



Novec™

Brand

3M™ Novec™ 1230 Fire Protection Fluid

Introduction

3M™ Novec™ 1230 Fire Protection Fluid is a next-generation halon alternative offering outstanding performance, a large margin of safety, and an excellent environmental profile.

- Zero ozone depletion potential
- 5-day atmospheric lifetime
- Global warming potential <1
- Large margin of safety for occupied spaces

Novec 1230 Fire Protection Fluid is based on a proprietary chemical from 3M called a fluoroketone. The full chemical name for this compound is dodecafluoro-2-methylpentan-3-one. Its ASHRAE nomenclature – the way it is designated in the NFPA and ISO 14520 clean agent standards – is FK-5-1-12.

Novec 1230 fluid offers a unique combination of safety, low environmental impact and extinguishing performance, making it the only chemical halon replacement to offer a viable, long-term, environmentally sustainable technology for special hazards fire protection.

Physical Properties

Novec 1230 fluid is applied as a gas, but is liquid at room temperature. It is electrically non-conducting in both the liquid and gaseous state. The breakdown voltage of Novec 1230 fluid vapor under saturated conditions at 1 atm, 21°C over a 2.7 mm electrode gap is 15.6kV, nearly 2.3 times that of dry nitrogen. The breakdown voltage of liquid Novec 1230 fluid under the same conditions is 48 kV.

The properties of Novec 1230 fluid are similar to many of the first-generation halon alternatives with one primary exception – this compound is a liquid at ambient conditions. The boiling point of Novec 1230 fluid is 49.2°C, meaning this product has a much lower vapor pressure than other clean agents, which are gases at ambient conditions.

Novec 1230 fluid has a very low heat of vaporization, approximately 25 times less than that of water. This, along with a vapor pressure 12 times higher than water causes Novec 1230 fluid to evaporate more than 50 times faster than water. This allows the agent to transition from a liquid to a gaseous state very rapidly. When discharged through a nozzle from a properly designed system, Novec 1230 fluid will rapidly vaporize and evenly distribute throughout the protected space.

3M™ Novec™ 1230 Fire Protection Fluid

Properties Description

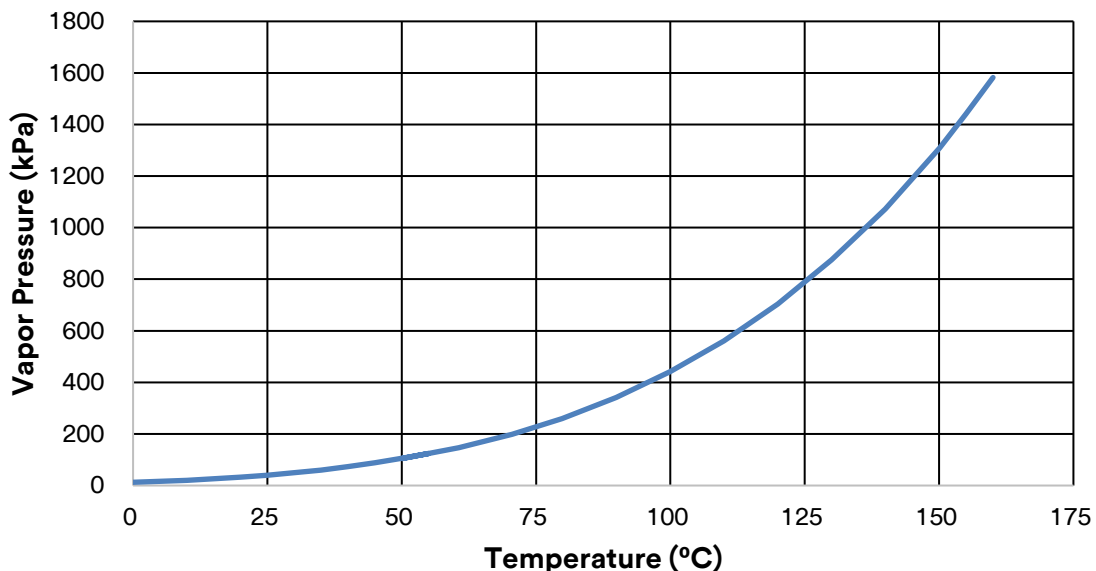
Not for specification purposes. All values @ 25°C(77°F) unless otherwise specified.

