

**WHO SPECIFICATIONS AND EVALUATIONS
FOR PUBLIC HEALTH PESTICIDES**

BENDIOCARB

2,2-dimethyl-1,3-benzodioxol-4-yl methylcarbamate



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Disclaimer¹

WHO 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.

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Additionally, WHO 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.

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¹ This disclaimer applies to all specifications published by WHO.

INTRODUCTION

WHO establishes and publishes specifications* for technical material and related formulations of public health 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 has followed the **New Procedure**, described in the 1st edition of Manual on Development and Use of FAO and WHO Specifications for Pesticides (2002) and amended with the revised edition 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 WHO and the experts of the “FAO/WHO Joint Meeting on Pesticide Specifications” (JMPS).

WHO Specifications now only apply to products for which the technical materials have been evaluated. Consequently, from the year 2002 onwards the publication of WHO 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 pesticide in accordance with chapters 4 to 9 of the “FAO/WHO Manual on Pesticide Specifications.”

Part Two: The Evaluation Report(s) of the pesticide, reflecting the evaluation of the data package carried out by WHO and the JMPS. The data are provided by the manufacturer(s) according to the requirements of chapter 3 of the “FAO/WHO Manual on Pesticide Specifications” 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.

WHO specifications developed 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. WHO 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.

* Footnote: The publications are available on the Internet under (<http://www.who.int/whopes/quality/en/>).

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SPECIFICATIONS

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WHO SPECIFICATIONS FOR PUBLIC HEALTH PESTICIDES

BENDIOCARB

INFORMATION

ISO common names

Bendiocarb (E-ISO, BSI, ANSI, ESA), bendiocarbe ((m) F-ISO)

Synonyms None

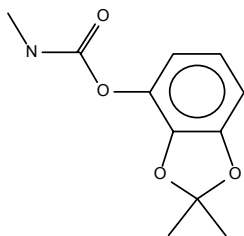
Chemical names

IUPAC: 2,2-dimethyl-1,3-benzodioxol-4-yl methylcarbamate

2,3-isopropylidenedioxyphenyl methylcarbamate

CA: 2,2-dimethyl-1,3-benzodioxol-4-yl methylcarbamate

Structural formula



Empirical formula

C₁₁H₁₃NO₄

Relative molecular mass

223.2

CAS Registry number

22781-23-3

CIPAC number

232

Identity tests

HPLC retention time, ¹H NMR spectrum.

WHO SPECIFICATIONS FOR PUBLIC HEALTH PESTICIDES

BENDIOCARB TECHNICAL MATERIAL

WHO specification 232/TC (December 2008*)

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 (232/2008). 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 report (232/2008), as PART TWO, forms an integral part of this publication.

1 Description

The material shall consist of bendiocarb together with related manufacturing impurities and shall be a beige crystalline powder, free from visible extraneous matter and added modifying agents.

2 Active ingredient

2.1 Identity tests (232/TC/(M)/2, CIPAC Handbook D, p.10, 1988)

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 Bendiocarb content (232/TC/(M)/3, CIPAC Handbook D, p.11, 1988)

The bendiocarb content shall be declared (not less than 970 g/kg) and, when determined, the average measured content shall not be lower than the declared minimum content.

3 Relevant impurities (Note 1)

Note1 There are no relevant impurities to be controlled in products of the manufacturer identified in evaluation report 232/2008. However, methyl isocyanate and/or toluene can occur as a result of certain manufacturing processes. If methyl isocyanate (≥ 1 g/kg), or toluene (≥ 10 g/kg), could occur in the bendiocarb TC of other manufacturers it may be designated as a relevant impurity and a specification clause may be required to limit its concentration.

* Specifications may be revised and/or additional evaluations may be undertaken. Ensure the use of current versions by checking at: <http://www.who.int/whopes/quality/en/>.

WHO SPECIFICATIONS FOR PUBLIC HEALTH PESTICIDES

BENDIOCARB WETTABLE POWDER

WHO specification 232/WP (December 2008*)

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 (232/2008). 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 (232/2008), as PART TWO, forms an integral part of this publication.

1 Description

The material shall consist of an homogeneous mixture of technical bendiocarb, complying with the requirements of WHO specification 232/TC (December 2008), 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 (232/WP/(M)/2, CIPAC Handbook D, p.12, 1988)

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 Bendiocarb content (232/WP/(M)/3, CIPAC Handbook D, p.12, 1988)

The bendiocarb content shall be declared (800 g/kg) and, when determined, the average measured content shall not differ from that declared by more than ± 25 g/kg.

3 Relevant impurities (Note 1)

4 Physical properties

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

Maximum: 1% retained on a 75 μ m test sieve.

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

A minimum of 70% of the bendiocarb content found under 2.2 shall be in suspension after 30 min in CIPAC Standard Water D at $30 \pm 2^\circ\text{C}$ (Note 4).

* Specifications may be revised and/or additional evaluations may be undertaken. Ensure the use of current versions by checking at: <http://www.who.int/whopes/quality/en/>.

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

Maximum: 50 ml after 1 min.

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

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

5 **Storage stability**

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

After storage at $54 \pm 2^\circ\text{C}$ for 14 days, the determined average active ingredient content must not be lower than 95% relative to the determined mean content found before storage (Note 6) and the formulation shall continue to comply with the clauses for:

- wet sieve test (4.1);
- suspensibility (4.2);
- wettability (4.4).

Note 1 There are no relevant impurities to be controlled in products of the manufacturer identified in evaluation report 232/2008. However, methyl isocyanate and/or toluene can occur as a result of certain manufacturing processes. If methyl isocyanate (≥ 1 g/kg of bendiocarb), or toluene (≥ 10 g/kg of bendiocarb), could occur in the formulations of other manufacturers it may be designated as a relevant impurity and a specification clause may be required to limit its concentration.

Note 2 The formulation should be tested at the highest and lowest rates of use recommended by the supplier provided 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 (5.1).

Note 4 Chemical assay is the only fully reliable method to measure the mass of active ingredient still in suspension. However, the 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.

PART TWO

EVALUATION REPORTS

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WHO SPECIFICATIONS AND EVALUATIONS FOR PUBLIC HEALTH PESTICIDES

BENDIOCARB

FAO/WHO EVALUATION REPORT 232/2008

Recommendations

The Meeting recommended that:

- (i) the specifications for bendiocarb TC and WP, proposed by Bayer CropScience and as amended, should be adopted by WHO; and
- (ii) the existing WHO specifications for bendiocarb TC, WP, DP and UL should be withdrawn.

