

# 3M Novec™ 7100 Engineered Fluid

## Introduction

3M™ Novec™ 7100 Engineered Fluid, methoxy-nonafluorobutane (C<sub>4</sub>F<sub>9</sub>OCH<sub>3</sub>), is a clear, colorless and low-odor fluid intended to replace ozone-depleting substances (ODSs) and compounds with high global warming potential (GWP) in many applications. Its physical properties are compared with several other ODS replacement fluid candidates in Table 1.

This proprietary fluid has zero ozone depletion potential and other favorable environmental properties (see Table 2). It has one of the best toxicological profiles of CFC replacement materials, with a time-weighted average exposure guideline of 750 ppm (eight hour average).

The high boiling point and low surface tension of Novec 7100 fluid make it ideal for use in vapor degreasing applications as a neat (pure), azeotropic component or co-solvent parts cleaner. In addition, its chemical and thermal stability, non-flammability and low toxicity make it useful for many other industrial and specialty solvent applications (see below).

## Typical Applications

- Cleaning and rinsing agent
  - Heavy-duty cleaning (co-solvent) – heavy oils, greases, fluxes
  - Medium-duty cleaning (azeotrope) – oils, greases, waxes
  - Light-duty cleaning (neat) – particulates, fluorolubes, light oils, fluoropolymers
- Lubricant carrier
  - Fluorocarbons
  - Hydrocarbons
  - Silicones
- Spot-free water drying agent (with surfactants added)
- Specialty solvents, dispersion media, reaction media
- Spray contact cleaner
- CFC, HCFC, HFC and PFC replacement
- Dielectric test media
- Heat transfer
  - See “3M™ Novec™ 7100 Engineered Fluid for Heat Transfer” Application Information

## Material Description

### Ingredients

### Novec 7100

|                                       |                  |
|---------------------------------------|------------------|
| Methoxy-nonafluorobutane <sup>1</sup> | 99.5% minimum    |
| Appearance                            | Clear, colorless |
| Non-volatile residue (NVR)            | 2.0 ppm maximum  |

<sup>1</sup> Novec 7100 fluid (C<sub>4</sub>F<sub>9</sub>OCH<sub>3</sub>) consists of two inseparable isomers with essentially identical properties. These are (CF<sub>3</sub>)<sub>2</sub>CFCF<sub>2</sub>OCH<sub>3</sub> (CAS No. 163702-08-7) and CF<sub>3</sub>CF<sub>2</sub>CF<sub>2</sub>OCH<sub>3</sub> (CAS No. 163702-07-6).

**Typical Physical Properties – Table 1**

Data compiled from published information

Not for specification purposes

| Properties                                  | Novec 7100                                     | CFC-113                                       | HCFC-141b                                       | HCFC-225 ca/cb <sup>1</sup>                    | HFC-4310mee                                   |
|---|--|---|---|--|---|
| Formula                                     | C <sub>4</sub> F <sub>9</sub> OCH <sub>3</sub> | C <sub>2</sub> Cl <sub>3</sub> F <sub>3</sub> | C <sub>2</sub> Cl <sub>2</sub> H <sub>3</sub> F | C <sub>3</sub> Cl <sub>2</sub> HF <sub>5</sub> | C <sub>5</sub> H <sub>2</sub> F <sub>10</sub> |
| Molecular Wt.                               | 250  | 187   | 117   | 203  | 252   |
| Boiling Pt °C                               | 61   | 48  | 32  | 54   | 54  |
| Freeze Pt °C                                | -135   | -35   | -103  | -131   | -80   |
| Liquid Density <sup>1</sup>                 | 1.52   | 1.56  | 1.23  | 1.55   | 1.58  |
| Surface Tension <sup>2</sup>                | 13.6   | 17.3  | 19.3  | 16.2   | 14.1  |
| Solubility of Solvent in Water <sup>3</sup> | 12   | 170   | 210   | 330  | 140   |
| Solubility of Water in Solvent <sup>3</sup> | 95   | 110   | 420   | 310  | 490   |
| Vapor Pressure <sup>5</sup>                 | 202  | 334   | 569   | 290  | 226   |

<sup>1</sup> g/ml @ 25°C    <sup>2</sup> dynes/cm @ 25°C    <sup>3</sup> ppm by weight  
<sup>4</sup> Vol % by ASTM E681-94 @ 100°C    <sup>5</sup> mm Hg @ 25°C

