Beta-pinene: Human health tier II assessment

29 June 2018

Chemicals in this assessment

Chemical Name in the Inventory	CAS Number
Bicyclo[3.1.1]heptane, 6,6-dimethyl-2-methylene-	127-91-3
Bicyclo[3.1.1]heptane, 6,6-dimethyl-2-methylene-, (1S)-	18172-67-3
Bicyclo[3.1.1]heptane, 6,6-dimethyl-2-methylene-,(1R)-	19902-08-0

Preface

This assessment was carried out by staff of the National Industrial Chemicals Notification and Assessment Scheme (NICNAS) using the Inventory Multi-tiered Assessment and Prioritisation (IMAP) framework.

The IMAP framework addresses the human health and environmental impacts of previously unassessed industrial chemicals listed on the Australian Inventory of Chemical Substances (the Inventory).

The framework was developed with significant input from stakeholders and provides a more rapid, flexible and transparent approach for the assessment of chemicals listed on the Inventory.

Stage One of the implementation of this framework, which lasted four years from 1 July 2012, examined 3000 chemicals meeting characteristics identified by stakeholders as needing priority assessment. This included chemicals for which NICNAS already held exposure information, chemicals identified as a concern or for which regulatory action had been taken overseas, and chemicals detected in international studies analysing chemicals present in babies' umbilical cord blood.

Stage Two of IMAP began in July 2016. We are continuing to assess chemicals on the Inventory, including chemicals identified as a concern for which action has been taken overseas and chemicals that can be rapidly identified and assessed by using

Stage One information. We are also continuing to publish information for chemicals on the Inventory that pose a low risk to human health or the environment or both. This work provides efficiencies and enables us to identify higher risk chemicals requiring assessment.

The IMAP framework is a science and risk-based model designed to align the assessment effort with the human health and environmental impacts of chemicals. It has three tiers of assessment, with the assessment effort increasing with each tier. The Tier I assessment is a high throughput approach using tabulated electronic data. The Tier II assessment is an evaluation of risk on a substance-by-substance or chemical category-by-category basis. Tier III assessments are conducted to address specific concerns that could not be resolved during the Tier II assessment.

These assessments are carried out by staff employed by the Australian Government Department of Health and the Australian Government Department of the Environment and Energy. The human health and environment risk assessments are conducted and published separately, using information available at the time, and may be undertaken at different tiers.

This chemical or group of chemicals are being assessed at Tier II because the Tier I assessment indicated that it needed further investigation.

For more detail on this program please visit:**www.nicnas.gov.au**

Disclaimer

ACRONYMS & ABBREVIATIONS

Grouping Rationale

The chemicals in this group are beta-pinene (unspecified enantiomer; CAS No. 127-91-3), the (-)-beta-pinene enantiomer (also called (1S,5S)-beta-pinene; CAS No. 18172-67-3) and the (+)-beta-pinene enantiomer ((1R, 5R)-beta-pinene; CAS No. 19902-08-0). These chemicals are structurally similar and are expected to have similar toxicological properties. The beta-pinene enantiomers are present in nature with varying proportions. In this assessment beta-pinene, refers to the unspecified enantiomer unless stated otherwise.

Import, Manufacture and Use

Australian

The chemical, bicyclo[3.1.1]heptane, 6,6-dimethyl-2-methylene-, (.+-.)- (CAS No 127-91-3) has reported domestic uses in automotive aftermarket products including car wash soaps, boat wash soaps, polishes and rubbing compounds.

There is no use information for the other isomers of beta-pinene (CAS No 18172-67-3 and CAS No 19902-08-0).

International

The following international uses were identified through Galleria Chemica; the European Union (EU) Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) dossier; Substances and Preparations in the Nordic countries (SPIN) database; United States (US) Department of Health National Toxicology Program (NTP); US Environmental Protection Agency

(EPA) Chemical and Product Categories (CPCat); US Household Product database (HPD); and Cosmetic Ingredients and Substances (CosIng) database.

The chemicals may have cosmetic uses as fragrances in perfumes and personal care products.

The chemicals may have domestic uses in:

- autocare products;
- cleaning products; and
- air fresheners.

The chemicals may have commercial uses in:

- toys;
- industrial cleaning products; and
- polishing agents.

The chemicals may have site-limited uses as starting materials for synthesis of fragrances.

The chemicals may have non-industrial uses in pesticides, flavouring agents and pharmaceuticals.

