

**Novec™**

Brand

3M™ Novec™ 4710 Insulating Gas Health & Safety Bulletin

Introduction

3M™ Novec™ 4710 Insulating Gas is non-flammable and has a wide safety margin for workers when used as designed for its intended applications, in the gas insulated electrical equipment industry. It is a versatile insulating gas for medium- and high-voltage applications, including gas insulated lines, gas insulated switchgear, load break switches, disconnectors, instrument transformers and high-voltage circuit breakers. Novec 4710 gas is mixed with inert gases for applications in the gas insulated electrical equipment industry.

Novec 4710 gas combines excellent electrical insulation performance and a wide operating temperature window with desirable environmental properties. With a GWP much lower than SF₆ (sulfur hexafluoride) and strong dielectric properties, Novec 4710 gas is a more sustainable alternative to SF₆ for arc quenching and insulation applications leading to dramatic environmental impact reductions in gas insulated equipment. Novec 4710 gas in unmixed form has a relative dielectric strength 2 times greater than SF₆ at a given pressure.

Composition of 3M™ Novec™ 4710 Insulating Gas

Novec 4710 gas is a fluoronitrile with the chemical formula (CF₃)₂ CFCN, and the chemical name is 2,3,3,3-tetrafluoro-2-(trifluoromethyl)-propanenitrile.

Regulatory status

Novec 4710 gas is in compliance with the chemical notification/registration requirements of the United States, Europe, Canada, Korea, China and Japan. Additional notification/registration activities are in progress in these and other countries (or regions). Certain restrictions may apply. Contact your local 3M sales representative for additional information.

Classification of 3M™ Novec™ 4710 Insulating Gas

Test results demonstrate that unmixed Novec 4710 gas demonstrates low acute inhalation toxicity and is classified as category 4 for acute inhalation toxicity under the Global Harmonized System of Classification and Labeling of Chemicals (GHS).¹ For more information, contact your 3M technical service representative.

Intended applications in the gas insulated electrical equipment industry typically mix Novec 4710 gas with other gases (such as CO₂ or CO₂/O₂). The mixed Novec 4710 gas thereby further decreases exposure risk. The Safety Data Sheet (SDS) for Novec 4710 gas can be found at 3M.com/sds.

¹ The hazards of a material are routinely characterized by conducting single and repeat exposure studies. Hazards are categorized by using the GHS (Globally Harmonized System of Classification and Labeling of Chemicals) classification scheme, which can be found at unece.org.

Additional testing on 3M™ Novec™ 4710 Insulating Gas

New chemicals brought to market are subject to registration regulations such as REACH in Europe, TSCA in the United States, IECSC in China or K-REACH in South Korea. Specific test requirements, including carcinogenicity, mutagenicity and reproductive toxicity (CMR), are either pre-defined or need to be agreed and approved with the regulatory bodies as part of the registration process.

The test requirements are often volume dependent. Taking the example of REACH, the European Union registration defines four volume bands:

- **Annex VII:** 1 to <10 metric tons per year
- **Annex VIII:** 10 to <100 metric tons per year
- **Annex IX:** 100 to <1000 metric tons per year
- **Annex X:** ≥1000 metric tons per year

Testing protocols are determined by the volume band, with varying requirements as higher volumes are reached. It is also important to understand that testing for higher volume bands is based on the collective body of knowledge generated from the testing at the lower volume bands, including short-term toxicity tests. In some cases, it is deemed not necessary by ECHA (the European Chemicals Agency which administers REACH) to do more specific testing based on the cumulative results from the toxicity tests completed at the lower volume levels. For example, SF₆ was not required to be tested for carcinogenicity at the Annex X volume band based upon the results of the shorter-term toxicity studies completed at the lower volume bands. 3M uses independent third-party labs to conduct testing and has extensive data sets supporting these 3M™ Novec™ 4710 Insulating Gas classifications.

The table below shows the CMR classification of Novec 4710 gas.

Product Name	Chemical Formula	Carcinogenicity	Mutagenicity	Reproductive Toxicity	REACH Status
Novec 4710 Gas	(CF ₃) ₂ CFCN	Not required ²	Not classified ³	Not classified ³	Annex VIII

Novec 4710 gas is currently registered at the Annex VIII volume band in REACH. In alignment with the Annex VII band requirements, 3M has performed in vitro genotoxicity studies (Ames assay, gene mutation in mouse lymphoma cells and chromosomal aberration tests), which demonstrates negative or equivocal results. Due to the occurrence of equivocal results, 3M has further performed in vivo genotoxicity studies to determine the safety of Novec 4710 gas. Micronucleus and Comet genotoxicity studies performed in rats were negative, indicating no genotoxicity hazard for Novec 4710 gas.

