1.1. Product identifier

3M™ Novec™ 649 Engineered Fluid

Product Identification Numbers
7100027554, 7100023600, 7100025284, 7100027553, 7010400219

1.2. Recommended use and restrictions on use

Recommended use
For industrial use only; not intended for use as a medical device or drug., Heat transfer application.

Restrictions on use
3M™ Novec™ Engineered Fluids are used in a wide variety of applications, including but not limited to precision cleaning of medical devices and as lubricant deposition solvents for medical devices.  When the product is used for applications where the finished device is implanted into the human body, no residual Novec solvent may remain on the parts.  It is highly recommended that the supporting test results and protocol be cited during FDA registration.

3M Electronics Markets Materials Division (EMMD) will not knowingly sample, support, or sell its products for incorporation in medical and pharmaceutical products and applications in which the 3M product will be temporarily or permanently implanted into humans or animals.  The customer is responsible for evaluating and determining that a 3M EMMD product is suitable and appropriate for its particular use and intended application.  The conditions of evaluation, selection, and use of a 3M product can vary widely and affect the use and intended application of a 3M product.  Because many of these conditions are uniquely within the user’s knowledge and control, it is essential that the user evaluate and determine whether the 3M product is suitable and appropriate for a particular use and intended application, and complies with all local applicable laws, regulations, standards, and guidance.

1.3. Supplier’s details

MANUFACTURER: 3M
DIVISION: Electronics Materials Solutions Division
ADDRESS: 3M Center, St. Paul, MN 55144-1000, USA
Telephone: 1-888-3M HELPS (1-888-364-3577)

1.4. Emergency telephone number

1-800-364-3577 or (651) 737-6501 (24 hours)
2.1. Hazard classification

2.2. Label elements
Signal word
Not applicable.

Symbols
Not applicable.

Pictograms
Not applicable.

SECTION 3: Composition/information on ingredients

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>C.A.S. No.</th>
<th>% by Wt</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone</td>
<td>756-13-8</td>
<td>&gt; 99.5</td>
</tr>
</tbody>
</table>

SECTION 4: First aid measures

4.1. Description of first aid measures

Inhalation:
Remove person to fresh air. If you are concerned, get medical advice.

Skin Contact:
Wash with soap and water. If signs/symptoms develop, get medical attention.

Eye Contact:
Flush with large amounts of water. Remove contact lenses if easy to do. Continue rinsing. If signs/symptoms persist, get medical attention.

If Swallowed:
No need for first aid is anticipated.

4.2. Most important symptoms and effects, both acute and delayed
See Section 11.1. Information on toxicological effects.

4.3. Indication of any immediate medical attention and special treatment required
Not applicable

SECTION 5: Fire-fighting measures

5.1. Suitable extinguishing media
Material will not burn. Use a fire fighting agent suitable for the surrounding fire.

5.2. Special hazards arising from the substance or mixture
Exposure to extreme heat can give rise to thermal decomposition.

Hazardous Decomposition or By-Products

<table>
<thead>
<tr>
<th>Substance</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon monoxide</td>
<td>During Combustion</td>
</tr>
</tbody>
</table>
Carbon dioxide
  Toxic Vapor/Gas  During Combustion

5.3. Special protective actions for fire-fighters
When fire fighting conditions are severe and total thermal decomposition of the product is possible, wear full protective
clothing, including helmet, self-contained, positive pressure or pressure demand breathing apparatus, bunker coat and pants,
bands around arms, waist and legs, face mask, and protective covering for exposed areas of the head.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures
Evacuate area. Ventilate the area with fresh air. For large spill, or spills in confined spaces, provide mechanical ventilation
to disperse or exhaust vapors, in accordance with good industrial hygiene practice. Refer to other sections of this SDS for
information regarding physical and health hazards, respiratory protection, ventilation, and personal protective equipment.

6.2. Environmental precautions
Avoid release to the environment. For larger spills, cover drains and build dikes to prevent entry into sewer systems or
bodies of water.

6.3. Methods and material for containment and cleaning up
Contain spill. Working from around the edges of the spill inward, cover with bentonite, vermiculite, or commercially
available inorganic absorbent material. Mix in sufficient absorbent until it appears dry. Remember, adding an absorbent
material does not remove a physical, health, or environmental hazard. Collect as much of the spilled material as possible.
Place in a closed container approved for transportation by appropriate authorities. Seal the container. Dispose of collected
material as soon as possible in accordance with applicable local/regional/national/international regulations.

SECTION 7: Handling and storage

7.1. Precautions for safe handling
Contents may be under pressure, open carefully. Do not breathe thermal decomposition products. For industrial or
professional use only. Do not use in a confined area with minimal air exchange. Avoid release to the environment.