Restrictions

Australian

No restrictions for industrial use have been identified for the chemicals in Australia.

The chemical beta-pinene (CAS No. 127-91-3) has restrictions for its non-industrial use as excipient in listed medicines (TGA, 2017) at certain concentrations depending on their use as a flavour or a fragrance:

Permitted for use only in combination with other permitted ingredients as a flavour or a fragrance.

- If used in a flavour, the total flavour concentration in a medicine must be no more than 5 %.
- If used in a fragrance, the total fragrance concentration in a medicine must be no more than 1 %.

International

The chemicals are subject to the EU Regulation (EC) No 1223/2009 of the European Parliament and of the Council of 30 November 2009 on cosmetic products. Annex III: List of Substances which cosmetic products must not contain except subject to the restrictions laid down. Peroxide levels must be less than 10 mM. This limit applies to the substance and not to the finished cosmetic product (CosIng).

Pinacea derivatives, including the chemicals in this group, are included in the International Fragrance Association (IFRA) Standards: Essential oils and isolates derived from the *Pinacea* family, should only be used when the level of peroxides is kept to the lowest practicable level, for instance by adding antioxidants at the time of production. Such products should have a peroxide value of less than 10 mM peroxide per litre (IFRA, 2009).

Existing Worker Health and Safety Controls

Hazard Classification

The chemicals are not listed on the Hazardous Chemical Information System (HCIS) (Safe Work Australia).

Exposure Standards

Australian

No specific exposure standards are available.

International

The following exposure standards were identified (Galleria Chemica):

beta-Pinenes are covered under exposure limits for monoterpenes which are between112–150 mg/m^3 (20–25 ppm) time weighted average (TWA) in different countries such as Canada, Estonia and Spain and short-term exposure limit (STEL) of 167–300 mg/m^3 (30–50 ppm) in Canada and Estonia.

The American Conference of Governmental Industrial Hygienists (ACGIH) recommends a threshold limit value (TLV) of 20 ppm (112 mg/m^3) TWA (ACGIH, 2011).

Health Hazard Information

The beta-pinenes are organic compounds which are found in various species of plants, including in coniferous trees. They are constituents of turpentine but the levels vary greatly depending on the origin. Beta-pinene levels are particularly low in turpentine from Greece, and Indonesia (1–3 %) and high in turpentine from New Zealand (40–60 %). Turpentine also contains alpha-pinene (positional isomer of beta-pinene) and other terpenes such as such limonene, camphene, and terpinolene (NTP, 2002). Where limited data are available for the assessed chemicals, hazard information for turpentine or related monoterpenes may be used to support the assessment conclusions.

The chemical is susceptible to auto-oxidation leading to formation of hydroperoxide species. These oxidised species are thought to be responsible for sensitisation reactions elicited by the chemical, acting as haptens.

Toxicokinetics

Beta-pinene is absorbed through the gastrointestinal and respiratory tract and skin. Elimination is mainly via urine as glucuronic acid conjugates of metabolites (NTP, 2002).

In a metabolic study, 8 male volunteers were exposed to 450 mg/m^3 (75 ppm) turpentine in an exposure chamber for 2 h during light physical exercise. Approximately 65 % of the inhaled beta-pinene was absorbed and 5 % of the uptake was detected in the expired air. Blood levels peaked 2 h after administration and the chemical was rapidly eliminated (Filipsson et al., 1996).

In a metabolic study, male albino rabbits (6/group) received a single oral dose of 400–700 mg/kg bw beta-pinene. Over 3 days, more than 80 % of the chemical was recovered in the urine as glucuronic acid conjugates of hydroxylated terpene hydrocarbons. Metabolites detected were trans-10-pinanol (39 %), l-p-menthene-1,8-diol (30 %) and alpha-terpineol (5 %) (MAK, 2002).

Acute Toxicity

Oral

Limited data are available for the chemicals. Based on an acute oral toxicity study in rats, beta-pinene has low acute oral toxicity. This is supported by data from other monoterpenes and turpentine.

In a study in rats the reported oral LD50 for beta-pinene was 4700 mg/kg bw. Sub-lethal signs of toxicity included local irritation, central nervous system depression and respiratory distress (Opdyke, 1978). No further details are available.