Properties	Novec 1230 fluid
Chemical Formula	CF ₃ CF ₂ C(O)CF(CF ₃) ₂
Molecular Weight	316.04
Boiling Point @ 1 atm	49.2°C (120.6°F)
Freezing Point	-108.0°C (-162.4°F)
Critical Temperature	168.7°C (335.6°F)
Critical Pressure	18.65 bar (270.44 psia)
Critical Volume	494.5 cc/mole (0.0251 ft ³ /lbm)
Critical Density	639.1 kg/m ³ (39.91 lbm/ft ³)
Density, Sat. Liquid	1.60 g/ml (99.9 lbm/ft ³)
Density, Gas @ 1 atm	0.0136 g/ml (0.851 lbm/ft ³)
Specific Volume, Gas @ 1 atm	0.0733 m ³ /kg (1.175 ft ³ /lb)
Specific Heat, Liquid	1.103 kJ/kg°C (0.2634 BTU/lb°F)
Specific Heat, Vapor @ 1 atm	0.891 kJ/kg°C (0.2127 BTU/lb°F)
Heat of Vaporization @ boiling point	88.0 kJ/kg (37.9 BTU/lb)
Liquid Viscosity @ 0°C/25°C	0.56/0.39 centistokes
Vapor Pressure	0.404 bar (5.85 psia)
Relative Dielectric Strength, 1 atm (N ₂ =1.0)	2.3

Physical Properties (continued)

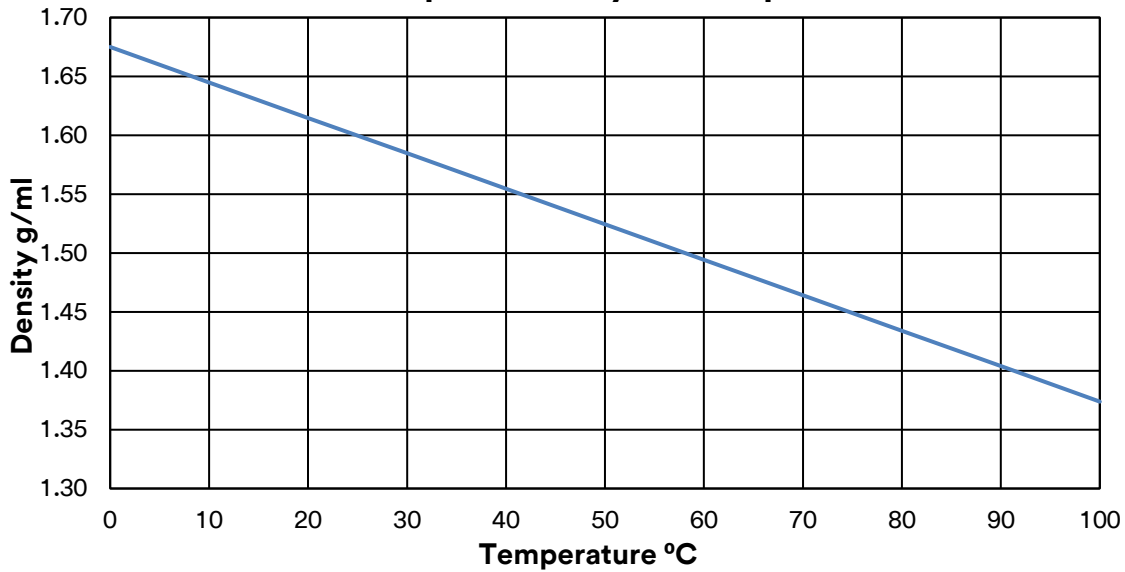
Although Novec 1230 fluid is a liquid at room temperature, its vapor pressure is sufficient for the agent to readily achieve vapor extinguishing concentrations in air. At 25°C, one could form vapor concentrations with Novec 1230 fluid up to 39 percent volume prior to reaching saturation. Typical fire suppression design concentrations for most applications are in the range of 4.5 to 6 percent by volume of the protected space. That large differential between design and saturation concentrations dictates that condensation of vapor will not occur.

