

# Certified Reference Material

## BAM-I012

Cadmium in dilute nitric acid

### Certified Isotopic Reference Material

The material causes skin burns and eye damage.  
It may cause cancer and may be corrosive to metals.  
For more details see the material safety data sheet.

#### Certified Values

Quantity	Unit	Value	Uncertainty *
<b>Isotope amount ratios:</b>			
$n(^{106}\text{Cd})/n(^{111}\text{Cd})$	mol/mol	0.09751	0.00007
$n(^{108}\text{Cd})/n(^{111}\text{Cd})$	mol/mol	0.06951	0.00003
$n(^{110}\text{Cd})/n(^{111}\text{Cd})$	mol/mol	0.97504	0.00010
$n(^{112}\text{Cd})/n(^{111}\text{Cd})$	mol/mol	1.8835	0.0004
$n(^{113}\text{Cd})/n(^{111}\text{Cd})$	mol/mol	0.95479	0.00016
$n(^{114}\text{Cd})/n(^{111}\text{Cd})$	mol/mol	2.2437	0.0007
$n(^{116}\text{Cd})/n(^{111}\text{Cd})$	mol/mol	0.58583	0.00026
<b>Isotope amount fractions:</b>			
$n(^{106}\text{Cd})/n(\text{Cd})$	mol/mol	0.012485	0.000009
$n(^{108}\text{Cd})/n(\text{Cd})$	mol/mol	0.008901	0.000004
$n(^{110}\text{Cd})/n(\text{Cd})$	mol/mol	0.124846	0.000016
$n(^{111}\text{Cd})/n(\text{Cd})$	mol/mol	0.128043	0.000013
$n(^{112}\text{Cd})/n(\text{Cd})$	mol/mol	0.24117	0.00004
$n(^{113}\text{Cd})/n(\text{Cd})$	mol/mol	0.122254	0.000022
$n(^{114}\text{Cd})/n(\text{Cd})$	mol/mol	0.28729	0.00006
$n(^{116}\text{Cd})/n(\text{Cd})$	mol/mol	0.07501	0.00004
<b>Molar mass in solution:</b>			
$M(\text{Cd})$	g/mol	112.41218	0.00018

\* Uncertainty is the expanded uncertainty with a coverage factor of  $k = 2$ .

This certificate is valid for 20 years for units with unbroken seal stored under required conditions. This validity, until the end of year 2034, may be extended as further evidence of stability becomes available.

## Indicative Value

Mass content	Unit	Value	Uncertainty *
w(Cd)	mg/kg	994	5

\* Uncertainty is the expanded uncertainty with a coverage factor of  $k = 4.5$ .

### Material Description

The cadmium isotopic reference material BAM-I012 is a solution of high purity cadmium with natural-like isotopic composition dissolved in 1 mol/L nitric acid and filled in flame-sealed quartz ampoules containing approximately 7 mL solution.

### Recommended Use

BAM-I012 is a primary isotopic reference material and is designed for calibration of cadmium isotope ratio measurements of all types.

### Handling

Before opening an ampoule, it should be shaken to homogenize the solution with potential droplets of condensed water in the neck. Then the whole ampoule should be carefully wiped with a clean, damp cloth and the body of the ampoule should be wrapped in absorbent material (e.g. clean cloth). Then an ampoule file with a diamond or WIDIA blade is used to score the neck of the ampoule with a quarter to a half circle. Holding the ampoule steady and with both hands, medium thumb pressure should be applied with both thumbs to the stem to snap it. Correctly done, the stem should break where scored.

The solution should be withdrawn with a precleaned pipette or syringe and should be transferred in a precleaned PFA bottle. Any contamination should be avoided, as they may lead to a bias in the isotopic composition.

### Safety Information

The usual laboratory safety precautions apply. BAM-I012 is an acidic solution sealed in quartz ampoules, which contains 1 mol/L nitric acid. All appropriate safety precautions, including the use of gloves and safety glasses, should be taken.

### Transport and Storage

This CRM should be stored under normal laboratory conditions (between 5 °C and 25 °C) at places, where the risk of mechanical damage is low.

BAM cannot be held responsible for changes that happen during storage of the material at the customer's premises, especially of opened samples.