7.2. Conditions for safe storage including any incompatibilities
Protect from sunlight. Store in a well-ventilated place. Store at temperatures not exceeding 38C/100F  Store away from
strong bases. Store away from other materials. Store away from amines.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters
Occupational exposure limits
If a component is disclosed in section 3 but does not appear in the table below, an occupational exposure limit is not available
for the component.

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>C.A.S. No.</th>
<th>Agency</th>
<th>Limit type</th>
<th>Additional Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,1,1,2,2,4,5,5,5-Nonafluoro-4-( trifluoromethyl)-3-pentanone</td>
<td>756-13-8</td>
<td>Manufacturer determined</td>
<td>TWA:150 ppm (1940 mg/m3)</td>
<td></td>
</tr>
</tbody>
</table>

ACGIH : American Conference of Governmental Industrial Hygienists
AIHA : American Industrial Hygiene Association
CMRG : Chemical Manufacturer's Recommended Guidelines
OSHA : United States Department of Labor - Occupational Safety and Health Administration
TWA: Time-Weighted-Average
STEL: Short Term Exposure Limit
CEIL: Ceiling
8.2. Exposure controls

8.2.1. Engineering controls
Provide appropriate local exhaust when product is heated. For those situations where the material might be exposed to extreme overheating due to misuse or equipment failure, use with appropriate local exhaust ventilation sufficient to maintain levels of thermal decomposition products below their exposure guidelines. Use general dilution ventilation and/or local exhaust ventilation to control airborne exposures to below relevant Exposure Limits and/or control dust/fume/gas/mist/vapors/spray. If ventilation is not adequate, use respiratory protection equipment.

8.2.2. Personal protective equipment (PPE)

Eye/face protection
Eye protection not required.

Skin/hand protection
No chemical protective gloves are required.

Respiratory protection
If thermal degradation products are expected, use a full facepiece supplied-air respirator.
If thermal decomposition occurs:
Use a positive pressure supplied-air respirator if there is a potential for over exposure from an uncontrolled release, exposure levels are not known, or under any other circumstances where air-purifying respirators may not provide adequate protection.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Physical Form:</td>
<td>Liquid</td>
</tr>
<tr>
<td>Specific Physical Form:</td>
<td>Liquid</td>
</tr>
<tr>
<td>Odor, Color, Grade:</td>
<td>Clear colorless liquid with low odor</td>
</tr>
<tr>
<td>Odor threshold</td>
<td>No Data Available</td>
</tr>
<tr>
<td>pH</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Melting point</td>
<td>-108 °C</td>
</tr>
<tr>
<td>Boiling Point</td>
<td>49 °C [@ 760 mmHg]</td>
</tr>
<tr>
<td>Flash Point</td>
<td>No flash point</td>
</tr>
<tr>
<td>Evaporation rate</td>
<td>&gt; 1 [Ref Std: BUOAC=1]</td>
</tr>
<tr>
<td>Flammability (solid, gas)</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Flammable Limits(LEL)</td>
<td>None detected</td>
</tr>
<tr>
<td>Flammable Limits(UEL)</td>
<td>None detected</td>
</tr>
<tr>
<td>Vapor Pressure</td>
<td>40.4 kPa [@ 25 °C]</td>
</tr>
<tr>
<td>Vapor Density</td>
<td>11.6 [Ref Std: AIR=1]</td>
</tr>
<tr>
<td>Density</td>
<td>1.6 g/ml</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>1.6 [@ 68 °F] [Ref Std: WATER=1]</td>
</tr>
<tr>
<td>Solubility in Water</td>
<td>Nil</td>
</tr>
<tr>
<td>Solubility- non-water</td>
<td>No Data Available</td>
</tr>
<tr>
<td>Partition coefficient: n-octanol/ water</td>
<td>No Data Available</td>
</tr>
<tr>
<td>Autoignition temperature</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Decomposition temperature</td>
<td>No Data Available</td>
</tr>
<tr>
<td>Viscosity</td>
<td>0.6 centipoise [@ 25 °C ]</td>
</tr>
<tr>
<td>Molecular weight</td>
<td>No Data Available</td>
</tr>
<tr>
<td>Volatile Organic Compounds</td>
<td>1600 g/l [Test Method: calculated SCAQMD rule 443.1]</td>
</tr>
<tr>
<td>Percent volatile</td>
<td>100 %</td>
</tr>
</tbody>
</table>
VOC Less H2O & Exempt Solvents 1600 g/l [Test Method: calculated SCAQMD rule 443.1]

SECTION 10: Stability and reactivity

10.1. Reactivity
This material may be reactive with certain agents under certain conditions - see the remaining headings in this section.

