FAO SPECIFICATIONS AND EVALUATIONS FOR AGRICULTURAL PESTICIDES

CARBARYL

1-naphthyl methylcarbamate

FOOD AND AGRICULTURE ORGANIZATION *of* THE UNITED NATIONS

TABLE OF CONTENTS

CARBARYL

DISCLAIMER[1]

FAO specifications are developed with the basic objective of promoting, as far as practicable, the manufacture, distribution and use of pesticides that meet basic quality requirements.

Compliance with the specifications does not constitute an endorsement or warranty of the fitness of a particular pesticide for a particular purpose, including its suitability for the control of any given pest, or its suitability for use in a particular area. Owing to the complexity of the problems involved, the suitability of pesticides for a particular purpose and the content of the labelling instructions must be decided at the national or provincial level.

Furthermore, pesticides which are manufactured to comply with these specifications are not exempted from any safety regulation or other legal or administrative provision applicable to their manufacture, sale, transportation, storage, handling, preparation and/or use.

FAO disclaims any and all liability for any injury, death, loss, damage or other prejudice of any kind that may arise as a result of, or in connection with, the manufacture, sale, transportation, storage, handling, preparation and/or use of pesticides which are found, or are claimed, to have been manufactured to comply with these specifications.

Additionally, FAO wishes to alert users to the fact that improper storage, handling, preparation and/or use of pesticides can result in either a lowering or complete loss of safety and/or efficacy.

FAO is not responsible, and does not accept any liability, for the testing of pesticides for compliance with the specifications, nor for any methods recommended and/or used for testing compliance. As a result, FAO does not in any way warrant or represent that any pesticide claimed to comply with a FAO specification actually does so.

[1] This disclaimer applies to all specifications published by FAO.

INTRODUCTION

FAO establishes and publishes specifications* for technical material and related formulations of agricultural pesticides, with the objective that these specifications may be used to provide an international point of reference against which products can be judged either for regulatory purposes or in commercial dealings.

From 2002, the development of WHO specifications follows the **New Procedure**, described in the 1st edition of "Manual for Development and Use of FAO and WHO Specifications for Pesticides" (2002) and amended with the supplement of this manual (2006), which is available only on the internet through the FAO and WHO web sites. This **New Procedure** follows a formal and transparent evaluation process. It describes the minimum data package, the procedure and evaluation applied by FAO and the Experts of the FAO/WHO Joint Meeting on Pesticide Specifications (JMPS). [Note: prior to 2002, the Experts were of the FAO Panel of Experts on Pesticide Specifications, Registration Requirements, Application Standards and Prior Informed Consent, which now forms part of the JMPS, rather than the JMPS.]

FAO Specifications now only apply to products for which the technical materials have been evaluated. Consequently from the year 2000 onwards the publication of FAO specifications under the **New Procedure** has changed. Every specification consists now of two parts namely the specifications and the evaluation report(s):

PART ONE: **The Specification** of the technical material and the related formulations of the plant protection product in accordance with chapter 4, 5 and 6 of the 5th edition of the "Manual on the development and use of FAO specifications for plant protection products".

PART TWO: **The Evaluation Report(s)** of the plant protection product reflecting the evaluation of the data package carried out by FAO and the JMPS. The data are to be provided by the manufacturer(s) according to the requirements of Appendix A, annex 1 or 2 of the "Manual on the development and use of FAO specifications for plant protection products" and supported by other information sources. The Evaluation Report includes the name(s) of the manufacturer(s) whose technical material has been evaluated. Evaluation reports on specifications developed subsequently to the original set of specifications are added in a chronological order to this report.

FAO specifications under the **New Procedure** do not necessarily apply to nominally similar products of other manufacturer(s), nor to those where the active ingredient is produced by other routes of manufacture. FAO has the possibility to extend the scope of the specifications to similar products but only when the JMPS has been satisfied that the additional products are equivalent to that which formed the basis of the reference specification.

Specifications bear the date (month and year) of publication of the current version. Dates of publication of the earlier versions, if any, are identified in a footnote. Evaluations bear the date (year) of the meeting at which the recommendations were made by the JMPS.

* NOTE: PUBLICATIONS ARE AVAILABLE ON THE INTERNET AT (http://www.fao.org/ag/agp/agpp/pesticid/) OR IN HARDCOPY FROM THE PLANT PROTECTION INFORMATION OFFICER.

PART ONE

SPECIFICATIONS

CARBARYL

CARBARYL

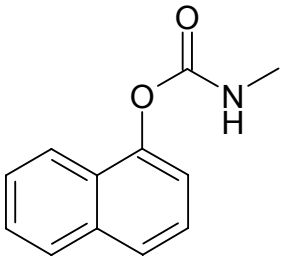
INFORMATION

ISO common name
Carbaryl (E-ISO, (m) F-ISO, ANSI, BAN, BSI, ESA, JMAF)

Synonyms
None

Chemical names
IUPAC 1-naphthyl methylcarbamate
CA 1-naphthalenyl-methylcarbamate

