

3M

Novec™

Engineered Fluid

HFE-7100



**For use as a carrier solvent
for Ninhydrin or DFO in latent
fingerprint development**

Get cleaner, crisper, more detailed images— without CFCs or

In 1974, CFC-113 was first used as a carrier solvent for latent fingerprint development on porous surfaces. This highly volatile, low toxicity, nonflammable fluid gave excellent ridge detail, did not cause inks to run when used with Ninhydrin and was safe for laboratory use.

But after a time, CFC-113 was identified as one of the materials responsible for depletion of the ozone layer

and a contributor to global warming, and by 1995 most developed nations had severely restricted its use.

Unfortunately for forensic scientists, no fluid existed that could perform with the level of precision exhibited by CFC-113. Fluids like acetone, petroleum ether and heptane achieved varying results, but all are flammable.



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flammable solvents

In 1996, however, 3M scientists introduced 3M™ Novec™ Engineered Fluids as CFC replacements. Drawing on 3M's long experience in organo-fluorine synthesis, these scientists designed Novec fluids using processes such as computational chemistry and toxicological modeling to reach a unique balance of performance, environmental and safety properties.

Now, Novec fluid HFE-7100 is being used as a carrier solvent in latent fingerprint development on porous surfaces. Novec fluid HFE-7100 is a selective solvent—as demonstrated by its inertness to most inks—and does not dissolve the amino acids transferred to the porous substrate in a fingerprint. Its surface tension is much lower than hydrocarbon solvents like petroleum ether (13.6 mN/m vs. 20 mN/m), allowing Novec fluid HFE-7100 to more easily and thoroughly carry dissolved Ninhydrin or DFO to where it is most useful—namely the edges of the fingerprint ridges. And because HFE-7100 fluid does not absorb moisture, ridge diffusion on the print is minimized.

Recently, Novec fluid HFE-7100 has been identified as an excellent replacement carrier solvent for CFC-113 by three independent forensic laboratories—Fingerprint Department, Institut de Recherche Criminelle de la Gendarmerie Nationale, France; Fingerprint Research Group, Police Scientific Development Branch, United Kingdom; and Forensic Services Division, Oregon State Police, Oregon, United States.

They found that Novec fluid HFE-7100:

- 1 Produced ridge crispness as good or better than CFC-113 with both Ninhydrin and DFO
- 2 Caused minimal running or smearing in a wide variety of inks and substrates
- 3 Had an excellent safety and environmental profile

Their findings are on the following pages.



If you can't see the ridges, you can't catch the perp

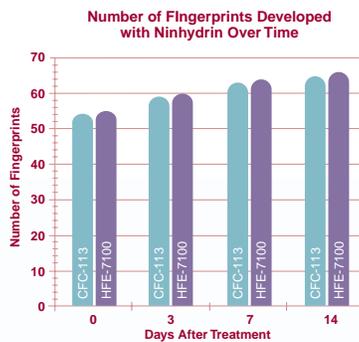
Ninhydrin

Formulation: Ninhydrin 5 g, Ethanol 45 ml, Ethyl acetate 2 ml, Acetic acid 5 ml, HFE-7100 1 L

It's a simple fact: without adequate ridge detail, you can't accurately identify a print. That's why the Fingerprint Research Group, Police Scientific Development Branch, UK, investigated 3M™ Novec™ Engineered Fluid HFE-7100 for use with Ninhydrin in 1997.¹

They concluded that there was “no significant difference” between Novec fluid HFE-7100 and CFC-113 in head-to-head experiments. The detail was superb with crisp, clear demarcation of the

ridges. In fact, in a later test—one testing the number of latent fingerprints containing 8 or more Galton points after 0, 3, 7 and 14 days—HFE-7100 fluid outperformed CFC-113.



As a result of further testing, the ninhydrin formulation using HFE-7100 fluid is currently being introduced into police service throughout the UK.²

Side-by-side comparisons show the outstanding performance of 3M™ Novec™ Engineered Fluid HFE-7100

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3M™ Novec™ Engineered Fluid HFE-7100 on the left, Petroleum ether on the right.