**Novec 1230 fluid
Vapor Pressure vs Temperature**



3M™ Novec™ 1230 Fire Protection Fluid

**Novec 1230 fluid
Liquid Density vs Temperature**



Design Concentrations

Like other halocarbon halon alternatives, Novec extinguishes principally by removing heat from the fire. Upon discharge, Novec 1230 fluid creates a gaseous mixture with air. This agent/air mixture has a heat capacity much larger than that of air alone. A higher heat capacity means that this gas mixture will absorb more energy (heat) for each degree of temperature change it experiences. At the system design concentration, the agent/air mixture absorbs sufficient heat to upset the conditions required for combustion to occur. The amount of heat the fire loses to the surroundings is increased by the presence of the agent. This causes the combustion zone to cool to the point that the fire extinguishes. Novec 1230 fluid has the highest heat capacity of the commercially available halon alternatives resulting in the lowest extinguishing concentrations for a given fuel. The design concentration for Class A combustibles is a minimum of 4.5 vol% for designs based on UL 2166 in the USA. Different minimum design concentrations may be required in other countries based on local approvals.

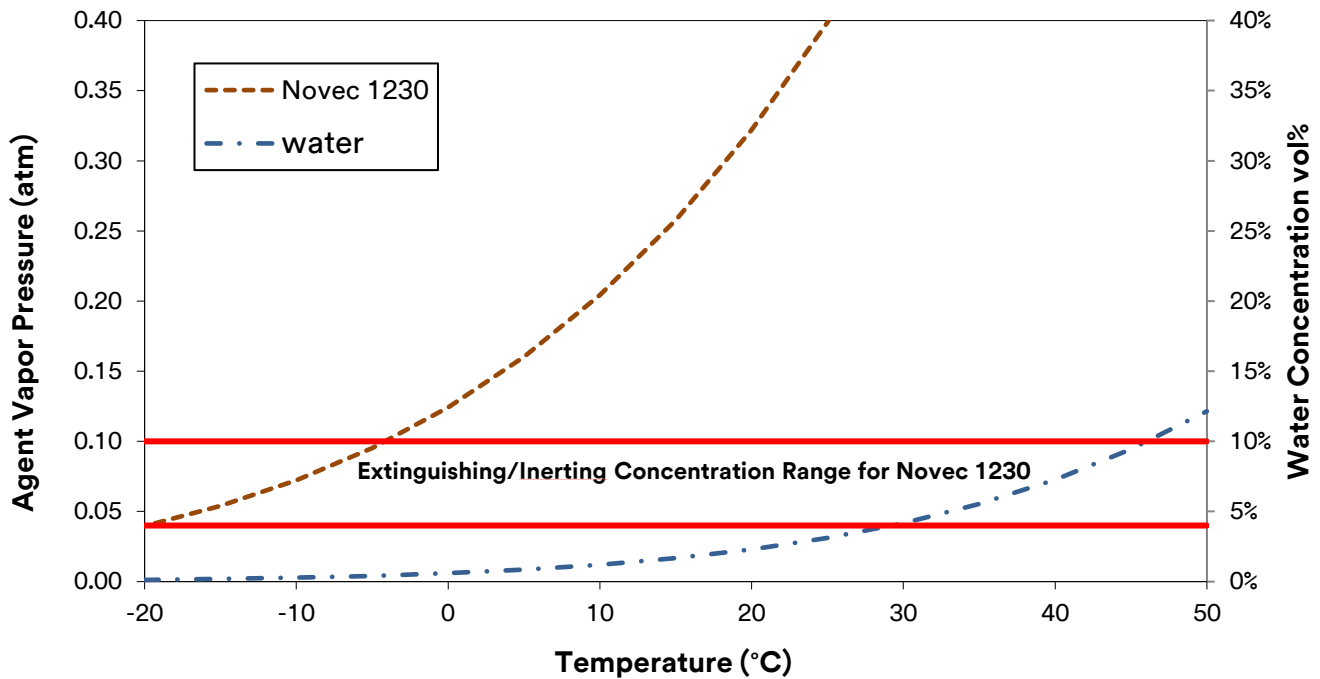


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Liquid to gas – how it works