Structural formula



Empirical formula
$C_{12}H_{11}NO_2$

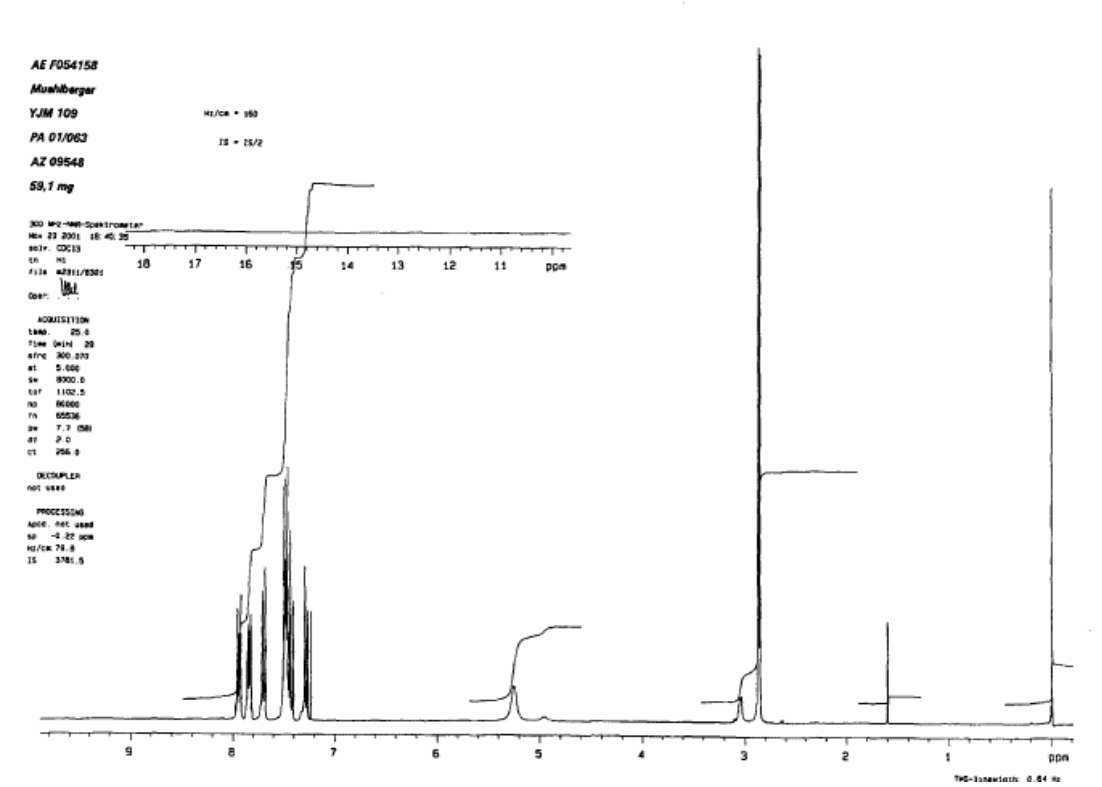
Relative molecular mass
201.2

CAS Registry number
63-25-2

CIPAC number
26

EINECS/ELINCS number
200-555-0

Identity tests
HPLC retention time, ^{1}H-NMR


AE F054158
Muehlberger
YJM 109
PA 01/063
AZ 09548
59,1 mg
ppm
ppm

CARBARYL TECHNICAL MATERIAL

FAO Specification 26/TC (March 2007*)

*This specification, which is PART ONE of this publication, is based on an evaluation of data submitted by the manufacturer whose name is listed in the evaluation reports (*26/2006*). It should be applicable to TC produced by this manufacturer but it is not an endorsement of those products, nor a guarantee that they comply with the specifications. The specification may not be appropriate for TC produced by other manufacturers. The evaluation reports (*26/2006*), as PART TWO, form an integral part of this publication.*

1 Description

The material shall consist of carbaryl, together with related manufacturing impurities, and shall be a white to cream-coloured crystalline powder, free from visible extraneous matter and added modifying agents.

2 Active ingredient

2.1 **Identity tests** (26/TC/M/2, CIPAC Handbook, Note 1)

The active ingredient shall comply with an identity test and, where the identity remains in doubt, shall comply with at least one additional test.

2.2 **Carbaryl content** (26/TC/M/3, CIPAC Handbook, Note 1)

The carbaryl content shall be declared (not less than 990 g/kg) and, when determined, the average measured content shall not be lower than the declared minimum content.

Note 1 Methods for the identification and determination of carbaryl content were adopted by CIPAC in 2006 but are not yet published in a Handbook. Prior to publication of the Handbook, copies of the methods may be obtained through the CIPAC website, http://www.cipac.org.

* Specifications may be revised and/or additional evaluations may be undertaken. Ensure the use of current versions by checking at: http://www.fao.org/ag/agp/agpp/pesticid/.

CARBARYL WETTABLE POWDER

FAO Specification 26/WP (March 2007*)

This specification, which is PART ONE of this publication, is based on an evaluation of data submitted by the manufacturer whose name is listed in the evaluation report (26/2006). It should be applicable to relevant products of this manufacturer, and those of any other formulators who use only TC from the evaluated source. The specification is not an endorsement of those products, nor a guarantee that they comply with the specification. The specification may not be appropriate for the products of other manufacturers who use TC from other sources. The evaluation report (26/2006), as PART TWO, forms an integral part of this publication.

1 Description

The material shall consist of a homogeneous mixture of technical carbaryl, complying with the requirements of FAO specification 26/TC (March 2007), together with filler(s) and any other necessary formulants. It shall be in the form of a fine powder free from visible extraneous matter and hard lumps.

2 Active ingredient

2.1 **Identity tests** (26/WP/M/2, CIPAC Handbook, Note 1)

The active ingredient shall comply with an identity test and, where the identity remains in doubt, shall comply with at least one additional test.

2.2 **Carbaryl content** (26/WP/M/3, CIPAC Handbook, Note 1)

The carbaryl content shall be declared (g/kg) and, when determined, the average content measured shall not differ from that declared by more than the following tolerances:

Declared content, g/kg	Tolerance
above 250 up to 500	±5% of the declared content
above 500	±25 g/kg of the declared content
Note: the upper limit is included in the lower range	

3 Physical properties

3.1 **pH range** (MT 75.3, CIPAC Handbook J, p.131, 2000)

The pH of an aqueous dispersion shall be in the range 4.0 to 7.0.

3.2 **Wet sieve test** (MT 185, CIPAC Handbook K, p.149, 2003)

Maximum: 2% retained on a 75 µm test sieve.