### Analytical Methods

The isotope ratios were determined by multi-collector TIMS and multi-collector ICPMS both calibrated by synthetic isotope mixtures. The cadmium mass content was determined by isotope dilution mass spectrometry and is considered as indicative value only.

### Metrological Traceability

BAM-I012 was certified by using multi-collector mass spectrometers calibrated by means of synthetic isotope mixtures yielding the highest accuracy for absolute

isotope ratios. BAM-I012, therefore is a primary isotopic reference material representing the highest metrological level for cadmium isotope ratio analysis.

All uncertainties are expanded measurement uncertainties with a coverage factor  $k = 2$  and are calculated according to ISO and EURACHEM guidelines. They contain the repeatability of the measurement, the uncertainty of the determined correction factors for mass discrimination/mass fractionation as well as other contributions.

This Isotopic Reference Material is traceable to the international unit, SI, for amount of substance – the mole – in the shortest possible way. Measurements calibrated against this Isotopic Reference Material will, therefore, also be traceable to the SI.

## Literature

Bericht zur Herstellung und Zertifizierung eines Cadmium-Isotopenreferenzmaterials - Zertifiziertes Referenzmaterial BAM-I012 (J. Vogl, W. Pritzkow, May 2015)

(Download: BAM homepage ([www.bam.de](http://www.bam.de)) via links <Reference Materials> and <Certificates and Reports>)

Pritzkow W, Wunderli S, Vogl J, Fortunato G, The isotope abundances and the atomic weight of cadmium by a metrological approach, Int J Mass Spectrom 261 (2007) 74-85.

BAM:2006 “Guidelines for the Production of BAM Reference Materials“

([http://www.bam.de/en/fachthemen/referenzmaterialien/referenzmaterialien\\_medien/bam\\_rm\\_guidelines.pdf](http://www.bam.de/en/fachthemen/referenzmaterialien/referenzmaterialien_medien/bam_rm_guidelines.pdf))

**Accepted as BAM-CRM on February 19, 2015**

## **BAM Federal Institute for Materials Research and Testing**

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**SAFETY DATA SHEET**

**FOR**

**“BAM-I012”**

according to Regulation (EC) No 1907/2006

Version number 4

Issue Date: 23.10.2018

Page: 1/10

**Section 1: Identification of the substance/mixture and of the company/undertaking**

**1.1. Product identifier**

Product name: BAM-I012  
Product information: Cadmium aqueous solution in 6 % nitric acid (1 mol/L) with an approximate Cd mass fraction of 994 µg/g and a total volume of 7 mL in flame-sealed quartz ampoules

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

Primary isotopic reference material, designed for calibration of cadmium isotope ratio measurements of all types. Any other use is discouraged.

**1.3. Details of the supplier of the safety data sheet**

Supplier / Producer: Bundesanstalt für Materialforschung und -prüfung (BAM)  
Unter den Eichen 87, 12205 Berlin, Germany  
Phone: +49 (0)30 8104-0  
Fax: +49 (0)30 8104-7-2222  
Homepage: [www.bam.de](http://www.bam.de)  
E-Mail: [info@bam.de](mailto:info@bam.de)

Contact person: Dr. Jochen Vogl, e-mail: [jochen.vogl@bam.de](mailto:jochen.vogl@bam.de)

Issuing person: Dr. Jochen Vogl, e-mail: [jochen.vogl@bam.de](mailto:jochen.vogl@bam.de)

**1.4. Emergency telephone number**

Emergency telephone: +49 (0)30 30686700  
Giftnotruf Berlin  
Charité-Universitätsmedizin Berlin  
Campus Benjamin Franklin  
Hindenburgdamm 30  
12203 Berlin

To avoid language problems and in case of nonavailability it is recommended to contact your national poison control centre. A list of national poison control centres inside the EU can be obtained at: [http://ec.europa.eu/growth/sectors/chemicals/poison-centres/index\\_en.htm](http://ec.europa.eu/growth/sectors/chemicals/poison-centres/index_en.htm)

For poison centres outside the EU the information is listed at the world directory of poison control centres at the WHO homepage: [http://www.who.int/gho/phe/chemical\\_safety/poisons\\_centres/en/](http://www.who.int/gho/phe/chemical_safety/poisons_centres/en/)

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**2. Hazards identification**

