disposal costs.\* Additionally, thanks to their positive environmental profile, 3M HFEs can reduce costs associated with regulatory record keeping and reporting requirements when compared to other ODS replacement options.

\*Program includes minimum return volume requirements. Contact your 3M representative or authorized 3M Specialty Fluids distributor for details.

## Drag-out Characteristics of Various Solvents: Simulation for Highly Complex Parts



# Regulations may change, but your precision cleaning operation doesn't have to.



While it's difficult to forecast the exact nature of future legislation, it's a good bet that it will continue to evolve in favor of environmental stewardship. 3M™ HFEs are well positioned meet regulations today and into the foreseeable future. The fluids were designed to address the very issues that drove regulations in the first place. They offer advantages over many aqueous and solvent-based cleaners, including zero ODP, low GWP, an extremely small waste stream and no U.S. EPA SNAP restrictions.

**3M™ HFE International Regulatory Status.**

3M HFEs have been accepted for commercial use by regulatory agencies in the United States, Japan, Europe (under the European List Inventory of Notified New Chemical Substances), Australia and Korea. 3M HFE-7100 and 3M HFE-7200 are not regulated by Germany’s 2.BImSchV. They have been accepted for limited commercial use in the Philippines through an import license to 3M for up to 1,000 kg/year for each isomer. Use in Canada requires reporting of some usage data.

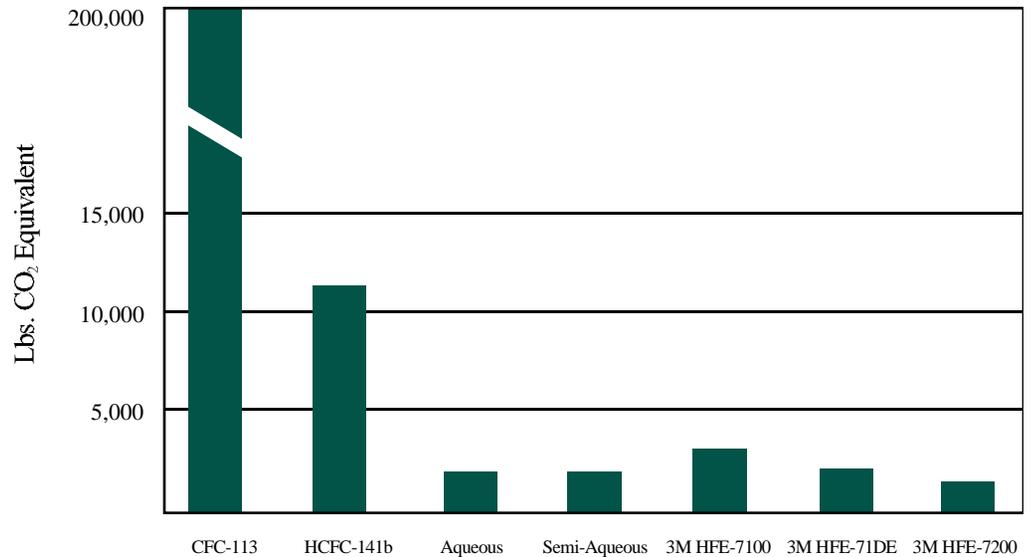
3M HFEs are included in the Significant New Alternatives Policy (SNAP) program of the U.S. Environmental Protection Agency (EPA). SNAP lists 3M HFE-7100 and its azeotropes, 3M HFE-71DE and 3M HFE-71DA, as “acceptable without restrictions” for use in precision cleaning, electronics cleaning, metal cleaning and aerosol solvent applications. In addition, 3M HFE-7100 and 3M HFE-7200 have been excluded by the U.S. EPA from the definition of a VOC on the basis that this compound has negligible contribution to tropospheric ozone formation. (Federal Register, August 25, 1997.)

**Total Equivalent Warming Impact.**

A methodology developed by the U.S. Department of Energy (DOE) and the Alternative Fluorocarbons Environmental Acceptability Study (AFEAS) is useful in comparing the climate change impact of various industrial cleaning solvents. This method strives to account for all environmental aspects of a cleaning process, including global warming by both direct contribution from the solvent and indirect contributions from energy usage, described as the Total Equivalent Warming Impact (TEWI).

