SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifier

Product name: Insert Product Name

Other common names or synonyms: TEMPO cellulose nanofibrils (T-CNF), microfibrillated cellulose, nanofibrils, microfibrils, nanofibrillated cellulose, cellulose nanofibers

CAS No: Insert CAS no. here; may be different from cellulose (9004-34-6) based on production method; consultation with CAS Inventory Expert Service recommended. Possible CAS No. include:

Name	CAS No.
Cellulose	9004-34-6
Cellulose, 6-carboxy (6-CC)	9032-53-5
6-carboxycellulose, sodium salt	9069-12-9

1.2 Relevant identified uses of the substance or mixture and uses advised against

Relevant identified uses:

Uses advised against:

1.3 Details of the supplier of the safety data sheet

Company: Insert Company Name

Address: Insert Address

Phone number: Insert Phone Number

Fax: Insert Fax

E-mail: Insert E-mail

1.4 Emergency telephone number

Emergency phone number: Insert Emergency Phone Number

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

STOT SE 3 (H335: May cause respiratory irritation)

2.2 Label elements

Hazard pictogram: GHS07: Exclamation mark

Signal word: WARNING

Hazard statements

H335: May cause respiratory irritation (if in powder form)

Precautionary statements

Precautionary statements – prevention

P210: If dry, keep away from all ignition sources including heat, sparks, open flames. Prevent dust accumulations to minimize explosion hazard.

P261: Avoid breathing dust

P262: Do not get in eyes, on skin, or on clothing

P264: Wash hands thoroughly after handling

P271: Use only outdoors or in a well-ventilated area

P280: Wear protective gloves/protective clothing/eye protection/face protection

Precautionary statements – response
P304+P340: IF INHALED Remove victim to fresh air and keep at rest in a position comfortable for breathing
P305+P351+P338: IF IN EYES Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P312: Call a POISON CENTER or doctor/physician if you feel unwell
Precautionary statements – storage
P235: Keep cool
P403+PP233: Store in well-ventilated place. Keep container tightly closed
Precautionary statements – disposal
P501: Dispose of contents/container in accordance with local/regional/national/international regulation.

2.3 Other hazards
Explosion hazard: If powder form, strong explosion hazard if dust is dispersed into air at high enough concentrations.

SECTION 3: Composition/information on ingredients

3.1 Substances

Chemical name:	Chemical name is based on molecular identity, consultation with CAS Inventory Expert Service recommended. Potentially TEMPO Cellulose Nanofibrils (T-CNF).
CAS no:	Insert CAS no. here. May be different from 9004-34-6 (Cellulose) because of carboxylated form. Consultation with CAS Inventory Expert Service recommended; see Section 1 above.
Composition:	Insert Composition/Information on ingredients (CAS number, name, Weight %)

SECTION 4: First aid measures

4.1 Description of first aid measures	***Inhalation***	If dry powder, move to fresh air. Get medical attention if symptoms appear.
	Skin contact	Soap wash. Get medical attention if irritation occurs.
	Eye contact	Remove any contact lenses. Irrigate immediately. Get medical attention if irritation occurs.
	Ingestion	Do not induce vomiting unless directed to do so by medical personnel. Get medical attention if symptoms appear.
4.2 Most important symptoms and effects, both acute and delayed	***Acute effects***	Potential symptoms: Hoarseness, cough and phlegm. Exercise-induced dyspnea.
	Delayed effects	No data available.
4.3 Indication of any immediate medical attention and special treatment needed	***Note to physician***	This product may contain nanoscale particles. At this time, there is no further guidance specific to nanomaterial exposure.

SECTION 5: Firefighting measures

5.1 Extinguishing media	Use water, alcohol-resistant foam, dry chemical, or carbon dioxide.

5.2 Special hazards arising from the substance or mixture	Carbon monoxide, oxides of sulfur, carbon dioxide may form when heated to decomposition. **Explosion**: If powder, avoid generating dust.
5.3 Advice for fire fighters	As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective clothing.