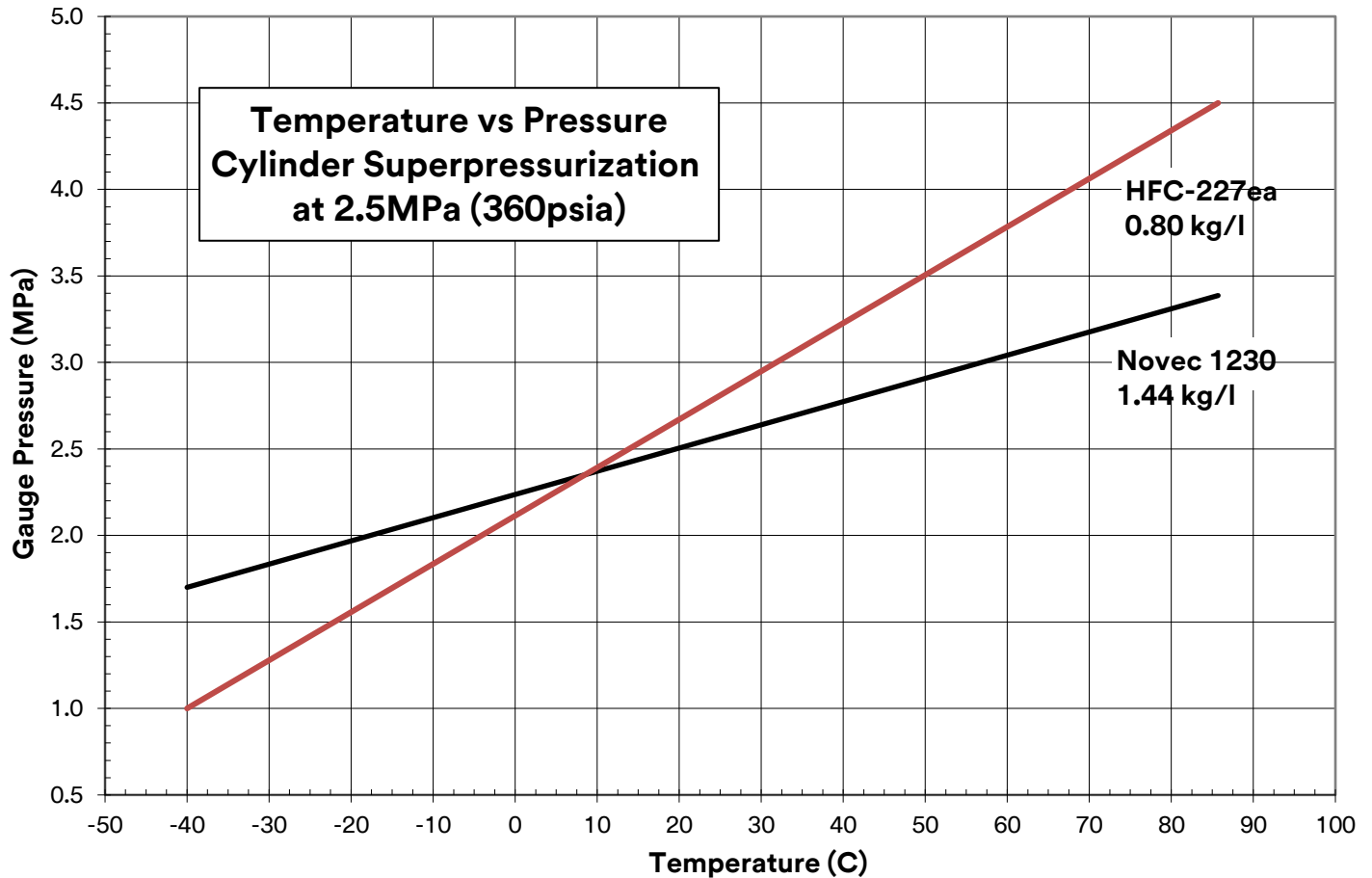
The following chart illustrates that Novec 1230 fluid is able to effectively vaporize over the expected range of design concentrations. Water is shown for comparison, because the evaporative behavior of water, while uncharacteristic of many fluids, is a more common experience. The left-hand ordinate measures the vapor pressure of the pure liquids in atmospheres. The right-hand ordinate measures the gas-phase concentration of Novec 1230 fluid or water assuming ideal solution and ideal gas behavior of a mixture with air at 1-atm total pressure (the liquid is considered a pure phase). In addition, boundary lines are drawn to represent a typical 4.5-10vol% Novec 1230 fluid concentration range for extinguishing or inerting applications. The plot shows that at an ambient 20°C(68°F) room temperature liquid Novec 1230 fluid will evaporate to create a 32vol% vapor, well above that of typical extinguishing concentrations for the material. Once evaporated, there is no driving force for a vapor to condense into a liquid unless the vapor/air mixture is compressed or cooled below its dew point. In fact, the vapor pressure of Novec 1230 fluid is such that it would support an extinguishing concentration of 5vol% at a temperature as low as -16°C(3°F). Water does not support a 5vol% concentration in air until the temperature exceeds 33°C(91°F).