Appraisal

The Meeting considered data and draft specifications (TC and WP only) for bendiocarb, submitted by Bayer CropScience in support of a review of existing WHO specifications for bendiocarb (TC, WP, DP, UL, all published in 1999). Existing specifications for bendiocarb DP and UL were not supported by the proposer.

Bendiocarb is not under patent.

Bendiocarb is a crystalline solid of low solubility in highly polar solvents (including water), and in solvents of low polarity, but is very soluble in various organic solvents of intermediate polarity. Bendiocarb is rapidly hydrolysed under moderately alkaline conditions but only slowly hydrolysed under moderately acidic conditions. Although it is subject to photolysis, degradation by this route does not occur very readily. It has no measurable acidic or basic properties.

The Meeting was provided with commercially confidential information on the manufacturing process and 5-batch analysis data on purity and all impurities ≥ 1 g/kg. These data were confirmed as identical to those submitted to the Health and Safety Executive (HSE) for registration in the U.K. Mass balances in the batch analytical data were good (98.7-99.7%) and the bendiocarb was of high purity (982-991 g/kg).

The Meeting and proposer considered in detail whether or not methyl isocyanate and toluene should be designated relevant impurities, for the purposes of WHO specifications, on the basis of their hazard characteristics.

The Meeting noted that the hazards associated with both impurities differ from those of bendiocarb but that their hazards have been well-characterized in the scientific literature. The Meeting also noted that both impurities are very volatile, in contrast with the low volatility of bendiocarb. In consequence, the patterns and routes of user and environmental exposure to the active ingredient and the two impurities were considered likely to be very different. Thus the simple "concentration and relative toxicity" approach, used by JMPS to determine the relevance of impurities having characteristics similar to those of the active ingredient, was not entirely appropriate in this case.

Methyl isocyanate. WHO/PCS advised the Meeting that methyl isocyanate is an eye and skin irritant and perhaps a respiratory sensitizer. However, in the proposer's bendiocarb TC, it was not detectable at or above 1 g/kg, the manufacturing limit

below which all impurities (other than those associated with exceptional hazards) are considered to become non-relevant. The Meeting therefore agreed that it was not necessary to designate methyl isocyanate as a relevant impurity in the proposer's TC, nor in WP prepared using TC from that source. The extent to which this volatile impurity would be likely to persist in (crystalline) bendiocarb TC or WP was unknown but the Meeting agreed that, although a specification clause is unnecessary in this case, a cautionary note should be appended to the specifications, alerting users to the possibility that the impurity may occur at ≥ 1 g/kg (and thus require control) in the bendiocarb products of other manufacturers.

Toluene. The large body of information available on the hazards involved in exposures to toluene would have been ignored by the default approach of JMPS to the determination of the relevance of impurities which have a hazard profile different from that of the active ingredient (i.e., the application of the GHS labelling limits for mixtures). Therefore, WHO/PCS proposed that a more refined approach should be adopted.

WHO/PCS advised that the assessment of toluene toxicity and classification by the European Union (EU 2003) is based on its toxicity arising from inhalation exposure, making it pertinent to the JMPS assessment of toluene in bendiocarb. The key end points that determine whether or not toluene should be designated as a relevant impurity in FAO/WHO specifications are related to its reproductive toxicity.

WHO/PCS advised that, with respect to reproductive toxicity, there are no data to indicate that toluene affects fertility or that it is teratogenic. However, it has been associated with developmental neurotoxicity in experimental animals and spontaneous abortions in humans. As there is uncertainty in the interpretation of these studies, the European union has classified toluene in reproductive toxicity category 3, corresponding to the GHS category 2. In addition, case reports have been published of "fetal alcohol syndrome" among toluene sniffers, with no information on exposure, although high levels almost certainly would have been involved. No information is available to show whether bendiocarb could produce similar effects but, to determine whether or not toluene levels should be controlled in bendiocarb, it was therefore conservatively assumed that the effects would be produced only by the toluene.

In the most informative study (Hass *et al.* 1999), adverse neuro-developmental effects were observed in rats exposed to air containing 4500 mg toluene/m³ for 6 h/d from pregnancy day 7 to post-natal day 18¹. These effects have not been studied at lower concentrations, so a no-observed-adverse-effect-concentration (NOAEC) is not available and the test level was considered to be the lowest-observed-adverse-effect-concentration (LOAEC).

Two studies in humans have indicated a possible increase of spontaneous abortions among women exposed to toluene, either alone (Ng *et al.* 1992) or in combination with other solvents (Taskinen *et al.* 1994). In the study involving exposure only to toluene, in which limited quantitative exposure data were available, an elevated incidence of spontaneous abortions was observed among

¹ The effects were not observed in animals exposed only during the pre-natal period.

women exposed to an average concentration of 330 mg toluene/m³ air in the workplace.

The default uncertainty factor used by the JMPR to derive acute reference doses (ARfD) and acceptable daily intakes (ADIs) from no-observable-adverse-effect-levels (NOAELs) is 100 (10 for inter-species extrapolation, 10 for inter-individual variation). When the NOAEL is not available to the JMPR, the use of the lowest-observed-adverse-effect-level (LOAEL) is usually compensated by incorporating an additional uncertainty factor of 3-10 (IPCS 1994, 1999; JMPR 2002; Solecki *et al.* 2005). WHO/PCS proposed that, for the hazard characterization of toluene in bendiocarb, the tolerable inhaled concentration (TIC), conceptually similar to the ARfD and ADI¹, should be used. The TIC represents a range² of concentrations of a chemical in air that may be inhaled without health consequences over a day (TIC for acute effects) or over long periods of time (TIC for chronic effects). Calculated TIC maximum values, equivalent to JMPR ARfD maximum values (developmental effects being considered acute effects), for an 8-h daily airborne exposure of humans³ to toluene would be:

$$(6/8 \times 4500) / (10 \times 10 \times [3 \text{ to } 10]) = 3.4 \text{ to } 11 \text{ mg/m}^3,$$

derived from data on adverse neuro-developmental effects in the study of reproductive toxicity in rats; and

$$(330 / (10 \times [3 \text{ to } 10])) = 3.3 \text{ to } 11 \text{ mg/m}^3,$$

derived from data on spontaneous abortions in the human study.