Reported LD50s in rats for turpentine and other monoterpenes are:

- alpha-pinene (CAS No. not specified): 2100–3700 mg/kg bw (HPV, 2006; MAK, 2012).
- alpha-pinene multiconstituent (containing alpha-pinene stereoisomers CAS No. 7785-70-8 and 7785-26-4): higher than 300 mg/kg bw but lower than 2000 mg/kg bw (NICNASa).
- delta-3-carene: 4800 mg/kg bw (NICNASb).
- turpentine: 2600–5760 mg/kg bw (NICNASc).

The chemical or mixtures containing the chemical could have the potential to cause chemical pneumonitis if aspirated. This would be dependent on the viscosity of the chemical as introduced. The threshold viscosity value for classification as an aspiration hazard is 20.5 mm^2/s at 40 °C.

Dermal

Limited data are available for the chemicals. Based on acute dermal toxicity study in rabbits, beta-pinene has low acute dermal toxicity. This is supported by data from other monoterpenes and turpentine.

In a limit test, 10 New Zealand White (NZW) rabbits (sex not reported) received a single application of 5000 mg/kg bw beta-pinene (CAS No. 127-91-3) on clipped abraded abdominal skin for 24 h. No mortalities occurred during the seven days of observation. An LD50 value of >5000 mg/kg bw was reported (REACHa).

Dermal LD50 values for turpentine and other monoterpenes including alpha-pinene and delta-3-carene are all above 2000 mg/kg bw (NICNASa; NICNASb and NICNASc).

Inhalation

Based on the limited data available for beta-pinene, the chemicals may have moderate acute inhalation toxicity. This is supported by other monoterpenes and turpentine that are known to be harmful via acute inhalation exposure (NICNASa; NICNASc). However, there is insufficient data to warrant hazard classification.

In a non-guideline acute inhalational toxicity study, rats, guinea pigs and mice were exposed to saturated beta-pinene vapour (19.6 mg/L). The shortest period to cause mortality was approximately 30 min in all species and after 5 h mortality was 100 % (Kasanen et al., 1999; Opdyke, 1978).

Corrosion / Irritation

Respiratory Irritation

Studies in mice suggest that turpentine is a sensory irritant. Sensory irritation is the result of the chemical stimulating the trigeminal nerve endings in the cornea and nasal mucosa, which evokes a stinging or burning sensation in the eyes and upper respiratory tract (nose and throat). This is a receptor mediated mode of action and occurs at relatively low concentrations. Sensory irritation is different to eye and skin irritation used for hazard classification and also different from the irritation leading to cytotoxicity. These latter example is a result of physical damage to the cells, whereas sensory irritation is a nerve response (NICNASd). While there is clear evidence of irritation, sensory irritation is not considered to be specific target organ toxicity (STOT) under GHS.

The concentration that causes a 50 % respiratory rate decrease (RD50) was determined using a mouse bioassay measuring a decrease in breathing rate due to stimulation of the trigeminal nerve endings in the nasal mucosa. In the study, Oncin France 1 (OF1) and National Institute of Health Swiss (NIH/S) mice were exposed to beta-pinenes (CAS No. 19902-08-0 or 18172-67-3) (8/strain), in a glass tube attached to an exposure chamber (head only exposure). The concentration in the chamber was regulated by airflow and the actual concentration in the chamber was continuously monitored by infrared spectroscopy. Control mice (n=8) were exposed to room air only. The maximum response generally occurred after 30 min. At higher concentrations, body movements slowed down and slight sedation or drowsiness was observed. Recovery was rapid and no macroscopic effects were seen 1 h or 7 days after the end of the exposure. The reported RD50s for (+)-beta-pinene (CAS No. 19902-08-0) were 1270 ppm and 1419 ppm in OF1 and NIH/S mice, respectively. (-)-beta-Pinene (CAS No. 18172-67-3) was less potent with reported RD50s of 4663 ppm and 5811 ppm OF1 and NIH/S mice, respectively (Kasanen et al., 1999). Similar effects were observed in OF1 mice exposed to turpentine containing 53 % of the chemical as well as beta-pinene (15 %), alpha-pinene (14 %) and limonene (2 %). The reported RD50 for turpentine was 1173 ppm (6.5 mg/L) (NICNASa).

Skin Irritation

Based on the available data in vitro and in humans (refer to ***Observation in Humans***), the chemicals are potential skin irritants, warranting hazard classification (refer to ***Recommendation*** section).

In an in vitro study similar to the Economic Co-operation and Development (OECD Test Guideline (TG) 439, 10 µL of beta-pinene was applied to reconstructed human epidermis for 15 min. The mean tissue viability was 38.5 %. Substances that reduce viability to less than 50 % are classified as irritants. Therefore the chemical can be considered a skin irritant (REACH).