TEWI is expressed in terms of the mass of CO<sub>2</sub> to which a cleaning process is equivalent. Testing shows a dramatic improvement for 3M HFEs over CFC and HCFC solvents. TEWI values for 3M HFE solvents compare favorably with aqueous and semi-aqueous cleaning processes.

**Total Equivalent Warming Impact (TEWI)**  
(Based on One Pound of Soil Removal)



Compared to other fluids, 3M™ HFEs have zero ozone depletion potential. They have short atmospheric lifetimes and consequently, low global warming potentials.

	Ozone Depletion Potential <sup>1</sup> -ODP	Global Warming Potential <sup>2</sup> -GWP	Atmospheric Lifetime-ALT (yrs)
3M HFE-7100	0.00	480	4.1
3M HFE-7200	0.00	90.0	0.8
CFC-113	0.80	5000	85
HCFC-141b	0.10	630	9.4
HCFC-225 ca/cb	0.03	170/530	2.5/6.6
HFC-4310mee	0.00	1300	17.1
nPB	0.026	0.31	0.03

NOTE: HCFC-225 ca/cb ratio is 45/55

Data compiled from published information

<sup>1</sup>CFC-11 = 1.0

<sup>2</sup>GWP-100 year Integration Time Horizon (ITH)

# How does your solvent behave outside of the tank?



As long as they're carefully contained, most cleaning solvents present little threat to worker safety. But what happens in the event of a leak or spill? To avoid the danger of exposing your co-workers to potentially toxic fumes from solvents, consider the advantages of working with 3M™ HFEs. These innovative cleaning solvents are nonflammable and low in toxicity. So they're safer to work with—whether inside your cleaning system or out.

**Safe When Things Are Going Well, And Even When They're Not.**

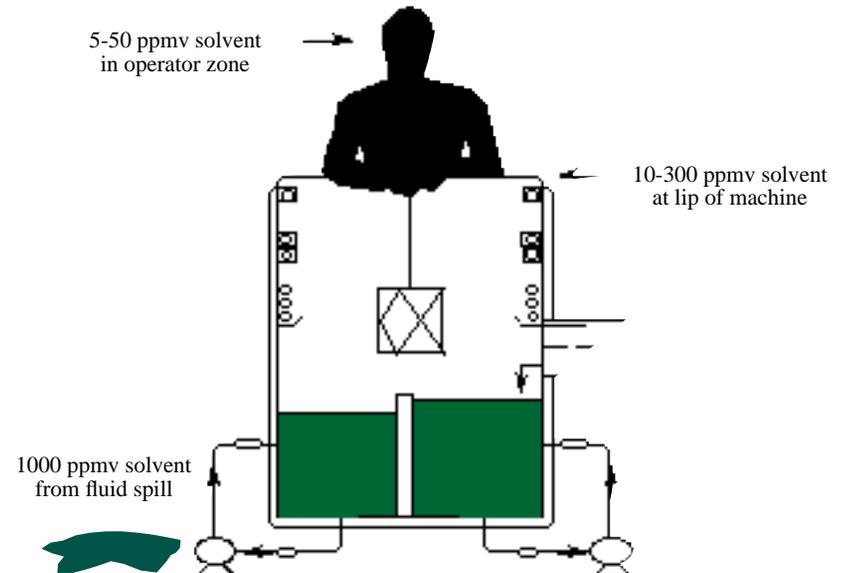
Under normal conditions, workers are exposed to a small amount of cleaning solvents during their shift. Studies have shown that typical solvent concentrations in the operator breathing zone around properly functioning vapor degreasers are in the range of 5 to 50 ppm. The advantage of using 3M™ HFEs is that their acceptable exposure limits are many times higher. Based on extensive toxicity testing, the 8 hour worker exposure guidelines for 3M HFE-7100 and 3M HFE-7200 are 750 ppm and 200 ppm, respectively. Other solvents with lower exposure limits do not offer nearly this same margin of safety.

In any manufacturing environment, the risk exists of exposing workers to much higher levels of solvent. In the event of spills, leaks or equipment maintenance, exposure to highly concentrated fumes for short periods of time can occur. Workers can face concentrations greater than 1000 ppm when cleaning up a one-gallon spill. During these short term situations, fluids with the lowest acute toxicity pose the least threat. As shown in the table below, 3M HFEs have the lowest acute toxicity (highest acute lethal concentration) of any of the alternative solvents.