The estimated maximum values for the TIC thus converge toward a geometric mean of 6 mg/m³.

In most circumstances when solid bendiocarb TC or WP is exposed to air, any volatilized toluene impurity would be diluted by the environmental air. However, if bendiocarb becomes airborne as a dust⁴ the toluene impurity concentration in air is maximized, as is the potential inhalation exposure to toluene. In such conditions, the toluene concentration in bendiocarb, the concentration of bendiocarb in air, and the toluene concentration in the air are related by the formula:

$$a = b \times c / 1000$$

where: a = toluene-in-air (mg/m³);
b = bendiocarb-in-air (mg/m³);
c = toluene-in- bendiocarb (g/kg).

So, for example, a toluene-in-air concentration of 6 mg/m³ (the estimated TIC maximum) would be reached at a toluene-in-bendiocarb concentration of 11 g/kg and a corresponding a bendiocarb-in-air concentration of 550 mg/m³. The corresponding bendiocarb-in-air concentration equals the 4-h inhalation toxicity LC₅₀ (rat) for bendiocarb. Therefore, at a toluene-in-bendiocarb concentration of 11 g/kg, the risk associated with the acute inhalation hazard of the bendiocarb active ingredient greatly overshadows the risk associated with the reproductive

¹ "Dose" being considered to be the amount inhaled at the TIC concentration over a working day.

² The minimum of the range being zero.

³ The rats were exposed for 6 h/d.

⁴ For example, during pouring or other transfer operations.

hazards of the toluene impurity and thus the contribution of toluene impurity to the overall hazard of the bendiocarb product is negligible. WHO/PCS therefore concluded that, at concentrations less than 10 g/kg of bendiocarb, toluene is a non-relevant impurity.

WHO/PCS also advised that the minimum toluene concentration for ignition in air is about 1% v/v and thus, as an impurity in bendiocarb, the toluene would present no fire/explosion risk at or about the proposed cut-off value of 10 g/kg.

The manufacturing limit for toluene in the proposer's bendiocarb was well below 10 g/kg and the Meeting agreed that it was not necessary to designate it as a relevant impurity in the proposer's TC, nor in WP prepared using TC from that source.

As in the case of methyl isocyanate, the extent to which (volatile) toluene would be likely to persist in (crystalline) bendiocarb TC or WP was unknown but, again, the Meeting agreed that, although a specification clause is unnecessary in this case, a cautionary note should be appended to the specifications, alerting users to the possibility that the impurity may occur at ≥ 10 g/kg (and require control) in the products of other manufacturers.

The Meeting agreed that none of the other impurities should be designated as relevant.

The analytical method for determination of the active ingredient (including identity tests) is a full CIPAC method, validated for analysis of TC and WP. Bendiocarb is determined by reversed-phase HPLC, using UV detection at 254 nm and internal standardization with propiophenone.

Test methods for determination of physico-chemical properties of the technical active ingredient were OECD, EPA or EC, while those for the WP formulation were CIPAC, as indicated in the specification. The Meeting questioned the melting point quoted for TC, as it was the same as that for the pure active ingredient. The proposer stated the similarity is a reflection of the generally very high purity of the TC in current production.

Noting that the existing WHO specifications for bendiocarb DP and UL were not supported by the proposer, the Meeting considered the following issues arising from the proposed specifications for TC and WP, which were otherwise in accordance with the requirements of the manual (FAO/WHO 2006).

TC. The Meeting welcomed the proposed increase in purity of bendiocarb (940 g/kg in the existing WHO specification) to 970 g/kg.

The existing clause for water content had been deleted. Although bendiocarb is subject to rapid hydrolysis under alkaline conditions, this does not occur in the crystalline solid TC and water is not considered to be a quality criterion for a TC used in the preparation of WP formulations.

WP. The Meeting noted that the existing WHO specification encompassed bendiocarb contents in the ranges 250-500 and >500 g/kg but was informed that only the 800 g/kg WP had been evaluated for efficacy by WHOPES. The Meeting therefore agreed that the new specification should be restricted to 800 g/kg products.

The Meeting questioned whether the existing specification limits for certain physical properties remained appropriate for the new specification, as they represented values at or about the limit of acceptability. After checking current product performance, the proposer revised the specification limits for wet sieve test (from 2% to 1% of the formulation retained on a 75 µm sieve); suspensibility (from 50% to 70% in suspension after 30 min in hard water); persistent foam (from 60 ml to 50 ml); and wettability (from 2 min to 1 min for complete wetting without swirling). These improvements were welcomed by the Meeting.

The Meeting questioned the need for a proposed clause to limit the pH range, as this was not included in the existing specification. Although bendiocarb is unstable in alkaline solution, the manufacturer agreed that significant degradation is unlikely in the storage and use of the WP and the proposed clause was withdrawn.

**SUPPORTING INFORMATION
FOR
EVALUATION REPORT 232/2008**

Uses

Bendiocarb is a cholinesterase-inhibitor *N*-methyl carbamate insecticide. It is mainly used in public health, industrial and storage applications, having low odour and no corrosive or staining properties.

Identity

ISO common names

Bendiocarb (E-ISO, BSI, ANSI, ESA), bendiocarbe ((m) F-ISO)

Synonyms None

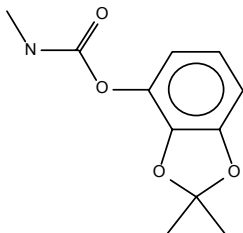
Chemical names

IUPAC: 2,2-dimethyl-1,3-benzodioxol-4-yl methylcarbamate

2,3-isopropylidenedioxyphenyl methylcarbamate

CA: 2,2-dimethyl-1,3-benzodioxol-4-yl methylcarbamate

Structural formula



Empirical formula

C₁₁H₁₃NO₄

Relative molecular mass

223.2

CAS Registry number

22781-23-3

CIPAC number

232

Identity tests

HPLC retention time, ¹H NMR spectrum.

