

Diagnóstico del Riesgo y Medidas de Protección para Incendios en Turbinas Eólicas

ANEXOS

Autor: Rafael Torres Silva
Director: Ricard Bosch Tous
Convocatòria: Octubre 2016

Màster en Enginyeria de l'Energia



Anexo A

Tabla 1: Tipos de detectores adecuados para cada zona

Type of detector	Smoke detector			Heat detector (index "R" according to DIN EN 54-5)		Flame detector		Multi-sensor smoke detector	
	Point-shaped	Multi-point-shaped	Linear	Point-shaped	Linear	IR	UV	Smoke and heat	Smoke and CO
	Scattered light	Aspirating	Light beam						
Room/Installation									
Nacelle with transformer, including hub and raised floors	-	+	-	-	-	-	-	-	-
Central electric power substation, switch cabinet rooms	+	+	+	+	+	-	-	+	+
Tower base/platform with available installations, if applicable	-	+	-	+	-	-	-	-	-
Switchgear cabinets	+	+	-	-	-	-	-	+	-
Hydraulic systems	-	+	-	+	-	-	-	-	-
Transformer	-	+	-	Buchholz relay		-	-	-	-
+ basically suitable - not likely suitable The data in this table refers to the basic suitability of several types of detectors with respect to functionality and general application conditions in the respective area of the wind turbine's system; it serves as orientation guide and does not replace the required proof of suitability as well as the object-specific technical planning by appropriate specialist planners, e.g., VdS-approved installers. Type-specific characteristics of wind turbines and fire detection systems have to be taken into account after consulting with the insurer (e.g., Engineering department), VdS Schadenverhütung GmbH (VdS loss prevention) as well as the certifying body for wind turbines, if applicable (for more information see also VdS guidelines for the planning and installation of fire detection systems).									



Tabla 2: Tipos de sistemas de extinción adecuados para cada zona

Extinguishing systems (extinguishing agents)	Gas extinguishing systems		Water extinguishing systems				Other extinguishing systems	
	CO ₂ (high pressure)	Inert gases	Sprinkler	Water spray	Fine spray	Foam	Powder	Aerosol ¹⁾
Room/Installation wind turbine								
Room protection, e.g.,								
Nacelle with generator, transformer, hydraulic systems, gearbox, brake, azimuth drive	+	+	+	+	+	-	-	-
Hub with pitch drive and generator, if applicable	+	+	+	+	+	-	-	-
Raised floors with oil sump and cable and electrical installations	+	-	+	+	+	+	-	-
Central electric power substation, switchgear rooms (without transformer)	+	+	-	-	+	-	-	-
Tower base/platform with available installations, if applicable	+	+	+	+	+	-	-	-
Installation protection, e.g.,								
Control, inverter, switchgear cabinets (LV/MV), closed	+	+	-	-	+	-	-	-
Transformer	+	-	-	+	+	-	-	-
Control, inverter, switchgear cabinets (LV/MV), open	+	-	-	-	+	-	-	-
Hydraulic system, open	+	-	+	+	+	+	-	-
+ basically suitable - not likely suitable The data in this table refers to the basic suitability of several fire extinguishing systems with respect to their functionality and general application conditions in the respective area of the wind turbine's system; it serves as a first orientation guide and does not replace the required proof of suitability as well as the object-specific technical planning by appropriate specialist planners, e.g., VdS-approved installers. Type-specific characteristics of wind turbines and fire extinguishing systems have to be taken into account after consulting with the insurer (e.g., Engineering department), VdS Schadenverhütung GmbH (VdS loss prevention) as well as the certifying body for wind turbines, if applicable (for more information see also VdS guidelines for the planning and installation of the respective fire extinguishing systems).								
¹⁾ There is currently no empirical information available on the reliability and effectiveness concerning the application of aerosol extinguishing systems								



APPENDIX 2

MATERIAL SAFETY DATA SHEET

3M Novec 1230 Fire Protection Fluid

64 Draft Rev A 2014-10-10 CONFIDENTIAL – NOT FOR DISTRIBUTION

Novec 1230

3M MATERIAL SAFETY DATA SHEET 3M (TM) Novec (TM) 1230 Fire Protection Fluid [FK-5-1-12]
02/01/2005

Material Safety Data Sheet

Copyright, 2005, 3M Company. All rights reserved. Copying and/or downloading of this information for the purpose of properly utilizing 3M products is allowed provided that: (1) the information is copied in full with no changes unless prior written agreement is obtained from 3M, and (2) neither the copy nor the original is resold or otherwise distributed with the intention of earning a profit thereon.

SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: 3M (TM) Novec (TM) 1230 Fire Protection Fluid [FK-5-1-12]

MANUFACTURER: 3M

DIVISION: Electronics Markets Materials Division

ADDRESS: 3M Center
St. Paul, MN 55144-1000

EMERGENCY PHONE: 1-800-364-3577 or (651) 737-6501 (24 hours)

Issue Date: 02/01/2005

Supersedes Date: 02/01/2005

Document Group: 16-3425-2

Product Use:

Specific Use: STREAMING AND FLOODING FIRE PROTECTION

SECTION 2: INGREDIENTS

Ingredient C.A.S. No. % by Wt

1,1,1,2,2,4,4,5,5-NONAFLUORO-4-(TRIFLUOROMETHYL)-3-PENTANONE 756-13-8 > 99.9

SECTION 3: HAZARDS IDENTIFICATION

3.1 EMERGENCY OVERVIEW

Specific Physical Form: Liquid

Odor, Color, Grade: clear colorless, low odor.

General Physical Form: Liquid

Immediate health, physical, and environmental hazards: This product, when used under reasonable conditions and

in accordance with the 3M directions for use, should not present a health hazard. However, use or processing of the product in a manner not in accordance with the product's directions for use may affect the performance of the product and may present potential health and safety hazards. This product is very low in acute toxicity. The LC50 (rat) is >10% v/v. The NOAEL for cardiac sensitization is also >10% v/v, providing a large margin of safety when used at effective design concentrations as a fire protection fluid.

3.2 POTENTIAL HEALTH EFFECTS

Page 1 of 7

3M MATERIAL SAFETY DATA SHEET 3M (TM) Novec (TM) 1230 Fire Protection Fluid [FK-5-1-12]
02/01/2005

65 Draft Rev A 2014-10-10



CONFIDENTIAL – NOT FOR DISTRIBUTION

Eye Contact:

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

Skin Contact:

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

Inhalation:

Prolonged or repeated exposure, above recommended guidelines, may cause:

May be absorbed following inhalation and cause target organ effects.

Ingestion:

No health effects are expected.

Target Organ Effects:

Prolonged or repeated exposure, above recommended guidelines, may cause:

Liver Effects: Signs/symptoms may include loss of appetite, weight loss, fatigue, weakness, abdominal tenderness and jaundice.

SECTION 4: FIRST AID MEASURES

4.1 FIRST AID PROCEDURES

The following first aid recommendations are based on an assumption that appropriate personal and industrial hygiene practices are followed.

Eye Contact: Flush eyes with large amounts of water. If signs/symptoms persist, get medical attention.

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

Inhalation: If signs/symptoms develop, remove person to fresh air. If signs/symptoms persist, get medical attention.

If Swallowed: Do not induce vomiting. Give victim two glasses of water. Never give anything by mouth to an unconscious person. If signs/symptoms develop, get medical attention.

SECTION 5: FIRE FIGHTING MEASURES

5.1 FLAMMABLE PROPERTIES

Autoignition temperature *Not Applicable*

Flash Point *Not Applicable*

Flammable Limits - LEL [*Details: Nonflammable*]

Flammable Limits - UEL [*Details: Nonflammable*]

5.2 EXTINGUISHING MEDIA

Product is a fire-extinguishing agent.

Page 2 of 7

3M MATERIAL SAFETY DATA SHEET 3M (TM) Novec (TM) 1230 Fire Protection Fluid [FK-5-1-12]
02/01/2005

66 Draft Rev A 2014-10-10



CONFIDENTIAL – NOT FOR DISTRIBUTION

5.3 PROTECTION OF FIRE FIGHTERS

Special Fire Fighting Procedures: Wear full protective equipment (Bunker Gear) and a self-contained breathing apparatus (SCBA).

Unusual Fire and Explosion Hazards: Not applicable.

Note: See **STABILITY AND REACTIVITY (SECTION 10)** for **hazardous combustion and thermal decomposition information.**

SECTION 6: ACCIDENTAL RELEASE MEASURES

Accidental Release Measures: Observe precautions from other sections. Call 3M- HELPS line (1-800-364-3577) for more information on handling and managing the spill. Ventilate the area with fresh air. Contain spill. For larger spills, cover drains and build dikes to prevent entry into sewer systems or bodies of water. 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. Collect as much of the spilled material as possible. Clean up residue. Place in a metal container approved for transportation by appropriate authorities. Seal the container. Dispose of collected material as soon as possible.

In the event of a release of this material, the user should determine if the release qualifies as reportable according to local, state, and federal regulations.

SECTION 7: HANDLING AND STORAGE

7.1 HANDLING

Contents may be under pressure, open carefully. Avoid breathing of vapors, mists or spray. Avoid eye contact with vapors, mists, or spray.