* Specifications may be revised and/or additional evaluations may be undertaken. Ensure the use of current versions by checking at: http://www.fao.org/ag/agp/agpp/pesticid/.

3.3 **Suspensibility** (MT 184, CIPAC Handbook K, p.142, 2003) (Notes 2 & 3)

A minimum of 70% of the carbaryl content found under 2.2 shall be in suspension after 30 min in CIPAC Standard Water D at 30 ± 2°C (Note 4).

3.4 **Persistent foam** (MT 47.2, CIPAC Handbook F, p.152, 1995) (Note 5)

A maximum of 30 ml of foam shall be observed after 1 min.

3.5 **Wettability** (MT 53.3, CIPAC Handbook F, p.164, 1995)

The formulation shall be completely wetted in 1 min without swirling.

4 Storage stability

4.1 **Stability at elevated temperature** (MT 46.3, CIPAC Handbook J, p.128, 2000)

After storage at 54 ± 2°C for 14 days, the determined average active ingredient content must not be lower that 95%, relative to the determined average content found before storage (Note 6), and the formulation shall continue to comply with the clauses for:

- pH range (3.1),
- wet sieve test (3.2),
- suspensibility (3.3),
- wettability (3.5).

Note 1 Methods for the identification and determination of carbaryl content were adopted by CIPAC in 2006 but are not yet published in a Handbook. Prior to publication of the Handbook, copies of the methods may be obtained through the CIPAC website, http://www.cipac.org.

Note 2 The formulation should be tested at the highest and lowest rates of use recommended by the supplier, provided that this does not exceed the conditions given in method MT 184.

Note 3 This test will normally only be carried out after the heat stability test, 4.1.

Note 4 Chemical assay is the only fully reliable method to measure the mass of active ingredient still in suspension. However, simpler methods such as gravimetric and solvent extraction determination may be used on a routine basis provided that these methods have been shown to give equal results to those of chemical assay. In case of dispute, chemical assay shall be the "referee method".

Note 5 The mass of sample to be used in the test should be at the highest rate of use recommended by the supplier. The test is to be conducted in CIPAC standard water D.

Note 6 Samples of the formulation taken before and after the storage stability test should be analyzed concurrently after the test in order to reduce the analytical error.

CARBARYL AQUEOUS SUSPENSION CONCENTRATE

FAO Specification 26/SC (March 2007*)

This specification, which is PART ONE of this publication, is based on an evaluation of data submitted by the manufacturer whose name is listed in the evaluation report (26/2006). It should be applicable to relevant products of this manufacturer, and those of any other formulators who use only TC from the evaluated source. The specification is not an endorsement of those products, nor a guarantee that they comply with the specification. The specification may not be appropriate for the products of other manufacturers who use TC from other sources. The evaluation report (26/2006), as PART TWO, forms an integral part of this publication.

1 Description

The material shall consist of a suspension of fine particles of technical carbaryl, complying with the requirements of FAO specification 26/TC (March 2007), in an aqueous phase together with suitable formulants. After gentle agitation the material shall be homogeneous and suitable for further dilution in water.

2 Active ingredient

2.1 **Identity tests** (26/SC/M/2, CIPAC Handbook, Note 1)

The active ingredient shall comply with an identity test and, where the identity remains in doubt, shall comply with at least one additional test.

2.2 **Carbaryl content** (26/SC/M/3, CIPAC Handbook, Note 1)

The carbaryl content shall be declared (g/kg or g/l at 20 ± 2ºC, Note 2) and, when determined, the average content measured shall not differ from that declared by more than the following tolerance:

Declared content, g/kg or g/l at 20 ± 2ºC	Tolerance
above 250 up to 500 Note: the upper limit is included in the range	±5% of the declared content

3 Physical properties

3.1 **pH range** (MT 75.3, CIPAC Handbook J, p.131, 2000)

The pH of an aqueous dispersion shall be in the range of 4.0 to 7.0.

3.2 **Pourability** (MT 148, CIPAC Handbook F, p.348, 1995)

Maximum "residue": 5%.

* Specifications may be revised and/or additional evaluations may be undertaken. Ensure the use of current versions by checking at: http://www.fao.org/ag/agp/agpp/pesticid/.

3.3 **Spontaneity of dispersion** (MT 160, CIPAC Handbook F, p.391, 1995)

A minimum of 90% of the carbaryl content found under 2.2 shall be in suspension after 5 min in CIPAC Standard Water D at 30 ± 2°C (Note 3).

3.4 **Suspensibility** (MT 161, CIPAC Handbook F, p.394, 1995)

A minimum of 90% of the carbaryl content found under 2.2 shall be in suspension after 30 min in CIPAC Standard Water D at 30 ± 2°C (Note 3).

3.5 **Wet sieve test** (MT 185, CIPAC Handbook K, p.149, 2003)

Maximum: 2% of the formulation shall be retained on a 75 µm test sieve.

3.7 **Persistent foam** (MT 47.2, CIPAC Handbook F, p.152, 1995) (Note 4)

Maximum: 50 ml after 1 min.

4 Storage stability

4.1 **Stability at 0°C** (MT 39.3, CIPAC Handbook J, p.126, 2000)

After storage at 0 ± 2°C for 7 days, the formulation shall continue to comply with suspensibility (3.4) and wet sieve test (3.5).

4.2 **Stability at elevated temperature** (MT 46.3, CIPAC Handbook J, p.128, 2000)

After storage at 54 ± 2°C for 14 days, the determined average active ingredient content must not be lower than 95%, relative to the determined average content found before storage (Note 5), and the formulation shall continue to comply with the clauses for:

- pH range (3.1),
- pourability (3.2),
- spontaneity of dispersion (3.3),
- suspensibility (3.4),
- wet sieve test (3.5).