Physico-chemical properties of bendiocarb

Table 1. Physico-chemical properties of pure bendiocarb

Parameter	Value(s) and conditions	Purity %	Method	Reference
Vapour pressure	4.6 x 10 ⁻³ Pa at 25°C (extrapolated)	99.8	gas saturation	A90090
Melting point	129°C	98.5	OECD 102	C047471
Boiling point	decomposed with boiling at about 264°C	98.5	OECD 103	C047471
Temperature of decomposition	≥240°C	98.5	OECD 103	C047471
Solubility in water at 20°C	0.31 g/l at pH 3-5 0.28 g/l at pH 7 0.03 g/l at pH 9-11 with significant hydrolysis	99.3	84/449/EEC A6	A90138
Octanol/water partition coefficient	K _{OW} log P = 1.7 at 25°C at pH 6.9	99.0	84/449/EEC A8	A90075
Hydrolysis characteristics, half-life at 25°C	46.5 d at pH 5 48.1 h at pH 7 43.8 min at pH 9	99.0	OECD 111	A90220
Photolysis characteristics	Half-life = 37.3 d (corrected for dark reaction); 187 d (extrapolated to natural sunlight 40° north, midday, summer); 1070-20000 days (using the quantum yield) *	99.0	US EPA NTIS PB83-153973 (1982)	A90107, A90108
Dissociation characteristics	Not measurable due to rapid hydrolysis in alkaline solution. Not protonated under acidic conditions. The "parent phenol" of bendiocarb (NC7312) has pKa = 8.8 at 20°C	99.0	US EPA OPPTS 830.6310, UV spectrophotometric method	A90087

Table 2. Chemical composition and properties of technical bendiocarb (TC)

Manufacturing process, maximum limits for impurities ≥ 1 g/kg, 5 batch analysis data	Confidential information supplied and held on file by WHO. Mass balances were 98.7-99.7% and no unidentified impurities were reported.
Declared minimum bendiocarb content	970 g/kg
Relevant impurities ≥ 1 g/kg and maximum limits for them	None
Relevant impurities < 1 g/kg and maximum limits for them	None
Stabilisers or other additives and maximum limits for them	None
Melting temperature of the TC	129°C

* Data from a laboratory study at pH 5 (to minimize hydrolysis) under artificial light conditions (light source: Hg-arc TQ 150, light intensity corresponding to about 2.5x natural sunlight at 290-320 nm, being the region in which bendiocarb absorbs sunlight).

Hazard summary

Bendiocarb was evaluated by the FAO/WHO JMPR in 1982 and 1984. In 1984, the JMPR set an ADI for bendiocarb of 0-0.004 mg/kg bw.

The WHO hazard classification of bendiocarb is: moderately hazardous, class II (WHO 2002).

Within the EU, according to the 19th adaptation to technical progress of Council Directive 67/548/EEC, bendiocarb is classified as: “toxic by inhalation and if swallowed (T, R23/25)”; “harmful in contact with skin (Xn, R21)”; and “very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment (N, R50/53)”.

In May 2005, as part of a review of anticholinesterase compounds, the UK Health & Safety Executive classified bendiocarb as: “toxic by inhalation and if swallowed (T, R23/25)” and “harmful in contact with skin (Xn, R21)”.

Formulations

The main formulation type available for public health is a wettable powder (WP), which is registered and/or sold in many countries throughout the world.

Bendiocarb is not usually co-formulated with other pesticides.

Methods of analysis and testing

The analytical method for the active ingredient (including identity tests) is a full CIPAC method, in which bendiocarb is determined by reversed-phase HPLC, using UV detection at 254 nm and internal standardization with propiophenone (CIPAC Handbook D). It was validated for analysis of the TC and WP formulation.

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

Physical properties

The physical properties, the methods for testing them and the limits proposed for the WP formulation, 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 bendiocarb.

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 bendiocarb having impurity profiles similar to those referred to in Table 2, above.

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

Species	Test	Purity %	Duration and conditions or guideline adopted	Result	Reference
Rat, Sprague Dawley (m)*	Oral	91-98.9	Single dose by gavage, in 0.5% w/v aqueous gum tragacanth, to groups of 6 m. Observed 7 d.	LD ₅₀ = 71.9-155.9 mg/kg bw (m)	A90464
Rat, Sprague Dawley (m,f)*	Oral	98.8	Single dose by gavage, in corn oil, to 4 groups of 6 m and 6 f. Observed 14 d.	LD ₅₀ = 25 mg/kg bw (m) 27.3 mg/kg bw (f)	A90517
Rat, Wistar (m,f)*	Oral	"pure"	Single dose by gavage, in glycerol formal, to 6 groups of 2-10 m and 8 groups of 2-6 f. Observed 24 h.	LD ₅₀ = 45-48 mg/kg bw (m) 34-40 mg/kg bw (f)	A90940
Rat, strain not specified (m)*	Oral	not known	Single dose by gavage, in glycerol formal, to 10 groups of 4 m. Observation period not specified.	LD ₅₀ = 40-64 mg/kg bw (m)	A90942
Mouse, CFW (f)*	Oral	"pure"	Single dose by gavage, in glycerol formal, to 3 groups of 2-4 f. Observed 24 h.	LD ₅₀ = 45 mg/kg bw (f)	A90940
Mouse, CD-1 (m,f)*	Oral	91.8	Single dose by gavage, in 0.5% w/v aqueous gum tragacanth, to 9 groups of 6 m and 6 f. Observed 14 d.	LD ₅₀ = 28.3 mg/kg bw (m) 28.2 mg/kg bw (f)	A90477
Guinea pig, strain not specified (f)*	Oral	"pure"	Single dose by gavage, in glycerol formal, to 2 groups of 2 f. Observed 24 h.	LD ₅₀ = 35mg/kg bw (f)	A90940
Hamster, Syrian (f)*	Oral	not known	Single dose by gavage, in water, to 5 groups of 4 f. Observed 7 d.	LD ₅₀ = 141 mg/kg bw (f)	A90384
Rabbit, strain not specified (m,f)*	Oral	"pure"	Single dose by gavage, in glycerol formal, to 3 groups of 2 m and 2 groups of 2 f. Observed 24 h.	LD ₅₀ = 35 mg/kg bw (f) 40 mg/kg bw (m)	A90940

* Studies performed prior to introduction of testing guidelines and GLP regulations but conducted according to good scientific practice.