7.2 STORAGE

Keep container in well-ventilated area.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 ENGINEERING CONTROLS

Provide local exhaust ventilation at transfer points. Provide appropriate local exhaust ventilation on open containers. Use general dilution ventilation and/or local exhaust ventilation to control airborne exposures to below Occupational Exposure Limits and/or control mist, vapor, or spray. If ventilation is not adequate, use respiratory protection equipment.

8.2 PERSONAL PROTECTIVE EQUIPMENT (PPE)

8.2.1 Eye/Face Protection

Avoid eye contact.

The following eye protection(s) are recommended: Indirect Vented Goggles.

8.2.2 Skin Protection

Avoid prolonged or repeated skin contact.

Select and use gloves and/or protective clothing to prevent skin contact based on the results of an exposure assessment. Consult with your glove and/or protective clothing manufacturer for selection of appropriate compatible materials.

Page 3 of 7

**3M MATERIAL SAFETY DATA SHEET 3M (TM) Novec (TM) 1230 Fire Protection Fluid [FK-5-1-12]
02/01/2005**

67 Draft Rev A 2014-10-10



CONFIDENTIAL – NOT FOR DISTRIBUTION

Gloves made from the following material(s) are recommended: Butyl Rubber.

8.2.3 Respiratory Protection

Avoid breathing of vapors, mists or spray. Under normal use conditions, airborne exposures are not expected to be significant enough to require respiratory protection.

Select one of the following NIOSH approved respirators based on airborne concentration of contaminants and in accordance with OSHA regulations: Half facepiece or fullface air-purifying respirator with organic vapor cartridges. Consult the current 3M Respiratory Selection Guide for additional information or call 1-800-243-4630 for 3M technical assistance. If thermal decomposition occurs, wear supplied air respiratory protection.

8.2.4 Prevention of Swallowing

Do not eat, drink or smoke when using this product. Wash exposed areas thoroughly with soap and water.

8.3 EXPOSURE GUIDELINES**Ingredient Authority Type Limit Additional Information**

1,1,1,2,2,4,5,5,5-NONAFLUORO-4-(TRIFLUOROMETHYL)-3-PENTANONE 3M TWA 150 ppm

SOURCE OF EXPOSURE LIMIT DATA:

ACGIH: American Conference of Governmental Industrial Hygienists

CMRG: Chemical Manufacturer Recommended Guideline

OSHA: Occupational Safety and Health Administration

AIHA: American Industrial Hygiene Association Workplace Environmental Exposure Level (WEEL)

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Specific Physical Form: Liquid

Odor, Color, Grade: clear colorless, low odor.

General Physical Form: Liquid

Autoignition temperature *Not Applicable*

Flash Point *Not Applicable*

Flammable Limits - LEL [*Details: Nonflammable*]

Flammable Limits - UEL [*Details: Nonflammable*]

Boiling point 49 °C

Vapor Density 11.6 [*Ref Std: AIR=1*]

Vapor Pressure 244 mmHg [*@ 20 °C*]

Specific Gravity 1.6 [*Ref Std: WATER=1*]

pH *Not Applicable*

Melting point -108 °C

Solubility in Water Nil

Evaporation rate > 1 [*Ref Std: BUOAC=1*]

Volatile Organic Compounds *No Data Available*

Percent volatile 100 %

VOC Less H₂O & Exempt Solvents *No Data Available*

Viscosity 0.6 centipoise [*@ 25 °C*]

SECTION 10: STABILITY AND REACTIVITY

Page 4 of 7

68 Draft Rev A 2014-10-10



CONFIDENTIAL – NOT FOR DISTRIBUTION

3M MATERIAL SAFETY DATA SHEET 3M (TM) Novec (TM) 1230 Fire Protection Fluid [FK-5-1-12]
02/01/2005

Stability: Stable.

Materials and Conditions to Avoid: Strong bases; Amines; Alcohols Additional Information: Avoid direct sunlight and ultraviolet light

Hazardous Polymerization: Hazardous polymerization will not occur.

Hazardous Decomposition or By-Products**Substance Condition**

Carbon monoxide During Combustion

Carbon dioxide During Combustion

Hydrogen Fluoride During Combustion

SECTION 11: TOXICOLOGICAL INFORMATION

Please contact the address listed on the first page of the MSDS for Toxicological Information on this material and/or its components.

SECTION 12: ECOLOGICAL INFORMATION**ECOTOXICOLOGICAL INFORMATION****Test Organism Test Type Result**

Green algae, *Selenastrum capricornutum* 96 hours Aquatic Toxicity - Acute >150 mg/L % weight

Additional Algae Species data for C6 Ketone:

Anabaena 96-hr EC50 = 920 mg/L (# cells) and >1000 (U) mg/L for C6 Ketone, calculated as 79.7 mg/L (# cells) and > 86.6 mg/L (u) for PFPA.

Duckweed 7-day EC50 = >500 mg/L for C6 Ketone and > 17.7 mg/L for PFPA.