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures	Remove ignition sources and provide sufficient ventilation. Avoid dispersal in air (i.e. clearing with compressed air), use current good practices. If powder, wear protective clothing and contained breathing apparatus for spills, avoid inhalation, and wash skin following contact. See section 8 for more details on protective equipment.
6.2 Environmental precautions	In the case of accidental spill, keep away from drains, surface, and ground water. No acute environmental hazard.
6.3 Methods and materials for containment and cleaning up	Ensure the product is not present at concentration level above cellulose TLV (section 8.1). Use HEPA-filtered vacuum or wet wiping methods and avoid re-dispersion of nanomaterial powder into the air. For gel spills, use absorbent materials/liquid traps.
6.4. Reference to other sections	See sections 8 and 13.

SECTION 7: Handling and storage

7.1 Precautions for safe handling	Use precautions taken for handling and storage of dusts and fine powder. Minimize dust generation and accumulation. Routine housekeeping should be instituted to ensure that dusts do not accumulate on surfaces.
7.2 Conditions for safe storage, including any compatibilities	Store in closed, tightly sealed containers in cool (4°C), dry, well-ventilated area, away from sources of ignition, electrostatic sparks, extreme heat, or mechanical friction. Prevent gels from drying to powder. Protect from freezing. Do not store food or beverages in areas where materials are handled. Store away from strong oxidizing agents. Do not smoke in work area where nanomaterials are stored.
7.3. Specific end use(s)	Insert if known.

SECTION 8: Exposure controls/personal protection

8.1 Control parameters	
T-CNF	**Cellulose dust**
Avoid inhalation exposure to dried/powder forms and dusts. No occupational exposure limits for nano-forms of cellulose exist.	*OSHA Permissible Exposure Limit (PEL)* - 15 mg/m^3 (total dust); 5 mg/m^3 (respirable fraction) Time Weighted Average (TWA) *NIOSH Recommended Exposure Limit (REL)* – 10 mg/m^3 (total dust) TWA; 5 mg/m^3 (respirable fraction) TWA *American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV)* - 10 mg/m^3 TWA

British Standards Institute has developed pragmatic guidance for Occupational Exposure Limit (OEL) - for insoluble nanomaterials a factor of 0.066*OEL of conventional material is proposed.	*British Columbia Occupational Exposure Limit (OEL)* – 10 mg/m^3 (total dust) TWA; 3 mg/m^3 (respirable fraction) TWA

8.2 Exposure controls

8.2.1. Appropriate engineering controls*:* If user operations generate dust, fume, or mist, handle in a negative pressure cabinet or fume hood which has been tested and shown to provide effective containment to keep exposure to airborne contaminants below exposure limits. It is recommended that dust control equipment contain explosion relief vents. Assess the most likely routes of exposure and minimize risk. Refer to section 4.2.8.1 of ISO/TR 13329 for more information.

8.2.2. Personal protection equipment*:* As with handling all substances, good hygiene practices are recommended. If dermal exposure is possible gloves, protective clothing, and goggles are recommended. In the absence of confirmatory measurements, inhalation exposure to dry forms should be avoided through the use of appropriate respirators when handled outside a glove box or fume hood.

Gloves	Preliminary evidence suggests that butyl rubber gloves may be more protective than nitrile gloves. Regular disposal and replacement of gloves is recommended.
Protective Clothing	Cover skin to minimize dermal exposure, avoid direct contact with abraded or lacerated skin. Non-woven protective clothing is preferable to woven fabric laboratory coats. Prolonged use or reuse should be avoided.
Respirators and filters	Limit dispersion into the air, minimizing and contain operations for handling powders, and working with proper exhaust ventilation with HEPA filters is recommended. When handled outside a glove box or fume hood, full face respirators with N100 cartridges are recommended; see Guidance from NIOSH

SECTION 9: Physical and chemical properties

Where no data available, required to include "no data available" for each section