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

Species	Test	Purity %	Duration and conditions or guideline adopted	Result	Reference
Rat, Wistar (m,f)*	Dermal	not known	In glycerol, applied to skin of 4 m and 4 f, 400, 800 mg/kg bw, held in contact by occlusive patch 24 h. Observed 7 d.	LD ₅₀ = 566 mg/kg bw (m,f)	A90347
Rat, Wistar (f)*	Dermal	"pure"	In glycerol formal, applied to skin of 2 m and 2 f, 400, 800 mg/kg bw, held in contact by occlusive patch 24 h. Observed 7 d.	LD ₅₀ = 800 mg/kg bw (f)	A90940
Rat, Sprague Dawley (m,f)	Inhalation	97.9	OECD 403, US EPA guideline 81-3 (GLP). Groups of 5 m and 5 f exposed whole body, 4 h, to 248, 377, 512, 701 mg/m ³ bendiocarb by dust generator at 25 l/min. Observed 14 d.	LC ₅₀ = 550 mg/m ³ (0.55 mg/l of air) (m,f)	A90617
Rabbit, New Zealand White (m,f)**	Skin irritation	not known	US EPA guideline 40 CFR 162	Not a skin irritant	A90987
Rabbit, New Zealand White (m,f)**	Eye irritation	99.2	US EPA guideline 40 CFR 162.	Not an eye irritant	A90435
Guinea pig, Dunkin/Hartley albino (f)	Skin sensitization	97.5	OECD guideline 406 (Buehler test - GLP).	Not a sensitizer	A90639

* Studies performed prior to introduction of testing guidelines and GLP regulations but conducted according to good scientific practice.

** Study conducted prior to introduction of GLP regulations.

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

Species	Test	Purity %	Duration and conditions or guideline adopted	Result	Reference
Rat, Sprague Dawley (m,f)*	Oral (dietary), sub-chronic	92.7-98	Administered to groups of 10 m and 10 f in diet for 13 weeks at 0, 2, 10, 50, 250 ppm (equivalent to 0, 0.13, 0.65, 3.45, 17.3 mg/kg bw/d).	NOAEL = 0.65 mg/kg bw/d based on inhibition of whole blood cholinesterase activity (up to 20%) at 3.45 mg/kg bw/d dose. LOAEL = 3.45 mg/kg bw/d	A90957
Dog, beagle (m,f)*	Oral (dietary), sub-chronic	96-97	Administered to groups of 4 m and 4 f in diet for 16 weeks at 0, 20, 100, 500-1000 ppm (1000 ppm for the last 4 weeks of the study) (equivalent to 0, 0.2, 1.0, 6.25 mg/kg bw/d).	NOAEL = 1.0 mg/kg bw/d based on inhibition of whole blood (43-46%) and brain (28-42%) cholinesterase activity at 6.25 mg/kg bw/d. LOAEL = 6.25 mg/kg bw/d	A90358
Rat, Sprague Dawley (m,f)	Inhalation, sub-chronic	97.2-97.6	US EPA guideline 82.4 (GLP). Groups of 10 m and 10 f exposed snout-only 6 h/d to particulate aerosol at 0, 0.18, 1.97, 19.3 mg/m ³ of bendiocarb. Exposure 5 d/week for 13 weeks.	NOAEL = 0.9 mg/m ³ = 0.24 mg/kg bw/d based on slight inhibition of whole blood cholinesterase activity at week 6 at 2 mg/m ³ . LOAEL = 2 mg/m ³ = 0.54 mg/kg bw/d	A89120, M-266196-01-1
Rat, Wistar (m)*	Dermal, repeated dose toxicity	80% WP	Doses 50, 100, 200, 400 or 800 mg bendiocarb/kg bw/d, aqueous suspension, to skin of 5 groups of 6 m under occlusive dressing for 6 h/d, 5 d/week for 3 weeks.	NOAEL = 50 mg/kg bw/d based on dose-related decrease in whole blood cholinesterase activity from 100 to 800 mg/kg bw/d. LOAEL = 100 mg/kg bw/d	A90343
Rabbit, New Zealand White (m,f)	Dermal, repeated dose toxicity	31% WP**	US EPA guideline 82.2 and Japan 59 NohSan No. 4200 (1985) (GLP). Administered daily to intact skin of 5 m and 5 f at 1.67, 5, 15 mg bendiocarb/kg bw/d for 21 consecutive days.	NOAEL = 5 mg/kg bw/d based on reduction in erythrocyte and plasma cholinesterase levels at 15 mg/kg bw/d. LOAEL = 15 mg/kg bw/d	A90605

* Studies performed prior to introduction of testing guidelines and GLP regulations but conducted according to good scientific practice and in-house quality assurance standards.

** Ficam Plus wettable powder formulation, nominally containing 31% bendiocarb, 3.0% natural pyrethrins and 7% piperonyl butoxide.

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

Species	Test	Purity %	Duration and conditions or guideline adopted	Result	Reference
Dog, beagle (m,f)*	Oral, chronic	98.1-99	Groups of 8 m and 8 f dosed in diet for 104 weeks at 0, 20, 100, 500 ppm (equivalent to 0, 0.65, 3.12, 16.24 mg/kg bw/d).	NOAEL = 0.65 mg/kg bw/d based on inhibition of brain cholinesterase activity (20%) at 3.12 mg/kg bw/d. LOAEL = 3.12 mg/kg bw/d	A90975
Rat, Sprague Dawley (m,f)**	Oral, long-term dietary & carcinogenicity	96.5	OECD guideline 453. 50 m and 50 f weanlings (100 animals/sex in control) from F ₁ litters of fertility study given 0, 10, 20, 200 ppm in diet for 104 weeks (equivalent to approx. 0, 0.4, 0.8, 8 (m) and 0, 0.5, 1, 10 (f) mg/kg bw/d)	NOAEL = 0.8/1 mg/kg bw/d (m/f) based on whole blood and brain cholinesterase inhibition at 8/10 mg/kg bw/d. No evidence of carcinogenicity. LOAEL = 8/10 mg/kg bw/d (m/f)	A90427, M-265313-01-1, M-265496-01-1
Mouse, CD-1 (m,f)**	Oral, long-term dietary & carcinogenicity	92.7	OECD guideline 453. 50 m and 50 f (100 animals/sex in control group) administered 0, 50, 250, 1250 ppm in diet for 104 weeks (equivalent to approx. 0, 8.06, 42.4, 211 (m) and 0, 10.7, 56.8, 286 (f) mg/kg bw/d).	NOAEL = 211/286 mg/kg bw/d (m/f). No evidence of carcinogenicity.	A90445
Rat, Sprague Dawley (m,f)**	Oral (dietary), 3-generation	97.0-99.3	OECD 2-generation reproduction toxicity study guideline. Groups of 30 m and 30 f (F ₀) fed continuously at 0, 10, 50, 250 ppm in diet (equivalent to approx. 0, 1, 4, 18 mg/kg bw/d) for 90 d prior to pairing, and during mating (max. 21 d), gestation and lactation of 2 litters, F _{1A} and F _{1B} . Repeated for 2 litters of 2d (F ₂) and 3d (F ₃) generations.	Parental and offspring toxicity NOAEL = 18 mg/kg bw/d (250 ppm) No effect upon fertility, no significant parental toxicity.	A90447

* Studies performed prior to introduction of testing guidelines and GLP regulations but conducted according to good scientific practice and in-house quality assurance standards.