Naviculla 96-hr EC50 = > 500 mg/L for C6 ketone and > 14.2 mg/L for PFPA.

Data for Pentafluoropropionic acid (PFPA), a hydrolysis product of C6 Ketone (L-15566):

Fish 96-hr LC50 (Fathead minnow) - >1070 mg/L measured conc.

Daphnia 48-hr EC50 - > 1080 mg/L measured conc.

Algae 96-hr EC50 (*Selenastrum capricornutum*) - 5.37 mg/L (# cells), 10.6 mg/L (u), measured conc.

OECD 209 (3-hour EC50) > 10,000 mg/L

Other Species 96-hr LC50 = 408 mg/L (orange-red killifish)

BCF 1.2 and < 4.8 (two levels tested)

CHEMICAL FATE INFORMATION

Hydrolysis Half-life of C6 Ketone - <2.5 min at pH 1.2, 5, 7 and 9

Biodegradation Information for Pentafluoropropionic acid (PFPA):

MITI - 28-day % biodegradation = 1%, STURM = 3% biodegradation

Page 5 of 7

69 Draft Rev A 2014-10-10



CONFIDENTIAL – NOT FOR DISTRIBUTION

3M MATERIAL SAFETY DATA SHEET 3M (TM) Novec (TM) 1230 Fire Protection Fluid [FK-5-1-12]
02/01/2005

SECTION 13: DISPOSAL CONSIDERATIONS

Waste Disposal Method: Incinerate in an industrial or commercial facility in the presence of a combustible material. Combustion products will include HF. Facility must be capable of handling halogenated materials.

As a disposal alternative, dispose of waste product in a facility permitted to accept chemical waste. Reclaim if feasible. For information on product return, contact your distributor.

EPA Hazardous Waste Number (RCRA): Not regulated

Since regulations vary, consult applicable regulations or authorities before disposal.

SECTION 14: TRANSPORT INFORMATION

ID Number(s):

98-0212-3030-9, 98-0212-3031-7, 98-0212-3201-6, 98-0212-3203-2, 98-0212-3217-2

Please contact the emergency numbers listed on the first page of the MSDS for Transportation Information for this material.

SECTION 15: REGULATORY INFORMATION

US FEDERAL REGULATIONS

Contact 3M for more information.

311/312 Hazard Categories:

Fire Hazard - No Pressure Hazard - No Reactivity Hazard - No Immediate Hazard - No Delayed Hazard - Yes

STATE REGULATIONS

Contact 3M for more information.

CHEMICAL INVENTORIES

The components of this product are in compliance with the chemical notification requirements of TSCA.

One or more of the components of this product have been notified to ELINCS (European List of Notified or New Chemical

Substances). Certain restrictions apply. Contact the selling division for additional information.

All the components of this product are listed on China's Inventory of Chemical Substances.

The components of this material are in compliance with the new chemical notification requirements for the Korean Existing Chemicals Inventory.

Contact 3M for more information.

Page 6 of 7

70 Draft Rev A 2014-10-10



CONFIDENTIAL – NOT FOR DISTRIBUTION

3M MATERIAL SAFETY DATA SHEET 3M (TM) Novec (TM) 1230 Fire Protection Fluid [FK-5-1-12]
02/01/2005

Additional Information: The components of this product are in compliance with the chemical notification requirements of the National Industrial Chemical Notification and Assessment Scheme (NICNAS) of Australia, the Canadian Environmental Protection Act (CEPA) and the Ministry of Economy, Trade and Industry of Japan.

INTERNATIONAL REGULATIONS

Contact 3M for more information.

This MSDS 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 Reactivity: 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.

HMIS Hazard Classification

Health: 0 Flammability: 0 Reactivity: 1 Protection: X - See PPE section.

Hazardous Material Identification System (HMIS(r)) 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(r) ratings are to be used with a fully implemented HMIS(r) program. HMIS(r) is a registered mark of the National Paint and Coatings Association (NPCA).

Revision Changes:

Section 14: ID Number(s) was modified.

DISCLAIMER: The information in this Material Safety Data Sheet (MSDS) is believed to be correct as of the date issued. 3M MAKES NO WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR COURSE OF PERFORMANCE OR USAGE OF TRADE.

User is responsible for determining whether the 3M product is fit for a particular purpose and suitable for user's method of use or application. Given the variety of factors that can affect the use and application of a 3M product, some of which 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 user's method of use or application.

3M provides information in electronic form as a service to its customers. Due to the remote possibility that electronic transfer may have resulted in errors, omissions or alterations in this information, 3M makes no representations as to its completeness or accuracy. In addition, information obtained from a database may not be as current as the information in the MSDS available directly from 3M.

3M MSDSs are available at www.3M.com