9.1 Information on basic physical and chemical properties *ADD OR LIST AS "NO DATA AVAILABLE"*	**9.2 Other information: Particle-specific properties (SEE ISO TR 13329) NOT REQUIRED BUT SUGGESTED AS BEST PRACTICE**
Appearance: Insert. ***Odor:*** Odorless ***Odor threshold:*** n/a ***pH:*** Insert ***Melting point/freezing point:*** ~0 C (T-CNF Gel, Rheocrysta SDS) ***Initial boiling point and boiling range:*** ~100 C (T-CNF Gel, Rheocrysta SDS) ***Flash point:*** Insert. Cellulose ca. 240°C. ***Evaporation rate:*** n/a ***Flammability (solid, gas):*** Insert. Cellulose may be combustible at high temperature (240°C).	***Particle core size:*** Insert # nm width, # nm length. Reported values for T-CNF range from 3-15 nm width and 10nm-micron lengths (Saito et al., 2007; Soni et al., 2015); 6-CC values range from 25-35nm (Sharma et al., 2014). ***Particle size distribution:*** Add # nm - # nm ***Agglomeration/aggregation state*:** Add hydrodynamic diameter (nm). ***Shape and aspect ratio:*** Insert shape, aspect ratio; Reported shapes for T-CNF are fiber-like, and high aspect ratio. ***Specific surface area:*** Add specific surface area

Upper/lower flammability or explosive limits: Insert. Cellulose dust explosion class "St 2 – strong explosion". Cellulose dust deflagration index Kst = 229. ***Vapor pressure*:** 3.1 kPa at 25C (T-CNF Gel, Rheocrysta SDS). ***Vapor density*:** n/a ***Relative density:*** ~1 at 25 C (T-CNF Gel, Rheocrysta SDS). ***Solubility(ies):*** Insoluble in water; forms a gel. ***Partition coefficient: n-octanol/water*:** No data ***Auto-ignition temperature:*** Insert. Cellulose may self-ignite at high temperatures (ca. 240°C). ***Decomposition temperature:*** 200-270 C (T-CNF Gel, Rheocrysta SDS) 154-213 C (6-CC, Sharma et al. 2014) ***Viscosity:*** ≥5,000 mPa/s (Gel, Rheocrysta SDS) ***Explosive properties:*** Insert if measured ***Oxidizing properties:*** Insert if measured	***Surface chemistry/elemental composition:*** Add surface chemistry (coatings). Reported values for T-CNF are carboxylate groups (up to 1.5 mmol/g; Saito et al., 2007). 6-CC reported values are carboxylate groups from 1.7 - 22% (Sharma et al., 2014). ***Surface charge (zeta potential):*** Insert surface charge (mV). Reported values for T-CNF are negative. ***Dustiness:*** Insert dustiness level. ***Crystallinity*:** Add crystallinity (%). Reported values range from 60-85% for T-CNF (Saito et al., 2004).

SECTION 10: Stability and reactivity

10.1 Reactivity
Cellulose is stable.
Cellulose dust is classified as "*St 2 – risk of strong explosion*", due to dust deflagration index Kst = 229 (OSHA CPL 03-00-008). At present, no data available for nanoscale cellulose.
10.2 Chemical stability: Data suggests T-CNF may have lower thermal degradation temperature compared to cellulose.
10.3 Possibility of hazardous reactions: No data for T-CNF. Cellulose is slightly flammable to flammable in presence of open flames and sparks, and non-flammable in the presence of shocks. Self-ignition may occur at high temperatures (240°C).
10.4 Conditions to avoid: For dust: high temperatures, extreme pressure, electrostatic sparks, collisions, mechanical friction.
10.5 Incompatible materials: No data for (COMPANY) T-CNF. Oxidizing agents (e.g. chlorates, perchlorates, nitrates, peroxides, chlorine). Fire and explosions may occur from reactions involving pentafluoride, acetic acid and micro crystalline cellulose. Contact between cellulose and sodium nitrite at elevated temperatures results in vigorous burning from decomposition reaction.
10.6 Hazardous decomposition products: Carbon monoxide, oxides of sulfur, carbon dioxide may form when heated to decomposition.