** Study conducted prior to introduction of GLP regulations.

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

Species	Test	Purity %	Duration and conditions or guideline adopted	Result	Reference
Rat, Sprague Dawley (f)	Teratogenicity	97.2	US EPA guideline 83.3 (GLP). Groups of 25-30 pregnant f dosed by oral gavage 0, 0.4, 2, 10 mg/kg bw/d in 1% methylcellulose on 6-15 d gestation (sacrifice 20 d gestation).	NOAEL developmental and maternal toxicity = 2 mg/kg bw/d No teratogenic effect.	A90627
Rabbit, New Zealand White (f)**	Teratogenicity	97.7-98.5	OECD guideline. Groups of 27-29 pregnant (artificially inseminated) f dosed by oral gavage 0, 1, 2.5, 5 mg/kg/d in 0.5% w/v aqueous gum tragacanth on d 6-28 of gestation (sacrifice on 29 d gestation).	NOAEL developmental toxicity = 2.5 mg/kg bw/d based on increased incidence of foetuses with incomplete ossification of cranial bones at highest dose. NOAEL maternal toxicity <1 mg/kg bw/d based on whole blood cholinesterase inhibition in dams at 1 mg/kg bw/d. No teratogenic effect.	A90442
Hen, domestic (f)**	Acute delayed neurotoxicity	not known	US EPA guideline 162, 81-8. 4 groups of 10 hens dosed at 20% concentration in corn oil (doses 0, 189, 378, 757 mg/kg), birds protected by atropine intramuscular injection at 1% concentration in sterile water at 10 mg/kg bw. Observed 21 days.	No signs of delayed neurotoxicity at levels up to and including 757 mg/kg.	A90423

** Study conducted prior to introduction of GLP regulations.

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

Species	Test	Purity %	Conditions and doses	Result	Reference
<i>S. typhimurium</i> (TA98, 100, 1535, 1537, 1538)	Ames test, <i>in vitro</i>	100	GLP study, ± S9 metabolic activation. 15, 50, 150, 500, 1500 µg/plate.	Negative	A90615
<i>S. typhimurium</i> (TA98, 100, 1535, 1537, 1538) and <i>E. coli</i> (WP2)**	Ames test, <i>in vitro</i>	98.8	Japanese guideline for Ames test. ± S9 metabolic activation. 5, 10, 50, 100, 500, 1000, 5000 µg/plate.	Negative	A90483
<i>S. cerevisiae</i> (D7)*	Conversion and mitotic recombination, <i>in vitro</i>	98.5	500, 1000, 2000, 4000, 6000 µg/plate ± S9 and 375, 750, 1500, 3000, 6000 µg/plate +S9.	Negative	A90499
Human lymphocytes	Chromosome aberration, <i>in vitro</i>	97.6	US EPA guideline 84-2; OECD guideline 473 (GLP). 17, 85, 170 µg/ml - S9 and 14.3, 71.5, 143 µg/ml -S9 and 30, 150, 225, 300 µg/ml +S9.	Positive (+S9) Negative (-S9)	A90616
Human epithelioid (HeLa) cells	Unscheduled DNA synthesis, <i>in vitro</i>	96.4	US EPA guideline 84-2; EPA TSCA 560/6-83-001; OECD guideline 482 (GLP). ± S9 metabolic activation. 1.25 to 2560 µg/ml.	Negative	A90618
Mouse lymphoma L5178Y cells*	Gene mutation, <i>in vitro</i>	98.5	± S9 metabolic activation. 0.2 to 25 µg/ml.	Negative	A90491
Rat, Sprague Dawley (m,f) bone marrow	Clastogenicity (metaphase analysis), <i>in vivo</i>	96.4	US EPA guideline 84-2; EPA TSCA 560/6-83-001; OECD guideline 475 (GLP). Single dose of 1% w/v in methylcellulose by oral gavage to groups of 5 m and 5 f at 2.6, 13, 26 mg/kg bw. 5 m and 5 f each group sacrificed 6, 24, 48 h after dosing	Negative	A90620

** Study conducted prior to introduction of GLP regulations.

* Studies performed prior to introduction of testing guidelines and GLP regulations but conducted according to good scientific practice and in-house quality assurance standards.

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

Species	Test	Purity %	Conditions and doses	Result	Reference
Mouse, Charles River CD-1 (m) bone marrow *	Clastogenicity (micronucleus), <i>in vivo</i>	97.9	2 intra-peritoneal injection in propylene glycol 24 h apart to groups of 5 m at 0.625, 1.25, 2.5 mg/kg bw. Femoral bone marrow cells harvested 6 h after 2 nd dose	Negative	A90496
Rat, Sprague Dawley (m,f) *	Dominant lethal mutations, <i>in vivo</i>	99	Administered in diet to groups of 20 m at 10, 50 or 250 ppm for 13 weeks. Treated m mated with untreated, mature virgin f for 7 d. Pregnant and non-pregnant f sacrificed 14 d post-mating and examined for numbers of <i>corpora lutea</i> , implantation sites, live and dead fetuses and early and late resorptions. Males subjected to gross pathological examination, those with abnormal gonads also examined histopathologically.	Negative	A90380

* Studies performed prior to introduction of testing guidelines and GLP regulations but conducted according to good scientific practice and in-house quality assurance standards.