Eye Irritation

The chemical is reported to be a slight eye irritant in animal studies. The effects are not sufficient to warrant hazard classification.

In an OECD TG 405 eye irritation study, 0.1 mL of undiluted beta-pinene was applied to one eye of 3 NZW rabbits while the other eye served as the control. The eyes were examined for irritation scores at 1 h and 1, 2, 3, 4, 7 and 8 days after application. Moderate redness of the conjunctivae was observed 1 h after the treatment. The average scores at 24, 48 and 72 h after exposure for the 3 rabbits were 0, 0, 0 for the cornea; 0, 0, 0 for the iris; 1, 1, 2 for the conjunctivae and 1.3, 1, 1 for chemosis. After 8 days the irritation had completely resolved (REACH).

Observation in humans

In patch tests in 30 patients that were not allergic to turpentine, beta-pinene was irritating to the skin at high concentrations (70–80 %) but not at lower concentrations (20–35 %). However, oxidised beta-pinene constituents (>2 % hydroperoxide) caused irritation in almost all patients (MAK, 2002).

Eye, nose and throat irritation was reported in human volunteers exposed to turpentine 75–81 ppm (NICNASa).

Sensitisation

Skin Sensitisation

Based on the weight of evidence from the available animal, human (refer to ***Observation in humans*** section) and in silico data, the chemicals are skin sensitisers and warrant hazard classification (refer to ***Recommendation*** section).

Hydroperoxide species originating from auto-oxidation are thought to be the major contributors.

In a local lymph node assay (LLNA) performed in accordance with OECD TG 429, female CBA/J mice (5/dose) received topical applications of 5.0, 10, 25, 50 or 100 % (v/v) beta-pinene in acetone/olive oil on three consecutive days. The reported

stimulation indices (SI) were 2.29, 1.16, 2.23, 7.17, 6.47 and 14.7 for concentrations of 5.0, 10, 25, 50 and 100 % respectively. The reported concentration producing a three-fold increase in lymphocyte proliferation (EC3) was 29 %, indicating weak sensitisation potential (REACH).

In a non-guideline LLNA, CBN/J (1/dose) mice received topical applications of 1, 25 and 100 % of the beta-pinene in acetone/olive oil on three consecutive days. The reported stimulation indices (SI) were 1.89, 1.82 and 2.55 for the concentrations 1, 25 and 100 %, respectively. As all SI values were below 3, an EC3 value could not be determined and the chemical was; therefore; considered a non-sensitiser (Wei et al., 2010).

No structural alerts for skin sensitisation were present for beta-pinenes (OECD QSAR Toolbox v3.4). However, when auto-oxidation was simulated, mechanistic alerts, including alerts for protein binding via nucleophilic addition and free radical formation were present for the metabolites.

In domain skin sensitisation predictions for beta-pinenes using OASIS–TIMES 2.27.19 were negative for the unmetabolised chemicals. Several auto-oxidised metabolites of beta-pinene were predicted to be weak sensitisers which were supported by mechanistic alerts for hydroperoxide free radical decomposition and Michael type addition on conjugated systems with electron withdrawing groups.

Observation in humans

In 63 patients who displayed positive reactions to fragrance mix, 2 patients had a positive response to beta-pinene. In a test series in 30 patients who were allergic to turpentine, 2 patients had a positive reaction to beta-pinene (SCCS, 2012).

In a case study in 2 patients who were allergic to a wide range of essential oils, neither had dermal reactions to beta-pinene (Dharmagunawardena, 2002).

In a human maximisation test, none of the 19 volunteers had dermal reactions to beta-pinene at 12 % in petrolatum (Opdyke, 1978).

Repeated Dose Toxicity

Oral

No data are available for the chemicals.

Dermal

No data are available for the chemicals.

Inhalation

No repeat dose toxicity data are available for the chemicals or for turpentine.

In general, terpenes can cause adverse health effects following repeated exposure via inhalation (refer to ***Observations in humans***). This is supported by toxicity following prolonged inhalation exposure to other terpenes in experimental animals and in humans (NICNASa; NICNASb).