SECTION 11: Toxicological information

[NOTE: Where available, data reported for T-CNF. Where not, studies with microcrystalline cellulose (MCC) or bulk cellulose.]
11.1 Information on toxicological effects
11.1.1 Likely routes of exposure
If in powder form: inhalation, eye. If a gel: dermal.

11.1.2 Immediate, delayed, or chronic effects

Short term exposure

Inhalation Acute Inhalation: (1) T-CNF LC50 > 20 mg/L (Vapor; Calculated value; Gel; Rheocrysta SDS); (2) T-CNF LC50 > 5 mg/L (Dust; Calculated value; Gel; Rheocrysta SDS). Dust may be harmful if inhaled.

Ingestion No acute oral toxicity in mice exposed to T-CNF (Shimotoyodome 2011). T-CNF LD50 > 2,000 mg/kg (Calculated value; Gel; Rheocrysta SDS). Acute oral exposure to microcrystalline cellulose reported no adverse effects (NOAEL 3160 mg/kg; unpublished report, WHO 1998).

Dermal T-CNF LD50 > 2,000 mg/kg (Calculated value; Gel; Rheocrysta SDS). Dermal exposure to CNF in mice did not have any adverse effects, necrosis or allergic reaction (Hakkarainen 2016). Human skin cells exposed to CNF did not have any adverse effects (Nordi 2016; Lopes 2017). Acute dermal exposure to microcrystalline cellulose in rabbits found no dermal irritation (unpublished report, WHO 1998).

Eye No data available for T-CNF. Acute ocular instillation of microcrystalline cellulose (MCC) reported only minimal irritation (unpublished report, WHO 1998).

Long term exposure

Inhalation Data are limited. Occupational studies have shown long term exposure to dust and fibers in a factory setting (>10 mg/m^3) may lead to decreased lung function (Kraus 2004).

Ingestion No data available for T-CNF. No adverse effects in rats consuming a 30% MCC diet for 72 days (WHO 1998); 0-20% cellulose diet for 4 weeks in rat, no death nor growth effects (Hove 1978); 5, 10, 20% cellulose diet for 21-days in rat, no death (Sundaravelli 1971); 10% MCC fed to rats for 35 weeks, no effects (Lupton 1988).

Dermal No data available.

Eye No data available.

11.1.3 Other measures of toxicity

Immunotoxicity No data available for T-CNF. High exposures *in vitro* to CNF did not result in toxicity to immune cells (Vartiainen 2011; Colic 2014). Low concentrations of MCC caused acute inflammation that resolved (Nagato 2008).

Neurotoxicity No data available for T-CNF.

Genotoxicity Aspiration of T-CNF caused acute DNA damage in the lungs of mice, but no systemic genotoxic effect was found (Catalan, 2017). No mutagenicity or genotoxicity observed for CNF or cellulose in Ames assay (Pitkänen 2010); micronucleus assay (Aimonen 2015; Catalán 2014); or *in vitro* DNA strand breakage nor chromosomal damage exposure (Lindberg 2014).

Carcinogenicity No data available for T-CNF, 6-Carboxy Cellulose (CAS 9032-53-5), or 6-Carboxy Cellulose, Sodium Salt (CAS 9069-12-9). Cellulose (CAS 9004-34-6), 6-Carboxy Cellulose (CAS 9032-53-5), 6-Carboxy Cellulose, Sodium Salt (CAS 9069-12-9) are not listed as a carcinogen by ACGIH, IARC, NTP or CA Prop 65. No increased tumorigenicity in rats fed 30% MCC diet (unpublished report, WHO 1998).

Reproductive toxicity No data available for T-CNF. Limited mammalian data for CNF. No reproductive effects noted in rats fed 30% MCC diet (unpublished report, WHO 1998).

Biodurability/biopersistence CNF (both TEMPO and homogenized) in artificial lung fluid did not degrade (Stefaniak 2014). Half time of cellulose fiber clearance from lungs was ~1000 days (Muhle 1997). MCC in artificial lung and alveolar fluid did not degrade (Seehra and Stefaniak 2013; Stefaniak 2014).