Saturation Concentrations in Air for Novec 1230 fluid and Water



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The following graph displays an example of the unique properties that differentiate Novec 1230 fluid from other agents. Over a wide range of temperatures, a high boiling material like Novec 1230 fluid, when superpressurized with nitrogen in a cylinder, does not vary significantly in storage pressure like the lower boiling gases. Note the pressure delta of only 10 bar for Novec 1230 fluid, whereas with some low boiling gases, there can be as much as a 33 bar delta over the same temperature range. The maximum fill density for Novec 1230 fluid is 1.8 times greater than lower boiling gases over the -40°C to 80°C range. This is important in applications where there is an expected wide range of temperatures, such as military flightline, oil exploration rigs or aboard ships that may enter tropical or arctic waters.



Source: NFPA 2001 and 3M Labs

Typical Applications

Novec 1230 fluid can effectively be applied in total and localized flooding, inerting and explosion suppression applications in the following areas:

- Anechoic chambers
- Data centers/Server rooms
- Laboratories
- Marine vessels
- Medical records storage
- Military
- Museums & archives
- Oil & gas
- Paint rooms
- Power generation & power storage
- Telecommunications
- Transportation

3M™ Novec™ 1230 Fire Protection Fluid

Environmental Properties

Once emitted into the environment, there are a number of ways for organic compounds to be removed from the atmosphere. Studies conducted on Novec 1230 fluid have determined the atmospheric loss rates via these removal mechanisms and the effect on the atmospheric lifetime of this compound. The very low water solubility of Novec 1230 fluid and the low degree to which it partitions into liquid water was found to preclude atmospheric hydrolysis from being a meaningful removal mechanism. The principal atmospheric sink for Novec 1230 agent is photolysis. It exhibits strong absorption of energy at near UV wavelengths, resulting in a very short atmospheric lifetime. The rate of photolysis under atmospheric conditions and the mechanism of decomposition of this compound have been investigated by two different research groups^{1,2}. The photolysis rate of the fluoroketone leads to an atmospheric lifetime of approximately 1 week, which is consistent with the 3M study that found the atmospheric lifetime of Novec 1230 fluid to be on the order of 5 days.

Ozone Depletion Potential

Novec 1230 fluid, which contains no chlorine or bromine, has an ozone depletion potential of zero.

Global Warming Potential

Global Warming Potential (GWP) is an index that provides a relative measure of the possible climate impact due to a compound that acts as a greenhouse gas in the atmosphere. The GWP of a compound, as defined by the Intergovernmental Panel on Climate Change (IPCC), is calculated as the integrated radiative forcing due to the release of 1 kilogram of that compound relative to the warming due to 1 kilogram of CO₂.

The potential for Novec 1230 fluid to have a climate impact is limited by its very short atmospheric lifetime and low global warming potential. The GWP of Novec 1230 is calculated to be less than 1 using the IPCC 2013 method and a 100-year integration time horizon³, including both the direct effect from the agent as well as the indirect effect from decomposition products. Taniguchi et al.¹ and D'Anna et al.² have concluded that “the global warming potential of the compound is negligible.”

Potential for Reducing GHG Emissions

The fire protection industry has made considerable progress in reducing emissions from the relatively high levels experienced during the use of halon. However, the high GWP of the HFCs used in these applications combined with their growing installed base, results in continually increasing greenhouse gas emissions. A single discharge of an average sized fire protection system containing HFCs is meaningful in itself. Based upon an average sized Halon 1301 system containing 200kg, an equivalent sized system using, for example, HFC-227ea, contains approximately 347 kg of agent. A GWP of 3350 results in CO₂ equivalent emissions of 1,160,000 kg when this HFC agent is discharged. This is equivalent to the emissions from more than 240 typical automobiles in the USA driven for an entire year!

Discharge of a fire protection system using Novec 1230 fluid in place of an HFC extinguishing agent results in significantly reduced greenhouse gas emissions. Due to the dramatically lower GWP, greenhouse gas emissions from discharge of Novec 1230 fluid are reduced by more than 99.9% compared to any of the HFCs used in fire protection. As a result, Novec 1230 fluid is a low GWP alternative that can reduce emissions of greenhouse gases in fire protection applications and help to further the environmental goals of the industry.

3M™ Novec™ 1230 Fire Protection Fluid

Environmental Properties

Not for specification purposes. All data other than those for Novec 1230 fluid were compiled from published sources.