**Other Safety Benefits.**

Extensive toxicity testing has been conducted on 3M HFEs. They are not irritating to the skin or eyes, and have tested negative in all mutagenicity screens. In addition, 3M offers technical assistance to help you in determining that your application is within recommended guidelines. Like CFCs and most other fluorochemicals, 3M HFEs and the azeotropes are non-flammable – even when subjected to direct flame or electrical arcs.

**Typical Worker Exposure Levels From Cleaning Systems**



Safety/Toxicity	CFC-113	HCFC-141b	HFC-4310	nPB	HCFC-225ca/cb	3M™ HFE-7100	3M™ HFE-7200
Exposure Guidelines (8 hr time-weighted avg.)	1,000 ppm	500 ppm	200 ppm	Pending	50 ppm	750 ppm	200 ppm
Acute lethal 4 hr LC50 Concentration (ppm)	55,000	62,000	11,100	NA <sup>1</sup>	37,000	>100,000	>50,000
Exposure Ceiling	None	None	400	Not Deter.	None	None	None

<sup>1</sup> Not Available.

# Ever seen a SWAT team with pocket protectors?



When you need help with precision cleaning, we've got just the team for the job. Our lab personnel, technical service and sales people are ready to show you just how easily 3M™ HFEs can become part of your operation. To get you started, our team will work with you to provide conversion support and process optimization. So you'll have all the help you need.

# Getting started is easy.

We'll make it easy for you to decide whether 3M™ HFEs offer the performance you've been looking for. Just choose from one of the three evaluation methods below, and complete and return this card. Or call 1-888-427-4666. We'll respond promptly, and get to work on your cleaning requirements. Be sure to visit us at [www.3m.com/fluids](http://www.3m.com/fluids) for the latest information.

## Unparalleled Support.

3M products are supported by global technical and customer service resources. Users benefit from 3M's broad technology base and continuing attention to product development, performance, safety and environmental issues.

These fluids were developed under 3M's Product Stewardship initiative, which addresses important health, safety and environmental issues — from research and development through manufacturing, marketing, distribution and end use. 3M can assist its 3M™ HFE users' efforts to address product stewardship issues in 3M HFE applications.

3M makes its cleaning fluids as easy to work with as possible. You can take advantage of our free Parts Cleaning Evaluation Service, or try 3M HFEs yourself with our 30-Day Risk-Free Trial and Acceptance Program. 3M HFEs are available through a nationwide network of stocking distributors. What's more, spent fluid disposal is available through the Used Fluid Return Program.

When you take advantage of all that 3M offers, you'll discover why 3M HFEs are the cleaning solution you can live with.

Vertrel is a registered trademark of E.I.DuPont de Nemours and Company.

## 1. ( ) Free Parts Cleaning Evaluation\*

We'll clean samples of soiled parts using several processes, then analyze the cleaned parts to determine the effectiveness of each process. Finally, we'll return the cleaned parts and recommend an appropriate cleaning process.

## 2. ( ) 30-Day Risk-Free Trial and Acceptance Program\*

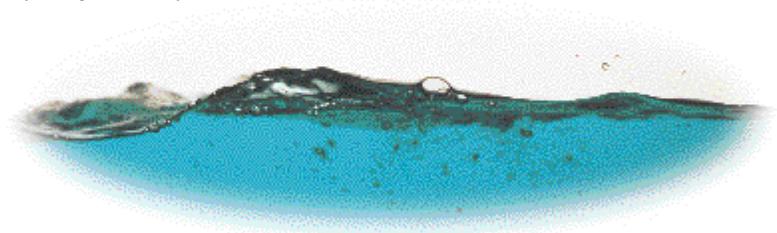
Try 3M HFEs for 30 days. If you're not convinced that 3M HFEs provide the effective and economical cleaning results you've been seeking, you may return them to 3M at no cost.

## 3. ( ) 3M Conversion Support Program

Get clear, concise suggestions for converting your existing cleaning equipment for use with the appropriate 3M HFE process.

Name/Title \_\_\_\_\_  
Company \_\_\_\_\_  
Address \_\_\_\_\_  
City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_ Country \_\_\_\_\_  
Phone \_\_\_\_\_ Fax \_\_\_\_\_  
Email \_\_\_\_\_

\* Offers valid for qualified respondents only.



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3M Chemicals**

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St. Paul, MN 55144-1000

*Printed on Recycled Paper*  
Issued 7/98

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98-0212-0445-2