3M™ Novec™ Engineered Fluid HFE-7100 on the left, CFC-113 on the right.

DFO

Formulation: DFO 0.25 g, Methanol 40 ml, Acetic acid 20 ml, HFE-7100 940 ml

In 1998, the Fingerprint Department, Institut de Recherche Criminelle de la Gendarmerie Nationale, France, evaluated HFE-7100 fluid as a carrier solvent for DFO versus CFC-113.³ The results were very encouraging:

- Fingerprints developed with HFE-7100 fluid have crisper ridges and better definition
- Ridges are more regular with HFE-7100 fluid

¹Hewlett, D.F., Sears, V.G., Suzuki, S., “Replacements for CFC-113 in the Ninhydrin Process: Part 2,” *Journal of Forensic Identification*, 300 / 47 (3), 1997.

²Hewlett, D.F., Sears, V.G., “An Operational Trial of Two Non-ozone Depleting Ninhydrin Formulations for Latent Fingerprint Detection,” *Journal of Forensic Identification*, 388 / 49 (4), 1999.

³Didierjean, C., Debart, M., Crispino, F., “New Formulation of DFO in HFE-7100,” *Fingerprint Whorld*, Vol. 24 No. 94, October 1998.

“... Results obtained with the new formulation of DFO in 3M™ Novec™ Engineered Fluid HFE-7100 seem to be of equal quality and sometimes superior to those obtained with... CFC-113 formulations.”

Fingerprint Department, Institut de Recherche Criminelle de la Gendarmerie Nationale

What good is a signature if your carrier solvent dissolves it?

Jon Stimac, Forensic Services Division, Oregon State Police, decided to address that very question.¹ The problem with many carrier solvents—notably acetone—is that they cause inks to run and bleed. Not only can this destroy evidence, it can destroy or smudge undeveloped fingerprints as well.

In his research, Jon Stimac concluded that 3M™ Novec™ Engineered Fluid HFE-7100 is compatible with a wide range of inks and substrates using both Ninhydrin and DFO.

	3M™ Novec™ Engineered Fluid HFE-7100	Acetone	Petroleum Ether
White Office Paper			
Kraft Paper			
Gray Stationery			

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¹Stimac, J., "Oregon State Police Forensic Services Division—3M™ Novec™ Engineered Fluid HFE-7100 Validation Study," July 1999.

Looking for a fluid you can live with?

Make the Smart Choice

Clearly, 3M™ Novec™ Engineered Fluid HFE-7100 performs at or above the level of CFC-113. But what about its environmental and safety profile?

No problem.

Novec fluid HFE-7100 has zero ozone depletion potential, low global warming potential (GWP), low toxicity and is nonflammable.

3M™ Novec™ Engineered Fluids are a new class of fluorochemicals derived from a technology developed

specifically to balance performance needs with human concerns such as low toxicity, nonflammability and environmental acceptability.

The idea of designing chemical products to achieve a desirable balance of properties is important. Using this approach, 3M is able to offer Novec fluids not as interim replacement products, but as long-term, sustainable solutions that take into account both current and pending regulations. This is an important consideration that can help provide a greater measure of stability in your forensics operations.

Exposure/Toxicity	HFE-7100	HFC-43-10mee	CFC-113	Petroleum Ether*	Acetone*	n-Heptane**
Exposure Guidelines (8-hr. time-weighted avg.)	750 ppm	200 ppm	1,000 ppm	300 ppm	750 ppm	400 ppm
Acute lethal 4 hr LC50 Concentration (ppm)	>100,000	11,100	55,000	2000-80,000	50,200-126,600	15,000-20,000
Exposure Ceiling	None	400	None	400	1000	500