10.2. Chemical stability
Stable.

10.3. Possibility of hazardous reactions
Hazardous polymerization will not occur.

10.4. Conditions to avoid
Light

10.5. Incompatible materials
Strong bases
Amines
Alcohols

10.6. Hazardous decomposition products

<table>
<thead>
<tr>
<th>Substance</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen Fluoride</td>
<td>At Elevated Temperatures - extreme conditions of heat</td>
</tr>
</tbody>
</table>

Refer to section 5.2 for hazardous decomposition products during combustion.

If the product is exposed to extreme condition of heat from misuse or equipment failure, toxic decomposition products that include hydrogen fluoride and perfluoroisobutylene can occur. Extreme heat arising from situations such as misuse or equipment failure can generate hydrogen fluoride as a decomposition product.

SECTION 11: Toxicological information

The information below may not be consistent with the material classification in Section 2 if specific ingredient classifications are mandated by a competent authority. In addition, toxicological data on ingredients may not be reflected in the material classification and/or the signs and symptoms of exposure, because an ingredient may be present below the threshold for labeling, an ingredient may not be available for exposure, or the data may not be relevant to the material as a whole.

11.1. Information on Toxicological effects

Signs and Symptoms of Exposure

Based on test data and/or information on the components, this material may produce the following health effects:

Inhalation:
No known health effects.

Skin Contact:
Contact with the skin during product use is not expected to result in significant irritation.
Eye Contact:
Contact with the eyes during product use is not expected to result in significant irritation.

Ingestion:
No known health effects.

Toxicological Data
If a component is disclosed in section 3 but does not appear in a table below, either no data are available for that endpoint or the data are not sufficient for classification.

Acute Toxicity

<table>
<thead>
<tr>
<th>Name</th>
<th>Route</th>
<th>Species</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone</td>
<td>Dermal</td>
<td>Professio nal judgemen t</td>
<td>LD50 estimated to be &gt; 5,000 mg/kg</td>
</tr>
<tr>
<td>1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone</td>
<td>Ingestion</td>
<td>Professio nal judgemen t</td>
<td>LD50 estimated to be &gt; 5,000 mg/kg</td>
</tr>
<tr>
<td>1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone</td>
<td>Inhalation-Vapor (4 hours)</td>
<td>Rat</td>
<td>LC50 &gt; 1,227 mg/l</td>
</tr>
</tbody>
</table>

ATE = acute toxicity estimate

Skin Corrosion/Irritation

<table>
<thead>
<tr>
<th>Name</th>
<th>Species</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone</td>
<td>Rabbit</td>
<td>No significant irritation</td>
</tr>
</tbody>
</table>

Serious Eye Damage/Irritation

<table>
<thead>
<tr>
<th>Name</th>
<th>Species</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone</td>
<td>Rabbit</td>
<td>No significant irritation</td>
</tr>
</tbody>
</table>

Skin Sensitization

<table>
<thead>
<tr>
<th>Name</th>
<th>Species</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone</td>
<td>Guinea pig</td>
<td>Not classified</td>
</tr>
</tbody>
</table>

Respiratory Sensitization
For the component/components, either no data are currently available or the data are not sufficient for classification.

Germ Cell Mutagenicity

<table>
<thead>
<tr>
<th>Name</th>
<th>Route</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone</td>
<td>In Vitro</td>
<td>Not mutagenic</td>
</tr>
<tr>
<td>1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone</td>
<td>In vivo</td>
<td>Not mutagenic</td>
</tr>
</tbody>
</table>

Carcinogenicity
For the component/components, either no data are currently available or the data are not sufficient for classification.

Reproductive Toxicity

Reproductive and/or Developmental Effects

<table>
<thead>
<tr>
<th>Name</th>
<th>Route</th>
<th>Value</th>
<th>Species</th>
<th>Test Result</th>
<th>Exposure Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone</td>
<td>Inhalation</td>
<td>Not classified for female reproduction</td>
<td>Rat</td>
<td>NOAEL 3,000 ppm</td>
<td>premating &amp; during</td>
</tr>
</tbody>
</table>
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone

Inhalation
Not classified for male reproduction
Rat
NOAEL 3,000 ppm
premating & during gestation

1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone

Inhalation
Not classified for development
Rat
NOAEL 3,000 ppm
premating & during gestation

Target Organ(s)

Specific Target Organ Toxicity - single exposure

<table>
<thead>
<tr>
<th>Name</th>
<th>Route</th>
<th>Target Organ(s)</th>
<th>Value</th>
<th>Species</th>
<th>Test Result</th>
<th>Exposure Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone</td>
<td>Inhalation</td>
<td>nervous system</td>
<td>Not classified</td>
<td>Rat</td>
<td>NOAEL 100,000 ppm</td>
<td>2 hours</td>
</tr>
<tr>
<td>1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone</td>
<td>Inhalation</td>
<td>cardiac sensitization</td>
<td>Not classified</td>
<td>Dog</td>
<td>Sensitization Negative</td>
<td>17 minutes</td>
</tr>
</tbody>
</table>