Properties	Novec 1230	Halon 1211	Halon 1301	HFC-125	HFC-227ea
Ozone Depletion Potential (ODP) ¹	0.0	4.0	12.0	0.0	0.0
Global Warming Potential – IPCC ²	<1	1750	6290	3170	3350
Atmospheric Lifetime (years)	0.019	16	65	28.2	38.9
SNAP (Yes/No)	Yes	N/A	N/A	No	No

¹ World Meteorological Organization (WHO) 1998, Model-Derived Method.

² Intergovernmental Panel on Climate Change (IPCC) 2013 Method, 100 Year ITH.

Safety Considerations

The safety of Novec 1230 fluid has been thoroughly evaluated through both acute and repeat dose toxicity testing. A full series of toxicological tests has been completed using this compound. In each case, Novec 1230 fluid has been demonstrated to be very low in toxicity and to have a large margin of safety in use as a clean extinguishing agent. Key testing of Novec 1230 fluid was conducted at independent laboratories as shown in the following table.

Toxicity testing results

Properties	Novec 1230
4-hour Acute Inhalation	Practically Non-Toxic (LC ₅₀ > 100,000 ppm)
Cardiac Sensitization	Not a Sensitizer (NOAEL = 100,000 ppm)
Acute Dermal Toxicity	Low Toxicity (LD ₅₀ > 2000 mg/kg)
Ames Assay	Negative
Primary Skin Irritation	Non-Irritating
Primary Eye Irritation	Minimally Irritating
Acute Oral Toxicity	Low Toxicity (LD ₅₀ > 2000 mg/kg)
Skin Sensitization	Not a Skin Sensitizer
28-Day Inhalation Study	NOAEL of this study: 4,000 ppm
Chromosomal Aberration	Negative

The no observable adverse effect level (NOAEL) for any end point of acute toxicity has been determined to be 10 volume percent (100,000 ppmv) in air. With a NOAEL of 10%, there is consensus that Novec 1230 fluid is not only safe for its intended end use but that it provides a large margin of safety relative to the typical design concentrations of fire protection systems. Typical design concentrations in the range of 4.5 to 5.9 volume percent result in safety margins of 69% to 122%.

Thermal Decomposition

Well over 90% of applications involving the use of halocarbons, like Novec 1230 fluid, protect Class A assets, including those related to computer and telecommunication facilities. Continuity of operation is paramount, and those types of assets, typically involving electronic switches and circuit boards, cannot tolerate even a relatively moderate fire. System design, therefore, must be such that fire size be kept to a minimum.

Levels of HF produced from fires extinguished by Novec 1230 fluid are similar to those involving other physically acting halocarbon agents. Industry practice over the last decade has demonstrated that fire extinguishing systems using halogenated halon alternatives can be designed to minimize thermal decomposition product formation and avoid adding to the potential toxic threat of a fire event (the hazards created by the combustion products of the fire).

3M™ Novec™ 1230 Fire Protection Fluid

Materials Compatibility

Compatibility of “O” Rings with Novec 1230 Fluid

Exposure Time: 1 Week @ 25°C, 100°C

Elastomer Type	Exposure Temperature	Change In Shore A Hardness	% Change In Weight	% Change In Volume
Neoprene	25°C	-1.8	-0.06	-1.2
	100°C	-2.2	+2.3	+0.8
Butyl Rubber	25°C	-2.7	+0.2	+0.1
	100°C	-4.0	+4.3	+4.2
Fluoroelastomer	25°C	-6.2	+0.7	+0.6
	100°C	-12.6	+9.5	+10.6
EPDM	25°C	-4.7	+0.6	+0.3
	100°C	-5.7	+3.3	+2.4
Silicone	25°C	N/A	+3.1	+2.8
	100°C	-5.4	+6.0	+5.1
Nitrile	25°C	-0.7	-0.3	-0.5
	100°C	+2.5	+4.6	+0.7

Effect of Novec 1230 Fluid on Various Metals

Metals	Effect
Aluminum Alloy 6262 T6511	A
Brass Alloy UNS C36000	A
AISI Type 304L stainless steel	A
AISI Type 316L stainless steel	A
Copper UNS C12200	A
ASTM A 516, Grade 70 carbon steel	A

A. No discoloration of destruction of fluid or metal at temperature indicated, 10 days minimum exposure, 48°C

3M has extensive data on compatibility with various materials. For more information, contact your local 3M technical service representative.