Note 1 Methods for the identification and determination of carbaryl content were adopted by CIPAC in 2006 but are not yet published in a Handbook. Prior to publication of the Handbook, copies of the methods may be obtained through the CIPAC website, http://www.cipac.org.

Note 2 Unless homogenization is carried out carefully, it is possible for the sample to become aerated. This can lead to error in the determination of mass per millilitre and in calculation of the active ingredient content (in g/l) if methods other than CIPAC MT 3.3 are used. If the buyer requires both g/kg and g/l at 20ºC, then in case of dispute the analytical results shall be calculated as g/kg.

Note 3 Chemical assay is the only fully reliable method to measure the mass of active ingredient still in suspension. However, simpler methods such as gravimetric and solvent extraction determination may be used on a routine basis provided that these methods have been shown to give equal results to those of the chemical assay method. In case of dispute, the chemical method shall be the referee method.

Note 4 The mass of sample to be used in the test should be at the highest rate of use recommended by the supplier. The test is to be conducted in CIPAC standard water D.

Note 5 Samples of the formulation taken before and after the storage stability test should be analyzed concurrently after the test in order to reduce the analytical error.

PART TWO

EVALUATION REPORTS

CARBARYL

CARBARYL

FAO/WHO EVALUATION REPORT 26/2006

Recommendations

The Meeting recommended that:

(i) the existing FAO specifications for carbaryl TC, DP and WP should be withdrawn;

(ii) the revised specifications for carbaryl TC, WP and the new specification for carbaryl SC, proposed by Bayer CropScience, should be adopted by FAO.

(iii) the revised specification for carbaryl DP, proposed by Bayer CropScience, should be adopted by FAO, subject to validation and adoption by CIPAC of the extension of the analytical method for determination of carbaryl to DP.

Appraisal

The data for carbaryl were evaluated in support of the review of the existing FAO specifications for TC, DP and WP, which were developed in 1988 (AGP: CP/231) and a proposed new specification for SC.

Carbaryl is no longer under patent.

Carbaryl was evaluated by the FAO/WHO JMPR for toxicology in 2001 (JMPR 2001) and for residues in 2002 (JMPR 2002). It is currently under evaluation/review by the European Commission (EU 2006) and the US EPA (US-EPA 2004).

Draft specifications for carbaryl TC and DP, WP, SC and the supporting data were provided by Bayer CropScience in 2005.

Carbaryl is a crystalline solid of low solubility in water and with a low vapour pressure. It is hydrolysed rapidly at pH 9, slowly at pH 7 and is stable at pH 5. Photolysis occurs only slowly.

The Meeting was provided with details of the manufacturing process, 5 batch analysis data from the current site of production, and manufacturing limits for purity and all impurities. Mass balances were high (990.9-999.7 g/kg), no unknowns were detected and minimum active ingredient content was 985 g/kg. These data were confirmed as identical to those submitted to Spain for the re-registration of carbaryl in the European Union.

The existing FAO specifications included clauses to limit the concentrations of two impurities: 2-naphthol (maximum 0.5 g/kg) and 2-naphthyl methylcarbamate (maximum 0.5 g/kg). The Meeting agreed with the manufacturer that neither of these qualify as relevant, within the terms of the manual (FAO/WHO 2006), and that none of the impurities should be designated as relevant.

The Meeting considered other aspects of the specifications.

TC. In the existing FAO specification for TC, the minimum declared active ingredient content was 980 g/kg with a tolerance of ±20 g/kg, so that the effective minimum value was 960 g/kg. The Meeting welcomed the proposed minimum of 985 g/kg, which was subsequently revised to 990 g/kg (BCS 2006), as it represented a

significant improvement in minimum purity. The Meeting noted that the previous clauses for melting point (now a non-standard requirement) and for loss on drying had been withdrawn in the proposed specification.

DP. The concentration range of the proposed specification (>25 to 100 g/kg) was narrower than those of the existing specification (<20 to >100 g/kg), reflecting the products currently available. The existing specification included clauses for acidity and alkalinity but none were proposed, as they are unnecessary for such a dry product. The existing specification also included a clause and limit for flowability "for information only", which the manufacturer had appropriately removed from the proposed specification. The clause for storage stability in the existing specification specified continued compliance with the active ingredient content clause after 14 days at 54C, whereas the proposed minimum was 95%. The manufacturer explained that there was no practical difference: the current guideline clause provides a more transparent indication of the stability of the product. The wording and limits of the existing clause for dry sieve test had been amended in accordance with the current requirements of the manual (FAO/WHO 2006).

WP. The clause for wet sieve test in the existing specification referred to the use of a 45 µm test sieve, whereas the proposed clause required the use of a 75 µm sieve, in accordance with the current requirements of the manual (FAO/WHO 2006). The limit (2%) for this characteristic was unchanged and the Meeting questioned whether it could be lower. The manufacturer stated that the value could, perhaps, be reduced to 1% for WP containing only carbaryl. However, when co-formulated with other active ingredients, compliance with the lower limit could not be guaranteed and the Meeting accepted that the proposed 2% limit should apply. The limit for suspensibility in the existing specification was 90%, whereas the proposed limit was for 70%. Although the lower figure was within the acceptable range, the Meeting questioned whether it could be higher. The manufacturer stated that carbaryl has a rather high relative density and that the 70% value applies primarily to WP with the highest content of active ingredient. The Meeting accepted the explanation and the proposed limit.. The proposed limit (30 ml) for persistent foam was higher than that of the existing specification (25 ml) but the Meeting accepted that the values were essentially similar. The Meeting accepted that the proposed limit for wettability (1 min), which was more stringent than the 2 min of the existing specification. The Meeting also noted that the clause for dispersibility in the existing specification, based on an obsolete CIPAC method, had been removed from the proposed specification.

SC. The proposed new FAO specification for carbaryl SC was in accordance with the requirements of the manual (FAO/WHO 2006).