Specific Target Organ Toxicity - repeated exposure

<table>
<thead>
<tr>
<th>Name</th>
<th>Route</th>
<th>Target Organ(s)</th>
<th>Value</th>
<th>Species</th>
<th>Test Result</th>
<th>Exposure Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone</td>
<td>Inhalation</td>
<td>liver</td>
<td>kidney and/or bladder</td>
<td>heart</td>
<td>endocrine system</td>
<td>hematopoietic system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not classified</td>
<td>Rat</td>
<td>NOAEL 3,000 ppm</td>
<td>90 days</td>
<td></td>
</tr>
</tbody>
</table>

Aspiration Hazard
For the component/components, either no data are currently available or the data are not sufficient for classification.

Please contact the address or phone number listed on the first page of the SDS for additional toxicological information on this material and/or its components.

SECTION 12: Ecological information

Ecotoxicological information

Please contact the address or phone number listed on the first page of the SDS for additional ecotoxicological information on this material and/or its components.

Chemical fate information

Please contact the address or phone number listed on the first page of the SDS for additional chemical fate information on this material and/or its components.

SECTION 13: Disposal considerations

13.1. Disposal methods
Dispose of contents/container in accordance with the local/regional/national/international regulations.

Dispose of waste product in a permitted industrial waste facility. As a disposal alternative, incinerate in a permitted waste incineration facility. Combustion products will include HF. Facility must be capable of handling halogenated materials. Empty drums/barrels/containers used for transporting and handling hazardous chemicals (chemical substances/mixtures/preparations classified as Hazardous as per applicable regulations) shall be considered, stored, treated...
& disposed of as hazardous wastes unless otherwise defined by applicable waste regulations. Consult with the respective regulating authorities to determine the available treatment and disposal facilities.

EPA Hazardous Waste Number (RCRA): Not regulated

SECTION 14: Transport Information

For Transport Information, please visit http://3M.com/Transportinfo or call 1-800-364-3577 or 651-737-6501.

SECTION 15: Regulatory information

15.1. US Federal Regulations
Contact 3M for more information.

EPCRA 311/312 Hazard Classifications:

<table>
<thead>
<tr>
<th>Physical Hazards</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Hazards</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

15.2. State Regulations
Contact 3M for more information.

15.3. Chemical Inventories
The components of this product are in compliance with the new substance notification requirements of CEPA.

The components of this material are in compliance with the China "Measures on Environmental Management of New Chemical Substance". Certain restrictions may apply. Contact the selling division for additional information.

The components of this material are in compliance with the provisions of the Korean Toxic Chemical Control Law. Certain restrictions may apply. Contact the selling division for additional information.

The components of this material are in compliance with the provisions of Japan Chemical Substance Control Law. Certain restrictions may apply. Contact the selling division for additional information.

The components of this material are in compliance with the provisions of Philippines RA 6969 requirements. Certain restrictions may apply. Contact the selling division for additional information.

The components of this product are in compliance with the chemical notification requirements of TSCA. All required components of this product are listed on the active portion of the TSCA Inventory.

Contact 3M for more information.

15.4. International Regulations
Contact 3M for more information.

This SDS has been prepared to meet the U.S. OSHA Hazard Communication Standard, 29 CFR 1910.1200.

SECTION 16: Other information

NFPA Hazard Classification
Health: 3  Flammability: 0  Instability: 1  Special Hazards: None

National Fire Protection Association (NFPA) hazard ratings are designed for use by emergency response personnel to address the hazards that are presented by short-term, acute exposure to a material under conditions of fire, spill, or similar emergencies. Hazard ratings are primarily based on the inherent physical and toxic properties of the material but also include the toxic properties of combustion or decomposition products that are known to be generated in significant quantities.

The NFPA Health code of 3 is due to emergency situations where the material may thermally decompose and release Hydrogen Fluoride. During normal use conditions, please reference Section 2 and Section 11 of the SDS for additional health hazard information.

HMIS Hazard Classification
Health: 1  Flammability: 0  Physical Hazard: 1  Personal Protection: X - See PPE section.

Hazardous Material Identification System (HMIS® IV) hazard ratings are designed to inform employees of chemical hazards in the workplace. These ratings are based on the inherent properties of the material under expected conditions of normal use and are not intended for use in emergency situations. HMIS® IV ratings are to be used with a fully implemented HMIS® IV program. HMIS® is a registered mark of the American Coatings Association (ACA).

Document Group: 19-2786-2  Version Number: 8.01
Issue Date: 07/26/18  Supercedes Date: 02/16/18

Reason for Reissue
Conversion to GHS format SDS.

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