Table D. Ecotoxicology profile of bendiocarb technical material

Species	Test	Purity %	Duration and conditions	Results	Reference
<i>Daphnia magna</i> (water flea)	Acute toxicity	97.62	OECD guideline 202, EEC C2 and US EPA guideline 72.2 (GLP). 48-h flow-through. 0.015, 0.029, 0.050, 0.11, 0.16 mg/l.	EC ₅₀ (48 h) = 0.0377 mg/l	M-259123-01-1
<i>Cyprinodon variegatus</i> (sheephead minnow)	Acute toxicity	98.0	US EPA guideline 72.3 (GLP). 96-h flow-through. 2.6, 1.9, 1.0, 0.64, 0.45 mg/l.	LC ₅₀ (96 h) = 0.86 mg/l	A90622
<i>Pseudokirchneriella subcapitata</i> (green alga)	Acute/chronic toxicity	97.62	OECD guideline 201 (GLP). 72-h, flasks. 0.015, 0.035, 0.087, 0.17, 0.54 mg/l.	ErC ₅₀ (0-48 h) = 0.408 mg/l NOEC (0-48h, growth rate) = 0.087 mg/l	M-259108-01-1
<i>Eisenia foetida andrei</i> (earthworm)	Acute toxicity	97.62	OECD guideline 207 (GLP). 14-d. 0.1, 0.18, 0.32, 0.56, 1.0, 3.2, 10, 100, 178, 316, 562, 1000 mg/kg dry soil.	LC ₅₀ (14 d) = 188 mg/kg dry soil	MO-05-010333, M-253937-03-1
<i>Colinus virginianus</i> (bobwhite quail)	Acute toxicity	97.5	EPA guideline 71-1 (GLP). Doses 20, 33, 54, 90, 148 mg/kg bw.	LD ₅₀ = 26 mg/kg bw	A90586
<i>Anas platyrhynchos</i> (mallard duck)	Acute toxicity	97.5	EPA guideline 71-1 (GLP). Doses levels of 2, 4, 8, 16, 32 mg/kg bw.	LD ₅₀ = 8.7 mg/kg bw	A90584
<i>Colinus virginianus</i> (bobwhite quail)**	Short-term toxicity	not known	US EPA guideline 162 70-4. Groups of 10 birds exposed 5 d to diet containing 10.0, 21.5, 46.4, 100.0, 215.0, 464.0, 1000.0, 2150.0, 2750.0, 3500.0, 4500.0 ppm. Observed 3 days.	LC ₅₀ = 1770 ppm	A90420

** Study conducted prior to introduction of GLP regulations.

Table D. Ecotoxicology profile of bendiocarb technical material

Species	Test	Purity %	Duration and conditions	Results	Reference
<i>Anas platyrhynchos</i> (mallard duck)**	Short term toxicity	not known	US EPA guideline 162 70-4. Groups of 10 birds exposed 5 d to diet containing 50, 100, 200, 400, 800, 1600, 2400, 3200, 4000 ppm. Observed 3 days.	LC ₅₀ = 477 ppm	A90950

ANNEX 2. REFERENCES

Bayer CropScience document number or other reference	Year and title of report or publication details
A89120	1995. Bendiocarb: Rat 13-Week Inhalation Toxicity Study (Snout-Only Exposure) and Range Finding Studies.
A90075	1988. Bendiocarb: Determination of the Partition Coefficient Between n-Octanol and Water at 25°C.
A90087	1988. 63-10 Dissociation Constant – Bendiocarb (R000174).
A90090	1988. Determination of the Vapour Pressure of Bendiocarb.
A90107	1988. The Photolysis of Bendiocarb (Schering Code No. ZK 52 020) in Aqueous Solution.
A90108	1992. The Photolysis of Bendiocarb (Schering Code No. ZK 52 020) in Aqueous Solution (supplement to APC 46/88 = A90107).
A90138	1992. Bendiocarb (R001062): Solubility in Water.
A90220	1988. The Hydrolysis of Bendiocarb at Acid, Neutral and Alkaline pH.
A90343	1972. Toxicology of NC 6897: 15-Dose Cumulative Dermal Study with Ficam 80 in Male Rats.
A90347	1972. The Toxicology of NC 6897: Acute Dermal Toxicity of Technical Bendiocarb.
A90358	1974. 16 Week Sub-Acute Toxicity Study in Dogs (NC 6897 Technical).
A90380	1977. Test for the Induction of Dominant Lethal Mutations in Male Rats by Technical CR 4799/1 NC 6897.
A90384	1977. The Acute Oral Toxicity to the Hamster of Technical Bendiocarb.
A90420	1978. The subacute dietary LC50 of NC 6897 technical, CR 4799/4 to the bobwhite quail.
A90423	1978. Examination of NC 6897 for Neurotoxicity in the Domestic Hen.
A90427	1981. NC 6897 Toxicity and Tumorigenicity to Rats in Long-Term Dietary Administration (Final Report – Reproductive Phase and Main Phase) Main Phase = 104 weeks.
A90435	1979-1981. Technical Bendiocarb Ex-Muskegon Primary Eye Irritancy in rabbits.
A90442	1981. Technical NC 6897: Effects of Oral Administration upon Pregnancy in the Rabbit (5) Definitive Study.
A90445	1981. A Chronic Toxicity and Carcinogenicity Study in Mice with Technical NC 6897 (Final Report).
A90447	1981. Technical NC 6897 (CR 4799/1): Effects of Dietary Administration upon Reproductive Performance and Teratogenic Response of Rats Treated Continuously through Three Successive Generations.
A90464	1980. A Comparison of the Acute Oral Toxicities of Bendiocarb CR 4971/2, CR 799/9 and CR 4500/20, to the Male Rat.
A90477	1981. The Acute Oral Toxicity of Unformulated Bendiocarb (NC 6897, CR 4799/10) to the Male and Female Mouse.
A90483	1981. The Microbial Mutagenicity Study of Bendiocarb (KNT).
A90491	1982. The Assessment of Mutagenic Potential with NC 6897 in the Mouse Lymphoma Mutation Assay.
A90496	1982. A Micronucleus Study in Mice using Technical NC 6897, CR 4971/2.
A90499	1982. Technical Bendiocarb: Induction of the Conversion and Mitotic Recombination in Yeast.
A90517	1983. The Acute Oral Toxicity of Technical Bendiocarb in the rat: Comparison with Dichlorvos and Propoxur.
A90584	1984. The acute oral toxicity (LD50) of technical bendiocarb and technical FBC 34570 to the mallard duck.
A90586	1984. The acute oral toxicity (LD50) of technical bendiocarb and technical FBC 34570 to the bobwhite quail.
A90605	1986. Ficam Plus WP Formulation: Twenty-one Day Dermal Toxicity Study in Rabbits.