* Patty's Handbook

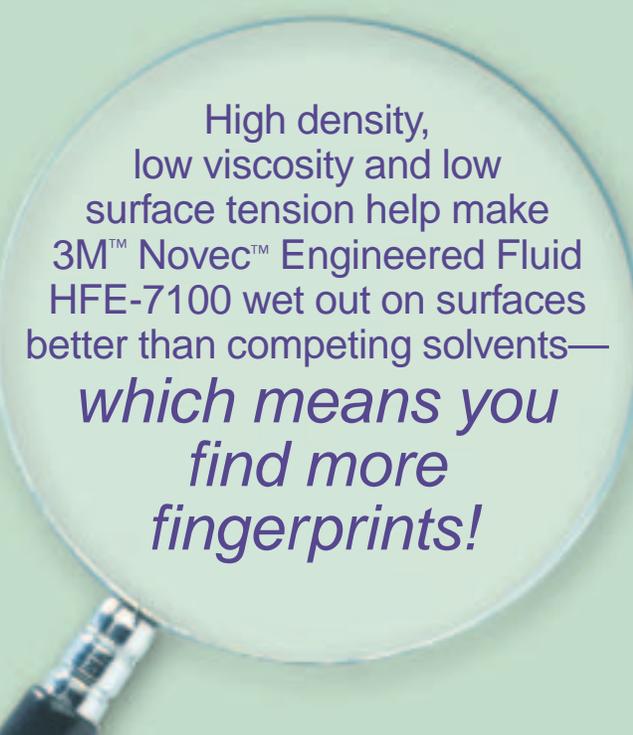
** ACGIH Documentation

"Its nonflammability, low toxicity and environmentally acceptable characteristics, coupled with its latent processing features—quality latent impression development, fast evaporation and no bleeding of inks—make 3M™ Novec™ Engineered Fluid HFE-7100 a welcome innovation."

Jon Stimac, technical leader—latent prints, Oregon State Police

A higher wetting index means you find more prints

There are a number of factors that go into developing a clear, distinct latent fingerprint, but 3M scientists believe that the combination of three physical properties—density, surface tension and viscosity—is responsible for the ability of 3M™ Novec™ Engineered Fluid HFE-7100 to effectively deliver ninhydrin or DFO in this application.



High density,
low viscosity and low
surface tension help make
3M™ Novec™ Engineered Fluid
HFE-7100 wet out on surfaces
better than competing solvents—
*which means you
find more
fingerprints!*

These properties are responsible in part for the number of fingerprints developed. In particular, the lower the surface tension of the carrier solvent, the more invasive the fluid is.

This means that it can find the “cracks” and “creases” in a porous surface more thoroughly than a solvent with higher surface tension, allowing it to develop older fingerprints—fingerprints whose amino acid signatures have gone deep into the porous surface.

In other words, you can find more fingerprints.

A parameter called the “wetting index” can help explain why density, surface tension and viscosity play such important roles. Introduced more than 20 years ago by Dr. William Kenyon, the wetting index was developed to evaluate the potential of different solvents to penetrate or “wet” tight spaces. It is based on empirical observations which indicate that a fluid with high density, low viscosity and low surface tension is better able to flow or wet a surface. 3M has found that the performance of various solvents does tend to scale with the wetting index in situations where the flow or wetting characteristics of the solvent are important.

The wetting index is calculated as:
 $1000 \cdot \text{density} / (\text{surface tension} \cdot \text{viscosity})$

The performance of various solvents appears to correlate with its wetting index:

The Wetting Index

Solvent	Density (g/ml)	Viscosity (cp)	Surface Tension (dynes/cm)	Wetting Index
Novec fluid HFE-7100	1.52	0.61	13.6	183
HFC-43-10mee	1.58	0.67	14.1	167
CFC-113	1.56	0.68	17.3	133
Petroleum Ether*	0.74	0.38	16.1	121
Acetone	0.79	0.32	23.7	106
Heptane	0.69	0.41	19.3	87

*35°C-60°C cut

With 3M, you get more:

3M products are supported by our 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.

Now try it yourself.

For any scientist, studies and opinions only carry so much weight. If you're going to switch carrier solvents, you want to evaluate them for yourself.

That's why we offer test samples so you can confirm your colleagues' research. Qualified respondents may call 1 800 810 8513 and we'll send you a 200 ml sample of 3M™ Novec™ Engineered Fluid HFE-7100 to evaluate.

Be sure to visit us at www.3m.com/specialtymaterials for the latest information.

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