The analytical method for the active ingredient (including identity tests) is based on reversed-phase HPLC, with isocratic elution, UV-absorption detection and external standardization. The method was adopted by CIPAC in 2006, with provisional status, for the analysis of carbaryl TC, WP and SC. The method was not similarly validated for analysis of DP formulations.

SUPPORTING INFORMATION
FOR
EVALUATION REPORT 26/2006

Uses

Carbaryl is a carbamate insecticide, used for control of insect and other arthropod pests in agriculture. It also has a plant growth regulating property. The main uses are in: crop protection (fruit trees, vegetables, olives, cotton, rice, forestry, etc.); apple thinning; poultry protection (lice, mites, fleas, ticks); domestic and farm animal protection (lice, fleas, ticks, horn flies); and in certain other pest control applications (cockroaches, mosquitoes, grasshoppers, lawn care).

Identity of the active ingredient

ISO common name

Carbaryl (E-ISO, (m) F-ISO, ANSI, BAN, BSI, ESA, JMAF)

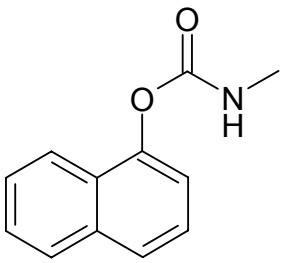
Synonyms

None

Chemical names

IUPAC 1-naphthyl methylcarbamate
CA 1-naphthalenyl-methylcarbamate

Structural formula



Empirical formula

$C_{12}H_{11}NO_2$

Relative molecular mass

201.2

CAS Registry number

63-25-2

CIPAC number

26

EINECS/ELINCS number

200-555-0

Identity tests

HPLC retention time, ^{1}H-NMR

Physico-chemical properties of carbaryl

Table 1. Physico-chemical properties of pure carbaryl

Parameter	Value(s) and conditions	Purity %	Method	Reference
Vapour pressure	4.16 x 10^{-5} Pa at 23.5°C	99.8	OECD 104; USEPA: CFR 40, 158, gas saturation method	M-188624-01-1
Melting point	138°C	99.1	OECD 102	M-203752-02-1
Boiling point	210°C	99.1	OECD 103	M-205640-02-1
Temperature of decomposition	>254°C	99.1	OECD 113	M-204896-02-1
Solubility in water at 20°C	9.4 mg/l at pH 4 9.1 mg/l at pH 7 7.2 mg/l at pH 9	99.1	OECD 105	M-202462-02-1
Partition coefficient	log P_{ow} = 2.36 at 23°C	99.8	OECD 107; USEPA CFR 40, 158, HPLC method	M-188695-01-1
Hydrolysis characteristics at 20°C	Stable at pH 5 Half-life 12.5/11.6 days at pH 7 Half-life 3.2 hours at pH 9	99.7	USEPA CFR 40, 158 Series 161-1	M-188860-01-1
Photolysis characteristics at 25°C	Half-life = 9.9 days at pH 5 under continuous artificial sunlight (510.5 Watts/m^2) corresponding to natural sunlight	>98.0	USEPA CFR 40, Series 161-2	M-188630-01-1
Dissociation characteristics at 24°C	pKa = 10.4 ± 0.4	99.7	OECD 112; USEPA CFR 40,158 Series 63.10	M-188661-01-1

Table 2. Chemical composition and properties of carbaryl technical material (TC)	
Manufacturing process, maximum limits for impurities ≥1 g/kg, 5 batch analysis data	Confidential information supplied and held on file by FAO. Mass balances were 990.9-999.7 g/kg.
Declared minimum carbaryl content	990 g/kg
Relevant impurities ≥ 1 g/kg and maximum limits for them	None
Relevant impurities < 1 g/kg and maximum limits for them:	None
Stabilizers or other additives and maximum limits for them:	None
Melting temperature range	Not stated

Hazard summary

Carbaryl was evaluated by the FAO/WHO JMPR in 2001 for toxicology (JMPR 2001) and in 2002 for residues (JMPR 2002). The 2001 JMPR established an ADI of 0-0.008 mg/kg bw/d and an acute RfD of 0.2 mg/kg bw.

The WHO hazard classification of carbaryl is: Category II, moderately hazardous (WHO 2002).

Formulations and co-formulated active ingredients

The main formulation types available are WP, SC, DP and GR. Carbaryl may be co-formulated with endosulfan. The formulations are registered and sold in more than 50 countries in Europe, North America, South America, Asia and Africa, for use on a very wide range of crops.

Methods of analysis and testing

The analytical method for identification and determination of the active ingredient in TC, DP, WP and SC is based on reversed-phase HPLC, with isocratic elution, UV-absorption detection and external standardization. The method was subjected to collaborative study under the auspices of CIPAC and adopted, with provisional status, in 2006.

Test methods for determination of physico-chemical properties of the technical active ingredient were OECD, EPA and/or EC, while those for the formulations were CIPAC, as indicated in the specifications.

Physical properties

The physical properties, the methods for testing them and the limits proposed for the TC, DP, WP and SC formulations, comply with the requirements of the manual (FAO/WHO 2006).

Containers and packaging

No special requirements for containers and packaging have been identified.

Expression of the active ingredient

The active ingredient is expressed as carbaryl, in g/kg or in g/l in the SC.

ANNEX 1

HAZARD SUMMARY PROVIDED BY THE PROPOSER

Note: Bayer CropScience provided written confirmation that the toxicological and ecotoxicological data included in the following summary were derived from carbaryl having impurity profiles similar to those referred to in Table 2, above.

Table A. Toxicology profile of carbaryl technical material, based on acute toxicity, irritation and sensitization.