Bayer CropScience document number or other reference	Year and title of report or publication details
A90615	1987. Technical Bendiocarb: Ames Bacterial Mutagenicity Test.
A90616	1988. Technical Bendiocarb: Metaphase Chromosome Analysis of Human Lymphocytes Cultivated <i>in vitro</i> .
A90617	1988. Technical Bendiocarb: Acute (4-Hour Exposure) Inhalation Toxicity Study in Rats.
A90618	1988. Technical Bendiocarb: Unscheduled DNA Synthesis in Cultured Mammalian cells.
A90620	1989. Technical Bendiocarb: Analysis of Metaphase Chromosomes from Rat Bone Marrow.
A90622	1989. Acute Toxicity of Bendiocarb Technical to Sheepshead Minnow (<i>Cyprinodon variegatus</i>) under Flow-Through Conditions.
A90627	1991. Technical Bendiocarb: Rat Oral Developmental Toxicity (Teratogenicity) Study.
A90639	1992. Technical Bendiocarb Guinea Pig Skin Sensitisation Study (Buehler Test).
A90940	1971. The Toxicology of NC 6897: Acute Toxicity of Pure NC 6897.
A90942	1970. The Toxicology of NC 6897: Acute Toxicity To The Rat of Technical Grade NC 6897.
A90950	1978. Subacute dietary toxicity (LC50) of NC 6897 technical CR 4799/6 to the mallard duck.
A90957	1979. NC 6897 Technical (CR 4799/3) toxicity to Rats when Administered in the Diet for 13 Weeks (Final Report).
A90975	1980. NC 6897 Toxicity Study in Beagle Dogs. Final Report: Dietary Intake for 104 Weeks. (Test Compound Technical NC 6897 CR 4799/3).
A90987	1978. Technical Bendiocarb Primary Skin Irritancy Study on Rabbits.
C047471	2005. Bendiocarb; Substance pure AE B052020 00 1B99 0005 – Melting point; Boiling point; Thermal stability.
CIPAC Handbook D	Collaborative International Pesticides Analytical Council, 1988. Handbook D, pp.10-12, Harpenden, U.K.
EU 2003	European Union Risk Assessment Report. Toluene, CAS No: 108-88-3, EINECS No: 203-625-9. European Communities, 2003. Available at: http://ecb.jrc.ec.europa.eu/esis/ .
FAO/WHO 2006	Manual on the development and use of FAO and WHO specifications for pesticides, March 2006 revision of the first edition. Available only on the internet at http://www.fao.org/ag/agp/agpp/pesticid/ or http://www.who.int/whopes/quality/
GHS 2007	Globally Harmonized System of Classification and Labelling of Chemicals of the United Nations Economic Commission for Europe (UNECE), 2 nd revised edition. Accessible under the Transport of Dangerous Goods heading at http://www.unece.org/trans/ .
Hass <i>et al.</i> 1999	Hass U, Lund SP, Hougaard KS, Simonsen L, 1999. Developmental neurotoxicity after toluene inhalation exposure in rats. <i>Neurotoxicol. Teratol.</i> , 21 (4), 349-57.
IPCS 1994	Environmental Health Criteria 170. Assessing human health risks of chemicals: derivation of guidance values for health-based exposure limits. Available at: http://www.who.int .
IPCS 1999	IPCS 1999. Environmental Health Criteria 210. Principles for the assessment of risks to human health from exposure to chemicals. Available at: http://www.who.int/ipcs/publications/ehc/ehc_numerical/en/index.html .
JMPR 2002	FAO/WHO Joint Meeting on Pesticide Residues (JMPR), 2002. Pesticide residues in food – 2002. Report of the Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and the WHO Core Assessment Group on Pesticide Residues Rome, Italy. 16- 25 September, 2002. Available at: http://www.fao.org/ag/AGP/AGPP/Pesticid/JMPR/Download/2002_rep/2002JMPRRep_ort2.pdf
M-253937-03-1	2007. 2d amendment to study report: Bendiocarb (tech): Acute Toxicity to Earthworms (<i>Eisenia fetida</i>) tested in Artificial Soil.

Bayer CropScience document number or other reference	Year and title of report or publication details
M-259108-01-1	2005. Bendiocarb technical: Alga, Growth Inhibition Test with <i>Pseudokirchneriella subcapitata</i> (syn. <i>Selenastrum capricornutum</i>).
M-259123-01-1	2005. Bendiocarb technical: Acute immobilisation test with daphnids (<i>Daphnia magna</i>) under flow-through conditions.
M-265313-01-1	2005. Historical Control Incidence of Survival in Sprague Dawley CD Rats at [laboratory] (1982-1987).
M-265496-01-1	2005. Historical Control Incidence of Lenticular Opacities in Sprague Dawley CD Rats at [laboratory] (1982-1987).
M-266196-01-1	2006. Regulatory Toxicology – Position Paper: Benchmark Dose Analysis of Whole Blood Acetylcholinesterase Activity of the Rat 90-day Inhalation Toxicity Study of Bendiocarb.
MO-05-010333	2005. Bendiocarb (tech): Acute Toxicity to Earthworms (<i>Eisenia fetida</i>) tested in Artificial Soil.
Ng <i>et al.</i> 1992	Ng TP, Foo SC, Yoong T, 1992. Risk of spontaneous abortion in workers exposed to toluene. <i>British J. Ind. Med.</i> , 49 , 804-808.
Solecki <i>et al.</i> 2005	Solecki R, Davies L, Dellarco V, Dewhurst I, van Raaij M, Tritscher A, 2005. Guidance on setting of acute reference dose (ARfD) for pesticides. <i>Food and Chemical Toxicology</i> 43 , 1569–1593.
Taskinen <i>et al.</i> 1994	Taskinen H, Kyyrönen P, Hemminki K, Hoikkala M, Lajunen K, Lindbohm M-L, 1994. Laboratory work and pregnancy outcome. <i>J. Occup. Med.</i> 36 , 311-319.
WHO 2002	The WHO recommended classification of pesticides by hazard and guidelines to classification, 2000-2002. World Health Organization, Geneva, 2002.