**2.1. Classification of the substance or mixture**

*Classification (Regulation (EC) No 1272/2008)*

Corrosive to metals, Category 1	H290: May be corrosive to metals
Skin corrosion, Category 1B	H314: Causes severe skin burns and eye damage
Carcinogenicity, Category 1B	H350: May cause cancer

*Classification (67/548/EEC or 1999/45/EC)*

C, corrosive	R34: Causes burns
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**SAFETY DATA SHEET**

**FOR**

**“BAM-I012”**

according to Regulation (EC) No 1907/2006

Version number 4

Issue Date: 23.10.2018

Page: 2/10

**2.2. Label elements**

**Labelling according to Regulation (EC) No 1272/2008:**

*Hazard pictogram:*



*Signal word:*

Danger

*Hazard statements:*

- H290 May be corrosive to metals  
H314 Causes severe skin burns and eye damage.  
H350 May cause cancer

*Precautionary statements:*

- P273 Avoid release to the environment  
P280 Wear protective gloves/protective clothing/eye protection/face protection.  
P303 + P361 + P353 IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower  
P305 + P351 + P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.  
P308+311 IF exposed or concerned: Call a POISON CENTER or doctor/physician  
P363 Wash contaminated clothing before reuse

Restricted to professional users.

For the full text of the H-Statements as well as S- and R-phrases mentioned in this Section, see Section 16.

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**Section 3: Composition/information on ingredients**

**3.1. Substances**

Does not apply. Product is prepared as mixture from substances listed under section 3.2.

**3.2. Mixtures**

Chemical nature: Cadmium nitrate in nitric acid solution.

**Hazardous components (Regulation (EC) No 1272/2008)**

*Chemical Name (Concentration)*

CAS-No.	EC-No./Registration number	Index-No.	Classification of the pure component
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*Nitric acid ( 5 % ≤ c < 20 %)*

7697-37-2	231-714-2	007-004-00-1	Oxidising liquid, Category 3, H272 Skin corrosion, Category 1A, H314 Corrosive to metals, Category 1, H290
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**SAFETY DATA SHEET**

**FOR**

**“BAM-I012”**

according to Regulation (EC) No 1907/2006

Version number 4

Issue Date: 23.10.2018

Page: 3/10

*Cadmium nitrate tetrahydrate (0.01 % < c < 0.1 %)*

10325-94-7	233-710-6	048-001-00-5	Acute toxicity, Category 3, oral, H301 Acute toxicity, Category 2, inhalation, H330 Reproductive toxicity, Category 1B, H360 Germ cell mutagenicity, Category 1B, H340 Carcinogenicity, Category 1B, H350 Specific Target Organ Toxicity, Cat. 1, H372 Aquatic acute, Category 1, H400 Aquatic chronic, Category 1, H410 M-Factor: 10
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**Hazardous components (67/548/EEC)**

*Chemical Name (Concentration)*

CAS-No.	EC-No./Registration Number	Index-No.	Classification of the pure component
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*Nitric acid (>= 5% -=<20 %)*

7697-37-2	231-714-2	007-004-00-1	O; R8 C; R35
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*Cadmium nitrate tetrahydrate (0.01 % < c < 0.1 %)*

10325-94-7	233-710-6	048-001-00-5	Xn, Harmful, R20/21/22 N, Dangerous for the environment, R50/53 M-Factor: 10
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For the full text of the R-phrases mentioned in this Section, see Section 16.

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**Section 4: First aid measures**

**4.1. Description of first aid measures**

After inhalation: fresh air.

After skin contact: wash off with plenty of water. Remove contaminated clothing.

After eye contact: rinse out with plenty of water. Call in ophthalmologist.

After swallowing: immediately make victim drink water (two glasses at the most). Consult a physician.

**4.2. Most important symptoms and effects, both acute and delayed**

Corrosive effect

The following applies to cadmium compounds in general: mucosal irritations, coughing and dyspnoea after inhalation. Inhalation may lead to the formation of oedemas in the respiratory tract. Toxic effect on gastrointestinal tract. Long-term exposure to the chemical results in toxic effect on kidneys, lungs, bones.

**4.3. Indication of any immediate medical attention and special treatment needed**

No information available

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**Section 5: Fire-fighting measures**

**5.1. Extinguishing media**

Use extinguishing measures that are appropriate to local circumstances and the surrounding environment. For this substance / mixture no restrictions on extinguishing media are known.