**Environmental and Safety Properties and Exposure Guidelines – Table 2**

Data compiled from published information

Not for specification purposes

| Properties   | Novec 7100 | CFC-113 | HCFC-141b             | HCFC-225 ca/cb <sup>1</sup> | HFC-4310mee |
|--|------------|---------|-----------------------|-----------------------------|-------------|
| Ozone Depletion Potential <sup>2</sup> –ODP            | 0.00       | 0.80    | 0.10                  | 0.03                        | 0.00        |
| Global Warming Potential <sup>3</sup> –GWP             | 320        | 6000    | 700                   | 180/620                     | 1700        |
| Atmospheric Lifetime–ALT (yrs)                         | 4.1        | 85      | 9.2                   | 2.1/6.2                     | 17.1        |
| Flashpoint   | None       | None    | None                  | None                        | None        |
| Flammability Range in Air                              | None       | None    | 7.6-17.7 <sup>4</sup> | None                        | None        |
| Exposure Guidelines, ppm (8 hr. time-weighted average) | 750        | 1000    | 500                   | 50                          | 200         |
| Exposure Ceiling (ppm)                                 | None       | None    | None                  | None                        | 400         |
| Acute Toxicity (4 hr. LC <sub>50</sub> [Rat])          | >100,000   | 55,000  | 62,000                | 37,000                      | 11,000      |

<sup>1</sup> HCFC-225 ca/cb ratio is 45/55    <sup>2</sup> CFC-11 = 1.0    <sup>3</sup> GWP–100 year Integration Time Horizon (ITH)  
<sup>4</sup> Vol % by ASTM E681-94 @ 100°C

## Regulatory Status

3M™ Novec™ 7100 Engineered Fluid has been accepted for commercial use by regulatory agencies in the United States, Europe, Canada, Australia, Japan, Korea and the Philippines. The components of Novec 7100 fluid have been nominated to China's draft chemical inventory.

Novec 7100 fluid has been approved under the Significant New Alternatives Policy (SNAP) of the U.S. EPA. In addition, Novec 7100 fluid has 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. The components of Novec 7100 fluid are not on any regulated lists.

Contact your local 3M representative regarding the regulatory status of Novec 7100 fluid in other countries.

## Toxicity Profile

The toxicological testing completed on Novec 7100 fluid shows the overall toxicity is low. The material is practically non-irritating to the eyes, minimally irritating to the skin and is not a mutagen or cardiac sensitizer. It is rated "practically non-toxic" through inhalation. A 90-day inhalation study has helped establish a recommended exposure guideline of 750 ppm for an eight-hour average worker exposure per day. This exposure guideline was established by the American Industrial Hygiene Association.

### Toxicological Test Results

| Properties                            | Novec 7100   |
|---------------------------------------|--|
| Acute lethal inhalation concentration | >100,000 ppm (4 hour)  |
| Oral                                  | Practically non-toxic (>5 g/kg)                              |
| Eye irritation                        | Practically non-irritating                                   |
| Skin irritation                       | Minimally irritating   |
| Skin sensitization                    | Not a skin sensitizer  |
| Developmental toxicity                | Detailed results are available                               |
| Mutagenicity                          | Negative in the three assays conducted                       |
| Cardiac sensitization                 | No signs of sensitization at exposures up to 100,000 ppm     |
| Ecotoxicity testing                   | Complete—very low aquatic toxicity                           |
| 90-day inhalation                     | 750 ppm exposure guideline<br>Detailed results are available |

**Vapor Pressure and Density**

The variation of vapor pressure and density with temperature for 3M™ Novec™ 7100 Engineered Fluid can be calculated using the following formulas:

Vapor Pressure:  $\ln P = 22.415 - 3641.9 [1/(t+273)]$

Density:  $D = 1.5383 - 0.002269t$

P = Vapor Pressure in Pascals

t = Temperature in °C

D = Density in g/ml

**Materials Compatibility**

**Continuous Exposure**

Novec 7100 fluid is compatible with most metals and hard polymers. Soft and elastomeric materials should be limited to compounds that contain the least amount of extractable plasticizer. 3M technical service engineers can suggest appropriate compounds and assist with material compatibility tests.

**Non-Continuous Exposure**

Short-term testing of Novec 7100 fluid demonstrates compatibility, after one hour exposure at boiling temperature, with a wide range of metals, plastics and elastomers, similar to the performance of perfluorinated liquids. Good short-term compatibility with particularly sensitive plastics such as polycarbonate and PMMA indicates utility in cleaning of assemblies containing many composite materials.

As with most fluorinated liquids, Novec 7100 fluid will absorb into fluorinated plastics and elastomers over longer exposures.