In an additional step, 3M's assessments on the available data and associated hazard classification recommendation for 3M™ Novec™ 4710 Insulating Gas was confirmed and validated in an external assessment by Ramboll, an independent third party consultant with toxicology experts providing their opinion on the available studies and data on Novec 4710 gas.

To further demonstrate the safety of Novec 4710 gas, 3M has conducted a 28-day repeated exposure study as well as a reproductive and developmental toxicity study in rats. The 28-day inhalation toxicity study showed Novec 4710 gas to be a nasal irritant at exposure concentrations much higher than the Occupational Exposure Limit (OEL) of 65 ppmv (parts per million by volume), which is recommended by 3M. OEL details of Novec 4710 gas are discussed below. Likewise, the reproductive and developmental toxicity study demonstrated no adverse effects to reproduction or fetal development.

Based on the above results, Novec 4710 gas has low acute inhalation toxicity, with nasal irritation identified as the adverse effect following repeated exposure (28 days) to concentrations well above the OEL, demonstrates no reproductive or developmental toxicity hazard, and is not mutagenic. Therefore, it is expected that Novec 4710 gas would not be classified for CMR.

²Testing not required at the Annex VIII volume band.

³Not classified as hazardous under GHS (Globally Harmonized System of Classification and Labeling of Chemicals).

Handling and use of 3M™ Novec™ 4710 Insulating Gas

The handling procedures for 3M™ Novec™ 4710 Insulating Gas will be similar to the handling procedure associated with SF₆ when used as designed for intended applications in the gas insulated electrical equipment industry. 3M understands that a wide safety margin is necessary for handling and using gases in this industry.

Based on toxicity study test results, 3M has established an OEL of 65 ppmv for unmixed Novec 4710 gas. OELs are airborne concentrations of a chemical to which an employee can be exposed in an occupational lifetime without experiencing adverse health effects. The 65 ppmv OEL of Novec 4710 gas is intended to be protective of human health based on exposure to the material for eight hours a day, five days a week, 52 weeks a year, for an occupational lifetime (typically assumed to be 30 years or more). The OEL for Novec 4710 gas is an 8-hour, time-weighted average (TWA) value. For more information, contact your 3M technical service representative.

A gas transfer operation may not be necessary in the field. In the event that such an operation is conducted, 3M has assessed the exposure of unmixed Novec 4710 gas during a gas transfer operation and found those concentrations to typically be less than 10 ppmv. While 3M expects others to find similar results with unmixed Novec 4710 gas, each site/operation should make a determination based on an industrial hygiene assessment. On this basis, there is a wide safety margin between the OEL of Novec 4710 gas and the anticipated workplace environment exposures.

In normal operation, Novec 4710 gas is mixed with inert gases thereby further decreasing its exposure risk.

Familiar materials with a similar Occupational Exposure Limit as 3M™ Novec™ 4710 Insulating Gas

The table below compares the OEL of Novec 4710 gas to other commonly used materials.

Material	Common Use	OEL (8-hour TWA)
Novec 4710 gas	Dielectric insulation gas	65 ppmv
Ammonia	Ingredient in glass cleaners	25 ppmv
Acetic acid	Ingredient in vinegar	10 ppmv
Hydrogen peroxide	Component of disinfectant solutions	1 ppmv

Ammonia (ingredient in glass cleaners), acetic acid (ingredient in vinegar) and hydrogen peroxide (component of disinfectant solutions) are three chemicals that have widespread consumer use and exposure to the general public. As shown in the above table, these chemicals have lower OELs when compared to Novec 4710 gas. On this basis, ammonia, acetic acid and hydrogen peroxide present a lower airborne threshold of experiencing potential adverse effects than Novec 4710 gas.

Additional considerations for arced 3M™ Novec™ 4710 Insulating Gas

In the case of electrical arcing events in equipment containing SF₆, high-toxicity decomposition byproducts such as HF, S₂F₁₀ and SO₂ can be generated. These byproducts are highly hazardous and pose a potential toxicity risk to those exposed. Depending on the nature of the arcing event, Novec 4710 gas may also undergo some degree of decomposition. Even though testing demonstrated that arced Novec 4710 gas mixtures can be less hazardous than arced SF₆ mixtures, similar precautions should be taken when handling such gas mixtures. Additional information can be found in the reference publication.⁴ A copy of this publication can be obtained from your 3M technical service representative.

Employees performing maintenance procedures on electrical switches containing arced SF₆ are required to use proper handling procedures and wear personal protective equipment. Similar precautions should be taken with arced Novec 4710 gas or mixtures of Novec 4710 gas with other gases.

⁴ Yannick Kieffel, François Biquez, Daniel Vigouroux, Philippe Ponchon, Audrey Schlernitzauer, Richard Magous, Gérard Cros, John G. Owens, 2017, "Characteristics of g⁹ – an alternative to SF₆" 24th International Conference on Electricity Distribution, Paper 0795.

Smart. Safe. Sustainable.

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 smart, safe and 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 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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