Regulatory Registries

When commercializing Novec 1230 fluid, inclusion of the chemistry on a region’s or country’s chemical registry was required. For example, in Japan, a chemical must attain METI approval and, in the EU, the ELINCS approval must be in place before a chemical may be imported. Local regulatory approvals and listing on chemical registries of key countries are complete. The following table lists eight of the major chemical registry approvals.

Chemical Registry Approvals

Chemical: dodecafluoro-2-methylpentan-3-one

CAS#: 756-13-8

Country/Region	Status
USA (TSCA)	Listed
Canada (CDSL)	Listed
EU (ELINCS)	EC# 436-710-6
Australia (AICS)	Listed
Japan (METI)	METI# (2)-4024
Korea (KECI)	KECI# 2002-3-2022
China (IECSC)	Listed
Philippines (PICCS)	Listed

3M™ Novec™ 1230 Fire Protection Fluid

Additionally, both the German Hygiene Institute and Swiss BUWAL approval have been attained. In the USA, Novec 1230 fluid has been approved by the EPA Significant New Alternatives Policy (SNAP) Program for use as a halon replacement in both total flooding and streaming applications.

Industry Approvals

Fire suppression systems containing Novec 1230 fluid are commercially available globally. Globally recognized system listings and approvals, with Novec 1230 fluid as a component, are included in the following table. Component recognitions have been attained from US-based Underwriters Laboratories, Inc. and FM Global, as well as EU-based LPCB, VdS and CNPP. Also, the German Amtliche Prüfstelle has approved systems using Novec 1230 fluid. While approval from the SSL in Australia is complete, other Asia Pacific approvals are in progress.

Novec 1230 fluid is included in the 2022 edition of NFPA 2001, Standard on Clean Agent Fire Extinguishing Systems and the 2015-16 edition of ISO 14520, Gaseous Media Fire Extinguishing Systems. In each standard, it is referenced by the ASHRAE nomenclature FK-5-1-12.

General Industry Listings and Approvals

Listing Organization	Country/Region
Underwriters Laboratories Inc (ULI)	USA
Underwriters Laboratories CA (ULC)	Canada
FM Global (FM)	USA
Loss Prevention Certification Board (LPCB)	United Kingdom
Scientific Services Laboratories (SSL) Also called Certifire Pty Ltd	Australia
VdS Schadenverhütung (VdS)	Germany
Centre National de Prévention et de Protection (CNPP)	France
Korea Fire Institute (KFI)	Korea

In addition to the general industry listings and approvals above, Novec 1230 fluid has also successfully passed several marine application test protocols, including but not limited to RINA and IMO MSC/CIRC 1267. A complete list of marine approvals is included in the table below.

Marine Industry Listings and Approvals

Listing Organization	Country/Region
American Bureau of Shipping (ABS)	International
Australian Maritime Safety Agency	Australia
Bureau Veritas (BV)	France
Canadian Coast Guard	Canada
Danish Maritime Authority (DMA)	Denmark
Det Norske Veritas (DNV)	Norway
Germanischer Lloyd (GL)	Denmark
Icelandic Maritime Administration	Iceland
Inland/Sea going acceptance (BZI)	Belgium
Lloyd's Register of Shipping (LR)	International
Maritime and Coastguard Agency (MCA)	UK
Marine Merchant Approval	France
Nippon Kaiji Kyokai (NK)	Japan
Polish Register of Shipping	Poland
Registro Italiano Navale (RINA)	Italy
Shipping Authority Acceptance – Inland/Sea going	Holland
United States Coast Guard (USCG)	USA

3M™ Novec™ 1230 Fire Protection Fluid

Marine Equipment Directive (MED) Module B

EU

Commercial Availability

Independent original equipment manufacturers (OEMs) have substantially invested to gain the necessary approvals and to commercialize their total flooding systems with Novec 1230 fluid. Information for these OEMs can be accessed at the Novec 1230 fluid website at 3M.com/novec1230fluid

Total flooding system development has been the near-term effort of these companies. All have invested heavily to test their systems against recognized test protocols and commercialize their products. Recent development has expanded into specialty and military clean agent applications as well as portable extinguishers.