**Short Term Exposure Compatibility**

**Metals**

Aluminum  
 Copper  
 Carbon Steel  
 302 Stainless Steel  
 Brass  
 Molybdenum  
 Tantalum  
 Tungsten  
 Cu/Be Alloy C172  
 Mg Alloy AZ32B

**Plastics**

Acrylic (PMMA)  
 Polyethylene  
 Polypropylene  
 Polycarbonate  
 Polyester  
 Epoxy  
 PET  
 Phenolic  
 ABS

**Elastomers**

Butyl Rubber  
 Natural Rubber  
 Nitrile Rubber  
 EPDM

Exceptions: Some swelling of PTFE and Silicone Rubber. Some surface oxidation of copper during heat aging.

### **Safety and Handling**

3M™ Novec™ 7100 Engineered Fluid is nonflammable and does not exhibit flammability characteristics under normal operating and storage conditions. This fluid is highly resistant to thermal breakdown and hydrolysis in storage and during use. Recommended handling procedures are provided in the pertinent Material Safety Data Sheet which is available from your local 3M representative upon request.

### **Environmental Policy**

3M will continue to recognize and exercise its responsibility to prevent pollution at the source wherever and whenever possible; develop products that will have a minimal effect on the environment; conserve natural resources through the use of reclamation and other appropriate methods; assure that its facilities and products meet and sustain the regulations of all federal, state and local environmental agencies; assist, wherever possible, governmental agencies and other official organizations engaged in environmental activities.

### **Packaging and Availability**

Novec 7100 fluid may be ordered in the following container sizes:

- 55-gallon drum; 30-gallon drum; 5-gallon pail; 1-gallon pail
- 4-ounce samples for limited or preliminary test work are available

**Recycle and  
Disposal Options**

**Used Fluid Return Program**

3M offers a program for free\* pickup and return of used 3M specialty fluids in the U.S. through Safety-Kleen Corp. A pre-negotiated handling agreement between users and this service provider offers users broad protection against future liability for used 3M product. The fluid return program is covered by independent third-party financial and environmental audits of treatment, storage and disposal facilities. Necessary documentation is provided. A minimum of 30 gallons of used 3M specialty fluid is required for participation in this free program.\*

Safety-Kleen Corp. has a network of 156 branch service centers in the U.S. This large fleet will provide timely, economical fluid disposal service.

For additional information on the 3M Used Fluid Return Program, contact Safety-Kleen at this toll-free line: 1.888.932.2731. Contact your local 3M representative for fluid return programs outside the U.S.

\* Must have a 30 or more gallon purchase to participate in the 3M paid program. Used product of 5-30 gallons can be returned through Safety-Kleen at the user's expense.



## Resources

3M™ Novec™ Engineered Fluids are supported by global sales, technical and customer service resources, with fully-staffed technical service laboratories in the U.S., Europe, Japan, Latin America and Southeast Asia. Users benefit from 3M's broad technology base and continuing attention to product development, performance, safety and environmental issues.

For additional technical information on 3M™ Novec™ 7100 Engineered Fluid in the United States, call 3M Customer Service, **800 810 8513**.

For information on additional 3M fluids, coatings and other chemical products for the electronics industry, visit our web site at:

[www.3M.com/electronics](http://www.3M.com/electronics)

---

**Product Use:** All statements, technical information and recommendations contained in this document are based on tests or experience that 3M believes are reliable. However, many factors beyond 3M's control can affect the use and performance of a 3M product in a particular application, including conditions under which the product is used and the time and environmental conditions in which the product is expected to perform. Since these factors are uniquely within the user's knowledge and control, it is essential that the user evaluate the 3M product to determine whether it is fit for a particular purpose and suitable for the user's method of application.

**Warranty and Limited Remedy:** Unless stated otherwise in 3M's product literature, packaging inserts or product packaging for individual products, 3M warrants that each 3M product meets the applicable specifications at the time 3M ships the product. Individual products may have additional or different warranties as stated on product literature, package inserts or product packages. **3M MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO, ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY IMPLIED WARRANTY ARISING OUT OF A COURSE OF DEALING, CUSTOM OR USAGE OF TRADE.** User is responsible for determining whether the 3M product is fit for a particular purpose and suitable for user's application. If the 3M product is defective within the warranty period, your exclusive remedy and 3M's and seller's sole obligation will be, at 3M's option, to replace the product or refund the purchase price.

**Limitation of Liability:** Except where prohibited by law, 3M and seller will not be liable for any loss or damage arising from the 3M product, whether direct, indirect, special, incidental, or consequential regardless of the legal theory asserted, including warranty, contract, negligence or strict liability.



### 3M Electronics

Building 21-1W-10  
900 Bush Avenue  
St. Paul, MN 55106

[www.3M.com/electronics](http://www.3M.com/electronics)

3M is a trademark of 3M Company.  
Used under license by 3M subsidiaries and affiliates.

Issued: 8/05

© 2005 3M

5045(HB)  
98-0212-2669-5