Species	Test	Duration and conditions or guideline adopted, purity	Result	Reference
Rat, Sprague Dawley (m,f)	Acute oral	OECD 401; USEPA 870-1100; purity 99.1%	LD_{50} = 614 (420-906) mg/kg	M-209990-01-1
Rat, Sprague Dawley (m,f)	Acute dermal	OECD 402; USEPA 870.1200; purity 99.1%	LD_{50} >5000 mg/kg	M-209986-01-1
Rat, Sprague Dawley (m,f)	Acute inhalation	OECD 403; USEPA 870.1300; purity 99.1%	LC_{50} (f) = 2.43 (2.05-2.88) mg/l	M-209981-01-1
Rabbit, New Zealand white (m)	Skin irritation	OECD 404; USEPA 870.2500; purity 99.1%	Non irritant	M-205686-01-1
Rabbit, New Zealand white (m)	Eye irritation	OECD 405; USEPA 870.2400; purity 99.1%	Non irritant	M-205682-01-1
Guinea pig, Hartley (m,f)	Skin sensitization, maximization test	OECD 406; USEPA 870.2600; purity 99.1%	Non sensitizing	M-205678-01-1

Carbaryl requires classification for oral and inhalation toxicity as harmful by inhalation (R20) and if swallowed (R22).

Table B. Toxicology profile of the carbaryl technical material based on repeated administration (sub-acute to chronic)

Species	Test	Duration and conditions or guideline adopted, purity	Result	Reference
Rat, Sprague Dawley (m,f)	Sub-acute oral toxicity study	6-8 weeks, no guideline available, purity 99.3%. Dosage 50 to 24000 ppm	No NOAEL determined. Inhibition of brain and erythrocyte cholinesterase activity from 3000 ppm (223.5 mg/kg bw/d)	M-240792-01-1
Mouse, CD-1 (m,f)	Sub-acute oral toxicity study	6-8 weeks, no guideline available, purity 99.3%. Dosage 30 to 16000 ppm	No NOAEL determined. Inhibition of brain and erythrocyte cholinesterase activity from 4000 ppm (660.2 mg/kg/d)	M-240793-01-1
Dog, beagle (m,f)	Sub-acute oral toxicity study	5 weeks, USEPA 82-1, purity 99.3%. Dosage 20 to 125 ppm	NOAEL (m) = 125 ppm (3.83 mg/kg bw/d). No adverse effects	M-188594-01-1
Rat, CD (SD) IGS BR (m,f)	Sub-acute dermal toxicity study	4 weeks, no guideline available, purity 99.49%. Dosage 20 to 100 mg/kg bw/d	NOAEL = 50 mg/kg bw/d (m) 20 mg/kg bw/d (f) Inhibition of brain and erythrocyte cholinesterase activity at 50 (f) & 100 mg/kg bw/d (m)	M-240814-01-1
Dog, beagle (m,f)	Chronic oral toxicity study	1 year, OECD 453; USEPA 83-1, purity 99%. Dosage 125 to 1250 ppm	NOAEL (m) = 125 ppm (3.37 mg/kg bw/d) NOAEL (f) <125 ppm (3.73 mg/kg bw/d) Inhibition of brain and erythrocyte cholinesterase activity at 125 (f) & 400 ppm (m)	M-188448-01-1

Table B. Toxicology profile of the carbaryl technical material based on repeated administration (sub-acute to chronic)

Species	Test	Duration and conditions or guideline adopted, purity	Result	Reference
Rat, Sprague Dawley (m,f)	Combined chronic toxicity and carcinogenicity study	US EPA 83-5, purity 99%. Dosage 250 to 7500 ppm	Chronic NOAEL = 250 ppm (10 mg/kg bw/d, m) Inhibition of brain and erythrocyte cholinesterase activity at 1500 ppm (160.2 mg/kg bw/d) Carcinogenic NOAEL = 1500 ppm (60.2 mg/kg bw/d, m) At highest dose tested (7500 ppm, 349.5 g/kg bw/d), which exceeded the MTD, induced thyroid tumours (m), liver tumours (f), and urinary bladder tumours (m,f)	M-188599-01-1
Mouse, CD-1 (m,f)	Oncogenicity study	US EPA 83-2, purity 99%. Dosage 100 to 8000 ppm	Chronic NOAEL = 100 ppm (14.7 mg/kg bw/d, m) Inhibition of brain and erythrocyte cholinesterase activity at 1000 ppm (146 mg/kg bw/d) Increased incidence of vascular tumours at all dose levels	M-188663-01-1
Mouse, p53 Knockout (m,f)	Carcinogenicity oral study	6 months, no guideline available, purity 99%. Dosage 10 to 4000 ppm	Chronic NOAEL = 30 ppm (5 mg/kg bw/d) Non-genotoxic carcinogenicity	M-189100-01-1
Rat, Sprague Dawley (m,f)	2-generation reproduction study	OECD 416; USEPA 83-4, purity 99.1%. Dosage 75 to 1500 ppm	Parental and reproductive NOAEL = 4.7 mg/kg bw/d Reduced parental body weight and food consumption and reduced number of F2 pups at 300 ppm (21 mg/kg bw/d)	M-205143-01-1
Rat, Sprague Dawley (m,f)	Oral developmental toxicity study	US EPA 870.3700, purity 99%. Dosage 1 to 30 mg/kg bw/d	Maternal and developmental NOAEL = 4 mg/kg bw/d Reduced maternal and foetal body weights at 30 mg/kg bw/d	M-183489-01-1
Rabbit, New Zealand white (m,f)	Oral developmental toxicity study	US EPA 83-3, purity 99%. Dosage 5 to 150 mg/kg/d	Maternal NOAEL = 5 mg/kg/d Inhibition of erythrocyte cholinesterase activity at 50 mg/kg bw/d Developmental NOAEL = 50 mg/kg/d Reduced foetal body weight at 150 mg/kg bw/d	M-189101-01-1

According to EFSA (EU 2006), the weight of evidence indicated that carbaryl is not an *in vivo* genotoxic agent. In mice and rats, carbaryl was found to be carcinogenic. The current classification is R40 'Limited evidence of a carcinogenic effect' but classification R45 'May cause cancer' was considered and forwarded to ECB.