Use of Novec 1230 Fluid – General Information

Novec 1230 fluid as a commercial product is supplied by 3M with the expressed intent and purpose for use in fire protection systems designed for its use as a clean extinguishing agent in total flooding and streaming applications. Considered a sustainable halon replacement alternative to HCFCs and HFCs, it is a specialty chemical uniquely designed for use in the highly regulated fire suppression market to help protect critical assets needing such high-performance protection. As reviewed and approved by the US Environmental Protection Agency, Novec 1230 fluid is manufactured, supplied, supported and approved specifically for such use only. It is not approved for use in any other non-fire protection/suppression applications. Novec 1230 fluid is not approved for battery immersion applications.

Use of Novec 1230 Fluid – Lithium-Ion Batteries

Novec 1230 fluid in a gaseous overhead fire suppression system, designed and installed per the ISO 14520 Standard or NFPA 2001 Standard, can extinguish Class A, B and C hazard fires.

In spaces where lithium-ion batteries are stored or utilized, owners may elect to install a fire suppression system using Novec 1230 fluid to suppress ancillary fires that are external to the battery. Extinguishing the ancillary Class A, B and C fuel fires in areas near the lithium-ion batteries may help prevent a battery from overheating due to an external fire.

Additionally, lithium-ion batteries may leak the electrolytes that are present within the battery, which may be combustible. Owners may elect to install fire extinguishing systems using Novec 1230 fluid to suppress fires external to the battery that are caused by electrolyte leakage, which are Class B hazards.

To be clear, Novec 1230 fluid, utilized in total flooding fire suppression systems designed for Class A, B and C hazard fires, cannot stop thermal runaway once initiated. Any additional benefit of a fire suppression mechanism, device or delivery system using Novec 1230 fluid to prevent a cascading lithium-ion battery thermal runaway event is highly dependent on the battery properties and the system itself which include factors outside of 3M's knowledge or control, including battery design, state of battery charge, and Novec 1230 fluid concentration levels, as a few illustrative examples. Accordingly, the fire suppression system manufacturer is solely responsible for ensuring that any claim regarding the ability of the system to prevent a cascading lithium-ion battery thermal runaway event is true and accurate.

Packaging and Availability

Novec 1230 fluid is currently available in 2425 lb. (1100kg) intermediate bulk containers (IBCs), 661 lb. (300kg) drums and 11 lb. (5kg) glass sample jugs.

A cylinder containing Novec 1230 fluid superpressurized with nitrogen varies less than 150 psi (10.3 bar) over a temperature range of 250°F (120°C). Also, because it is packaged in IBCs and drums, it can be air freighted without the restrictions of gaseous alternatives.

Resources and Distribution



3M™ Novec™ 1230 Fire Protection Fluid

Novec 1230 fluid is supported by global sales, technical and customer service resources, with 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.

Extensive OEM policies and equipment design guidelines have been prepared for system retrofit, installers and equipment manufacturers in support of Novec 1230 fluid.

For additional technical information on Novec 1230 fluid in the United States, or for the name of a local authorized distributor, call 3M Electronic Markets Materials Division at **800 810 8513**.

For other 3M global offices, and information on additional 3M products, visit our web site at **3m.com/novec1230fluid**.

References

1. Taniguchi, N., Wallington, T.J., Hurley, M.D., Guschin, A.G., Molina, L.T., Molina, M.J., *Journal of Physical Chemistry A*, 107(15), 2674-2679, 2003.
2. D'Anna, B., Sellevag, S., Wirtz, K., and Nielsen, C.J., *Environmental Science and Technology*, 39, 8708-8711, 2005.
3. IPCC, 2013: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp.

3M™ Novec™ 1230 Fire Protection Fluid

The 3M™ Novec™ Brand Family

The Novec brand is the hallmark for a variety of proprietary 3M products. Although each has its own unique formula and performance properties, all Novec products are designed in common to address the need for safe, effective, sustainable solutions in industry-specific applications. These include precision and electronics cleaning, heat transfer, fire protection, protective coatings, immersion cooling, advanced insulation media replacement solutions and several specialty chemical applications.

3M™ Novec™ Engineered Fluids
3M™ Novec™ Aerosol Cleaners

3M™ Novec™ 1230 Fire Protection Fluid
3M™ Novec™ Electronic Surfactants

3M™ Novec™ Electronic Grade Coatings
3M™ Novec™ Insulating Gases

Safety Data Sheet: Consult Safety Data Sheet before use.

Regulatory: For regulatory information about this product, contact your 3M representative.

Technical Information: The technical information, recommendations and other statements contained in this document are based upon tests or experience that 3M believes are reliable, but the accuracy or completeness of such information is not guaranteed.

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