**SAFETY DATA SHEET**

**FOR**

**“BAM-I012”**

according to Regulation (EC) No 1907/2006

Version number 4

Issue Date: 23.10.2018

Page: 4/10

**5.2. Special hazards arising from the substance or mixture**

Not combustible.  
Ambient fire may liberate hazardous vapours.

**5.3. Advice for fire fighters**

Do not stay in dangerous zone without self-contained breathing apparatus. In order to avoid contact with skin, keep a safety distance and wear suitable protective clothing.

*Further information*

Prevent fire extinguishing water from contamination surface water or the ground water system.

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**Section 6: Accidental release measures**

**6.1. Personal precautions, protective equipment and emergence procedures**

Do not breathe vapours, aerosols. Avoid substance contact. Ensure adequate ventilation.  
Wear protective glasses and gloves. See section 8

**6.2. Environmental precautions**

Do not empty into drains.

**6.3. Methods and materials for containment and cleaning up**

Take up with liquid-absorbent and neutralizing material. Forward for disposal. Clean up affected area.

**6.4. Reference to other sections**

Information on disposal see section 13.

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**Section 7: Handling and storage**

**7.1. Precautions for safe handling**

Work under hood. Do not inhale substance. Avoid generation of vapours/aerosols. Observe label precautions. Wear protective equipment, see section 8.  
Keep general hygiene standards for laboratories.

**7.2. Conditions for safe storage, including any incompatibilities**

Keep container tightly closed. Keep in a well-ventilated place. Store at +15 °C to +25 °C.

**7.3. Specific end use**

Not applicable

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**Section 8: Exposure controls/personal protection**

**8.1. Control parameters**

Components with workplace parameters

*Components*

Basis	Value	Threshold limits	Remarks
<i>Nitric acid (7697-37-2)</i> Directive 2006/15/EC	Short Term Exposure Limit (STEL):	2.6 mg/m <sup>3</sup> (1 ppm)	15 minutes

## SAFETY DATA SHEET

FOR

“BAM-I012”

according to Regulation (EC) No 1907/2006

Version number 4

Issue Date: 23.10.2018

Page: 5/10

*Inorganic cadmium and its compounds*

EH40 WEL (2007)

Occupational exposure  
limit value 8h

25µ mg/m<sup>3</sup>

8 h average

### Recommended monitoring procedures

Methods for measurement of the workplace atmosphere have to correspond to the requirements of standards DIN EN 482 and DIN EN 689.

## 8.2. Exposure controls

### *Personal protective equipment*

Protective clothing should be selected specifically for the working place, depending on concentration and quantity of the hazardous substances handled. The resistance of the protective clothing to chemicals should be ascertained with the respective supplier.

### *Hand protection:*

Full contact:	Glove material:	Latex or polyvinylchloride
	Glove thickness:	0.5 mm
	Break through time:	> 8 h
Splash contact:	Glove material:	Latex or polyvinylchloride
	Glove thickness:	0.5 mm
	Break through time:	> 8 h

The protective gloves to be used must comply with the specifications of EC Directive 89/686/EEC and the resultant standard EN374.

This recommendation applies only to the product stated in the safety data sheet and supplied by us as well as to the purpose specified by us. When dissolving in or mixing with other substances and under conditions deviating from those stated in EN374 please contact the supplier of CE-approved gloves.

### *Eye protection:*

Safety glasses

### *Respiratory protection:*

Required when vapours/aerosols are generated

### *Hygiene measures:*

Immediately change contaminated clothing. Apply skin-protective barrier cream. Wash hands and face after working with substance.

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## Section 9: Physical and chemical properties

### 9.1. Information on basic physical and chemical properties

Appearance	colourless liquid
Odour	odourless
Odour threshold	No information available
pH	ca. 0 at 20 °C, for the nitric acid component, literature data
Melting point/freezing point	between 0 °C and -10 °C
Initial boiling point and boiling range	between 100 °C and 110 °C at 1013 hPa
Flash point	not required, inorganic substance
Evaporation rate	no data available
Flammability (solid, gas)	not combustible
Upper/lower flammability or explosive limits	no data available