According to the US-EPA (US-EPA 2004), carbaryl is classified as "likely to be carcinogenic to humans", based on increased incidence of vascular tumours in mice. The Agency estimated dietary (food) exposure and cancer risk, using the Q1* approach, and concluded that the risk of cancer from dietary (food) exposure to carbaryl is not of regulatory concern.

Table C. Mutagenicity profile of carbaryl technical material, based on *in vitro* and *in vivo* tests

Species	Test	Conditions, purity	Result	Reference
Salmonella typhimurium, TA 98, TA 100, TA 1535, TA 1537, TA 1538	*In vitro* bacterial gene mutation	OECD 471; USEPA 84-2, ± S9, purity 99.3%	Negative	M-188551-01-1
Chinese hamster ovary cells (CHO)	*In vitro* mammalian gene mutation	OECD 476, USEPA 84-2, ± S9, purity 99.3%	-S9: negative +S9: equivocal	M-188559-01-1
CHO cells	*In vitro* mammalian chromosome aberration	OECD 473, USEPA 84-2, ± S9, purity 99.3%	-S9: negative +S9: positive	M-188549-01-1
Primary rat hepatocytes	*In vitro* Unscheduled DNA synthesis (UDS)	OECD 482, USEPA 84-2, ± S9, purity 99.3%	Negative	M-188895-01-1
Mouse, CD-1, bone marrow cells	*In vivo* mammalian chromosome aberration assay (micronucleus test)	OECD 474; USEPA 84-2, purity 99%	Negative	M-183400-01-1
Rat, Sprague-Dawley, bone marrow cells	*In vivo* mammalian chromosome aberration assay	OECD 475; USEPA 84-2, purity 99.7%	Negative	M-188662-01-1
Mouse, CD-1 (m), liver cells	*In vivo* mammalian DNA and protein binding assay	No guideline available, purity 99.6%	Negative	M-188979-01-1

Table D. Ecotoxicology profile of carbaryl technical material

Species	Test	Duration and conditions or guideline adopted, purity	Result	Reference
Oncorhynchus mykiss (rainbow trout)	Acute toxicity, dynamic	OECD 203, 96 h, purity 81.5%	LC_{50} = 3.3 mg/l	M-188581-01-1
Lepomis macrochirus (bluegill sunfish)	Acute toxicity, dynamic	OECD 203, 96 h, purity 99.1%	LC_{50} >7.75 mg/l	M-203363-01-1
Daphnia magna (water flea)	Acute toxicity, static	OECD 202, 48 h, purity 99.1%	EC_{50} = 0.0164 µg/l	M-204790-01-1
*Selenastrum capricornutum (*green algae)	Effect on growth, static	OECD 201, 96 h, purity 99.1%	EC_{50} = 1.37 mg/l	M-206219-01-1
Eisenia foetida (earthworm)	Acute toxicity, artificial soil	OECD 207, 14 d, purity 99.3%	LC_{50} >654 mg/kg dry soil	M-204400-01-1
Apis mellifera (honey bee)	Acute toxicity, contact	OECD 213, 72 h, purity 99.3%	LD_{50} = 0.14 µg/bee	M-206136-01-1
Apis mellifera (honey bee)	Acute toxicity, oral	OECD 213, 72 h, purity 99.3%	LD_{50} = 0.23 µg/bee	M-206133-01-1

Table D. Ecotoxicology profile of carbaryl technical material

Species	Test	Duration and conditions or guideline adopted, purity	Result	Reference
Anas platyrhynchos (mallard duck)	Acute toxicity, oral	EPA FIFRA 71-1, purity 99.1%	LD_{50} >2000 mg/kg bw	M-203435-01-1
Coturnix coturnix (Japanese quail)	Acute toxicity, oral	EPA FIFRA 71-1, purity >85%	LD_{50} >2290 mg/kg bw	M-204096-01-1
Anas platyrhynchos (mallard duck)	Acute toxicity, dietary	OECD 205, 5 d, purity 99.8%	LC_{50} >5000 mg/kg diet	M-099662-01-1
Colinus virginianus (bobwhite quail)	Acute toxicity, dietary	OECD 205, 5 d, purity 99.8%	LC_{50} >5000 mg/kg diet	M-099662-01-1

Based on extensive ecotoxicological data, carbaryl is very toxic to aquatic organisms (daphnids), terrestrial arthropods and bees. Classification and specific labelling for environmental hazards of carbaryl:

Symbol N;
R50, very toxic to aquatic organisms;
R57, toxic to bees

ANNEX 2. REFERENCES

BCS document number or other reference	Year and title of report or publication details
BCS 2006	Carbaryl_JMPS_request for specification correction. E-mail sent by Bayer CropScience to FAO, dated 13 November 2006.
EU 2006	Carbaryl, European Union DAR 2006, EFSA March 2006, Published. (http://www.efsa.eu.int/science/praper/conclusions/1534_en.html). Carbaryl, EFSA Conclusion Report, EFSA May 2006, (http://www.efsa.eu.int/science/praper/conclusions/1534_en.html).
FAO/WHO 2006	Manual on the development and use of FAO and WHO specifications for pesticides, March 2006 revision of the 1st edition. http://www.fao.org/ag/agp/agpp/pesticid/
JMPR 2001	Pesticide residues in food – 2001 evaluations. Part II. Toxicological. World Health Organization, Geneva, Switzerland, WHO/PCS/02.1, 2002.
JMPR 2002	Pesticide residues in food – 2001 evaluations. Part I. Residues. FAO plant production and protection paper 171 FAO, Rome, 2002.
M-099662-01-1	Hill. E.F., Health, R.G., Spann, J.W. and Williams, J.D., 1975. Lethal dietary toxicities of environmental pollutants to birds, U.S. Fish and Wildlife Service, Special Scientific Report - Wildlife No. 191, Washington, D.C. 1975.
M-183400-01-1	1996. Carbaryl: Induction of Micronuclei in the Bone marrow of Treated Mice.
M-183489-01-1	1998. Carbaryl: Developmental Toxicology Study in the Rat by gavage.
M-188448-01-1	1987. One-Year Oral Toxicity Study in Beagle Dogs with Carbaryl Technical.
M-188549-01-1	1989. Carbaryl technical: In an *in vitro* cytogenetic assay measuring chromosomal aberration frequencies in Chinese hamster ovary (CHO) cells.
M-188551-01-1	1989. Mutagenicity test on carbaryl (technical) in the Ames Salmonella / Microsome reverse Mutation Assay.
M-188559-01-1	1989. Mutagenicity test on carbaryl (technical) in the CHO/HGPRT forward Mutation Assay.
M-188581-01-1	1992. Sevin® 80S: Acute Toxicity to rainbow trout, *Oncorrynchus mykiss*, Under Flow-Through test conditions.
M-188594-01-1	1991. Subchronic Toxicity Study in Dogs with Carbaryl Technical.
M-188599-01-1	1991. Combined Chronic Toxicity and Oncogenicity Study with Carbaryl Technical in Sprague-Dawley Rats.
M-188624-01-1	1989. Vapor Pressure Determination of Carbaryl.
M-188630-01-1	1990. Photodegradation of [1-naphtyl-^{14}C] Carbaryl in Aqueous Solutions Buffered at pH 5 under Artificial Sunlight.
M-188661-01-1	1993. Carbaryl Product Chemistry.
M-188662-01-1	1993. Carbaryl: Study to evaluate the chromosome damaging potential of carbaryl technical by its effects on the bone marrow cells of treated rats.
M-188663-01-1	1993. Oncogenicity Study with Carbaryl Technical in CD-1® mice.
M-188695-01-1	1989. Octanol/Water Partition Coefficient Determination of Carbaryl.
M-188860-01-1	1990. Hydrolysis of ^{14}C-Carbaryl in Aqueous Solutions Buffered at pH 5, 7 and 9.
M-188895-01-1	1991. Carbaryl technical: In an *in vitro* rat primary hepatocyte unscheduled DNA synthesis assay.
M-188979-01-1	1994. Investigation of the Potential for Protein- and DNA-Binding of Carbaryl.
M-189100-01-1	1999. Carbaryl: 6-month carcinogenicity study in p53 knockout mice by dietary administration.
M-189101-01-1	1999. Developmental Toxicity Evaluation (with Cholinesterase Assessment) of Carbaryl Administered by Gavage to New Zealand White Rabbits.
M-202462-02-1	2002. Determination of water solubility of carbaryl AE F054158.
M-203363-01-1	2002. Acute toxicity *to Lepomis macrochirus* (bluegill sunfish) in a 96-hour – flow – through study - Carbaryl, substance, technical.
M-203435-01-1	2001. Mallard duck Acute oral toxicity study - Carbaryl, substance, technical.

BCS document number or other reference	Year and title of report or publication details
M-203752-02-1	2002. Determination of the Melting Point of carbaryl AE F054158.
M-204096-01-1	Hudson, R.H., Tucker, R.K. and Haegele, M.A., 1984. Handbook of toxicity of pesticides to wildlife, United States Department of the Interior, Fish and Wildlife Service, publication 153, Washington, D.C.
M-204400-01-1	2002. Acute toxicity *to* earthworms *(Eisenia foetida)* - Carbaryl, substance, technical.
M-204790-01-1	2002. Acute toxicity *to Daphnia magna* (Water flea) under static testing conditions - Carbaryl, substance, technical.
M-204896-02-1	2002. Screening Test of Thermal stability and Stability in Air of carbaryl AE F054158.
M-205143-01-1	2001. Two-Generation Reproductive Toxicity Evaluation of Carbaryl (RPA007744) Administered in the Feed to CD® (Sprague-Dawley) Rats.
M-205640-02-1	2002. Determination of the Boiling Point of carbaryl AE F054158.
M-205678-01-1	2001. Carbaryl: Skin Sensitization test in guinea pigs.
M-205682-01-1	2001. Carbaryl: Acute Eye Irritation in Rabbits.
M-205686-01-1	2001. Carbaryl: Acute Dermal Irritation in Rabbits.
M-206133-01-1	2002. Oral toxicity (LD50) *to* honey bees *(Apis mellifera L.)* - Carbaryl, substance, technical.
M-206136-01-1	2002. Contact toxicity (LD50) *to* honey bees *(Apis mellifera L.)* - Carbaryl, substance, technical.
M-206219-01-1	2002. Algal growth inhibition – *Pseudokirchneriella subcapitata* - Carbaryl, substance, technical.
M-209981-01-1	2001. Carbaryl: Acute Inhalation Toxicity (Nose only) Study in the Rat.
M-209986-01-1	2001. Carbaryl: Acute dermal toxicity in rats.
M-209990-01-1	2001. Carbaryl: Acute oral toxicity in rats.
M-240792-01-1	1990. Range-Finding toxicity Study in Rats with Carbaryl Technical.
M-240793-01-1	1990. Range-Finding toxicity Study in Mice with Carbaryl Technical.
M-240814-01-1	2002. 4 week Repeated-Dose Dermal Toxicity Study with Carbaryl Technical in Rats.
US-EPA 2004	2004. US-EPA Carbaryl Interim Reregistration Eligibility Decision.
WHO 2002	The WHO classification of pesticides by hazard and guidelines to classification, 2000-2002. WHO, Geneva, Switzerland, 2002