SECTION 12: Ecological information

12.1 Toxicity

Acute data

Zebrafish embryo	T-CNF (Forest Products Laboratory)	LOEC = ~ 2000 mg/L	Harper 2016
	CNF (Forest Products Laboratory)	LOEC = 2000 mg/L	Harper 2016
	CNF (Maine Pilot Plant)	No mortality up to 2000 mg/L	Harper 2016
Bacteria (*V. fischeri)*	CNF	1250 mg/L exposure = 9% fluorescence inhibition	Vartiainen 2011
Bacteria (*E.coli, S. aureus, B. subtilis, M. tuberculosis*)	6-CC	MIC_{99} = 2.5-4.5 mg/mL	Sharma 2016
Algae (*C. vulgaris)*	CNF	1-100 mg/L exposure found decreased viability after 96h	Pereira 2014

Chronic data

No data for (COMPANY) T-CNF.

12.2 Persistence and biodegradability	No data for (COMPANY) T-CNF. T-CNF films had 51-95% recovery after 30 days in soil burial test (Homma 2013). CNF readily biodegradable: Non-functionalized CNF >70% degraded by day 28, approx. 90% degraded by day 70 (under "controlled composting conditions") (SUNPAP 2012). Using EN 14046, >60% degradation of CNF-based products (concentrated CNF granules, paper with 1.5% CNF additive, CNF film) after 65 days – 76%, 95%, and 100%, respectively (Vikman et al. 2014). Cellulose fibers readily biodegradable: Using ISO 14855-1999 and EN 14046-2003, complete degradation by 25 days (Fernandes et al. 2011). Using EN14046 cellulose powder and Whatman cellulose paper were >60% after 28 days, and 82% and 69% after 65 days (Vikman et al. 2014).
12.3 Bioaccumulative potential	No data available.
12.4 Mobility in soil	No data available.
12.5 Results of PBT and vPvB assessment	No data available.
12.6 Other adverse effects	No data available.

SECTION 13: Disposal considerations

13.1 Waste treatment methods

All components are derived from natural materials and not anticipated to require specific handling for disposal. Avoid dust generation upon disposal. Not specifically listed as a hazardous waste under Transport of Dangerous

Goods Act (TDG) or the U.S. Resource Conservation and Recovery Act (RCRA). However, if waste exhibits one or more of the following characteristics: ignitability, corrosivity, reactivity, or toxicity as described by 40 CFR 261.21-24, then waste must be classified as hazardous. At present, no nano-specific regulations exist. Waste must be disposed of in accordance with federal, provincial/state, and local environmental control regulations.

SECTION 14: Transport information

14.1 UN number: None
14.2 UN proper shipping name: Not applicable
14.3 Transport hazard class: Not applicable
14.4 Packing group: Not applicable
14.5 Environmental hazards: Not classified as hazardous to the environment
14.6 Special precautions for user: No additional information available
14.7 Transport in bulk according to Annex II of MARPOL73/78 and the IBC code: Not applicable
Cellulose is not a DOT controlled material (United States).

SECTION 15: Regulatory information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture
None for T-CNF. For related substances**, OSHA regulations:** See Section 8.
15.2 Chemical safety assessment: No chemical safety assessment has been carried out for this substance by the supplier.

SECTION 16: Other information

SDS preparation date: Insert data here
SDS last known revision date and changes made: Version #, Month, Year
SDS prepared by: Vireo Advisors, LLC. P.O. Box 51368, Boston, MA 02205 USA www.VireoAdvisors.com
Other comments:
Refer to NFPA 654, Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids, for safe handling.
See ISO TR 13329.
NFPA Rating (based on cellulose dust):

Health	1;	Flammability	1;	Reactivity	0;	Special information	0

NOTE:
The information in the safety data sheet should be provided to all who will use, handle, store, transport or otherwise be exposed to this product. All information concerning this product and/or suggestions for handling and use contained herein are offered in good faith and are believed to be reliable as of the date of publication. No warranty is made regarding the accuracy of and/or sufficiency of such information. Nothing contained herein shall be construed as granting or extending any license under any patent. If the date on this document is more than three years old, call to ensure that this sheet is current.