**SAFETY DATA SHEET**

**FOR**

**“BAM-I012”**

according to Regulation (EC) No 1907/2006

Version number 4

Issue Date: 23.10.2018

Page: 6/10

Vapour pressure	no data available
Vapour density	no data available
Relative density	ca. 1035 kg/m <sup>3</sup> at 20 °C (tabulated for dilute nitric acid)
Solubility(ies)	water soluble (quantitatively)
Partition coefficient: n-octanol/water	no data available
Auto-ignition temperature	no data available
Decomposition temperature	no data available
Viscosity	no data available
Explosive properties	not classified as explosive
Oxidising properties	no data available

**9.2. Other information**

Corrosion	may be corrosive to metals
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**Section 10: Stability and reactivity**

**10.1. Reactivity**

No dangerous reactions known.

**10.2. Chemical stability**

Stable under normal storage conditions (0 – 40 °C)

**10.3. Possibility of hazardous reactions**

Generates dangerous gases or fumes in contact with metals.  
Violent reactions possible with generally known reaction partners of water.

**10.4. Conditions to avoid**

No information available

**10.5. Incompatible materials**

*Increased reactivity with:*

oxidizable substances, organic solvent, metals, metal alloys, alkali metals, alkaline earth metals, ammonia, alkalines, acids

*Unsuitable working materials:*

Metals, metal alloys

**10.6. Hazardous decomposition products**

no information available

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**Section 11: Toxicological information**

**11.1. Information on toxicological effects**

*Acute oral toxicity:*

Symptoms: burns of mucous membranes in the mouth, pharynx, oesophagus and gastrointestinal tract when ingested.

*Acute inhalation toxicity*

Symptoms: mucosal irritations, cough, shortness of breath, possible damage of respiratory tract.

*Acute dermal toxicity*

This information is not available.

*Skin corrosion/irritation:*

Mixture causes burns.

*Serious eye damage/irritation:*

Causes serious eye damage.

*Respiratory or skin sensitisation:*

Sensitization possible in predisposed persons.

*Carcinogenicity*

This information is not available.

*Germ cell mutagenicity*

This information is not available.

*Reproductive toxicity*

This information is not available.

*Specific target organ toxicity – single exposure*

This information is not available.

*Specific target organ toxicity – repeated exposure*

This information is not available.

*Aspiration hazard*

This information is not available.

**11.2. Further information**

*CMR effects:*

Carcinogenicity:

May cause cancer by inhalation.

The following applies to cadmium compounds in general: mucosal irritations, coughing and dyspnoea after inhalation. Inhalation may lead to the formation of oedemas in the respiratory tract. Toxic effect on gastrointestinal tract. Long-term exposure to the chemical results in toxic effect on kidneys, lungs, bones.

Quantitative data on the toxicity of this product are not available.

Handle in accordance with good industrial hygiene and safety practice.

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**Section 12: Ecological information**

**12.1. Toxicity**

No information available.

**12.2. Persistence and degradability**

No information available. The methods for determining biological degradability are not applicable to inorganic substances.

**12.3. Bio accumulative potential**

No information available.

**12.4. Mobility in soil**

No information available.

**SAFETY DATA SHEET**

**FOR**

**“BAM-I012”**

according to Regulation (EC) No 1907/2006

Version number 4

Issue Date: 23.10.2018

Page: 8/10

**12.5. Results of PBT and vPvB assessment**

No information available.

**12.6. Other adverse effects**

No information available.

*Further information on ecology*

Do not allow to enter waters, waste water, or soil!

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**Section 13: Disposal considerations**

**13.1. Waste treatment methods**

*Product*

Chemicals must be disposed of in compliance with the respective national regulations.

*Packaging*

The product packaging must be disposed of in compliance with the country-specific regulations or must be passed to a packaging return system.

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**Section 14: Transport information**

**Land transport (ADR/RID)**

<b>14.1. UN number</b>	3264
<b>14.2. UN proper shipping name</b>	CORROSIVE LIQUID, ACIDIC, INORGANIC, N.O.S. (NITRIC ACID MORE THAN 5 % BUT NOT MORE THAN 20 %)
<b>14.3. Transport hazard class(es)</b>	8
<b>14.4. Packing group</b>	II
<b>14.5. Environmental hazards</b>	- -
<b>14.6. Special precautions for users</b>	yes
Tunnel restriction code	E

**Inland waterway transport (ADN)**

Not relevant

**Air transport (IATA/ICAO)**

<b>14.1. UN number</b>	3264
<b>14.2. UN proper shipping name</b>	CORROSIVE LIQUID, ACIDIC, INORGANIC, N.O.S. (NITRIC ACID MORE THAN 5 % BUT NOT MORE THAN 20 %)
<b>14.3. Transport hazard class(es)</b>	8
<b>14.4. Packing group</b>	II
<b>14.5. Environmental hazards</b>	- -
<b>14.6. Special precautions for users</b>	no

**Sea transport (IMDG)**

<b>14.1. UN number</b>	3264
<b>14.2. UN proper shipping name</b>	CORROSIVE LIQUID, ACIDIC, INORGANIC, N.O.S. (NITRIC ACID MORE THAN 5 % BUT NOT MORE THAN 20 %)
<b>14.3. Transport hazard class(es)</b>	8

## SAFETY DATA SHEET

FOR

“BAM-I012”

according to Regulation (EC) No 1907/2006

Version number 4

Issue Date: 23.10.2018

Page: 9/10

14.4. Packing group	II
14.5 Environmental hazards	--
14.6. Special precautions for users	yes
EmS	F-A S-B
14.7. Transport in bulk according to Annex II of Marpol 73/78 and the IBC code	
Not relevant	

### Additional Transport Information:

Product BAM-I012 fulfils the limits for excepted quantities according to ADR and IMDG:

ADR:	Limited quantity (LQ):	1 L	
	Excepted quantity (EQ) Code:	E2	maximum net quantity per inner packaging: 30 mL maximum net quantity per outer packaging: 500 mL
IMDG	Limited quantities (LQ):	1L	
	Excepted quantities (EQ):	E2	maximum net quantity per inner packaging: 30 ml Maximum net quantity per outer packaging: 500 ml

The transport regulations are cited according to international regulations and in the form applicable in Germany. Possible national deviations in other countries are not considered.

## Section 15: Regulatory information

### 15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

#### *EU regulations*

Occupational restrictions	Health and safety protection at work, directive 98/24/EC Take note of Directive 94/33/EC on the protection of young people at work
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#### *National legislation*

Above regulations for health and safety protection at work are cited which are valid within the EU. As many EU-countries have additional regulations, please consult and follow your national regulations. National regulations should be considered in general for countries outside the EU.

### 15.2 Chemical safety assessment

For this product a chemical safety assessment is not required and therefore was not carried out.

## Section 16: Other information

Full text of H-Statements referred to under sections 2 and 3

H272	May intensify fire; oxidizer
H290	May be corrosive to metals
H301	Toxic if swallowed
H314	Causes severe skin burns and eye damage
H330	Fatal if inhaled
H340	May cause genetic defects
H350	May cause cancer
H360	May damage fertility or the unborn child

## SAFETY DATA SHEET

## FOR

“BAM-I012”

according to Regulation (EC) No 1907/2006

Version number 4

Issue Date: 23.10.2018

Page: 10/10

H372	Causes damage to organs through prolonged or repeated exposure
H400	Very toxic to aquatic life
H410	Very toxic to aquatic life with long lasting effects

Full text of precautionary statements referred to under sections 2 and 3:

P273	Avoid release to the environment
P280	Wear protective gloves/protective clothing/eye protection/face protection.
P303 + P361 + P353	IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower
P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P308+311	IF exposed or concerned: Call a POISON CENTER or doctor/physician
P363	Wash contaminated clothing before reuse

Full text of R-phrases referred to under sections 2 and 3

R8	Contact with combustible material may cause fire.
R20/21/22	Harmful by inhalation, in contact with skin and if swallowed
R34	Causes burns
R35	Causes severe burns.
R50/53	Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment

Full text of S-phrases referred to under sections 2 and 3

S23	Do not breathe gas/fumes/vapor/spray
S26	In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S36	Wear suitable protective clothing
S45	In case of accident or if you feel unwell seek medical advice immediately.

Release management: Regulation (EC) No 453/2010

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***The information contained herein is based on data considered to be accurate and on the present state of our knowledge. It characterizes the sample with regard to the appropriate safety precautions. However, no warranty is expressed or implied regarding the accuracy of these data or the results to be obtained from the use thereof.***