Observation in humans

Fumes in sawmills contain a mix of volatile terpenes including beta-pinene, alpha-pinene and delta-carene. In a study of 24 non-smoking sawmill workers, symptoms in the mouth and throat, constriction in the chest and coughing were reported more often

than in 30 non-exposed workers. Sawmill employees that had been exposed to terpenes for up to 37 years (average 7.6 years) had reduced lung function. Employees exposed to high concentrations reported coughing or chronic bronchitis and irritation in the throat more often than persons exposed to concentrations below 25 mg/m^3 (MAK, 2002). Information on confounding factors such as wood dust exposure is not available for the study.

Genotoxicity

Based on in vitro genotoxicity studies with beta-pinene and studies conducted using turpentine oil (CAS No 8006-64-2) containing beta-pinene as one of the components, the chemicals are not considered to be genotoxic.

The chemical beta-pinene was negative in several in vitro assays (FFHPVC, 2006):

- in vitro point mutation studies in *Salmonella typhimurium* strains TA100, TA98, TA1538, TA1537 and TA1535 at concentrations up to 5 µL/plate, with or without metabolic activation.
- in vitro point mutation studies in *S.typhimurium* strains TA100, TA98, TA1538, TA1537 and TA1535 at concentrations up to 5000 µg/plate, with or without metabolic activation.
- sister chromatid exchange study in Chinese hamster ovary cells at concentrations up to 1000 µM.

Turpentine was negative in several in vitro assays (REACH):

- gene mutation in the thymidine kinase (tk) locus in L5178Y mouse lymphoma cells treated with turpentine at 5–70 µL/mL with metabolic activation and 5–60 µL/mL without metabolic activation.
- chromosome aberration study in human lymphocytes exposed to 0.17 µL/mL for 22 h with and without metabolic activation.

Carcinogenicity

No data are available.

Reproductive and Developmental Toxicity

No reproductive or developmental studies have been undertaken using beta-pinene as a pure chemical. Data is available for a mixture containing beta-pinene.

In a US Food and Drug Administration (FDA) sponsored study, toxicity of an essential oil containing alpha-pinene (20–25 %), beta-pinene (15–18 %) and sabinene (38–42 %) was evaluated in CD-1 mice, Wistar rats and golden hamsters. Pregnant Wistar rats (22–23/dose) received 0, 3, 2, 56 or 260 mg/kg bw/day of the test material in corn oil on GD6 through to GD15 by oral gavage. No effects were observed on implantation, maternal survival or any measured foetal parameter. Similar results were reported for pregnant golden hamsters receiving up to 600 mg/kg bw/day and in pregnant mice receiving up to 560 mg/kg bw/day of the test substance (FFHPVC, 2006).

Risk Characterisation

Critical Health Effects

The critical health effects for risk characterisation are local effects including sensory irritation, skin irritation and skin sensitisation. The local effects are expected to be mainly caused by the oxidised beta-pinene. The chemical or mixtures containing the chemical could have the potential to cause chemical pneumonitis if aspirated depending on the viscosity as introduced.

Public Risk Characterisation

Based on the international uses identified, the chemicals may be used in cosmetic products in Australia. The chemical, bicyclo[3.1.1]heptane, 6,6-dimethyl-2-methylene-, (.+-.)- (CAS No 127-91-3) has reported domestic uses in automotive aftermarket products including car wash soaps, boat wash soaps, polishes and rubbing compounds in Australia. The general public could be exposed to the chemicals when using these products.

In Europe, the chemicals are restricted in cosmetics and can only be used if the peroxide levels are below 10mM (CosIng). The distribution of the chemical for fragrance purposes is expected to be controlled by members of IFRA. The restriction of the chemical under the IFRA Standard is expected to sufficiently address the public risks associated with chemical exposure through fragrances (e.g. concentration limits of peroxide levels in the product of 10mM) (IFRA, 2015).

Consumer products containing the chemicals could oxidise over time; however, the concentration of the chemical in domestic and cosmetic products is expected to be low, hence peroxide levels are expected to very low. The risk to public health is not considered to be unreasonable and further risk management is not considered necessary for public safety.

Occupational Risk Characterisation

The main occupational exposure to beta-pinenes is expected to occur during wood processing activities. Exposure may also occur during product formulation, dermal and inhalation exposure might occur, particularly where manual or open processes are used. These could include transfer and blending activities, quality control analysis, and cleaning and maintaining equipment. Worker exposure to the chemical at lower concentrations could also occur while using formulated products containing these chemical. The level and route of exposure will vary depending on the method of application and work practices employed.

Given the critical local health effects, the chemical could pose an unreasonable risk to workers unless adequate control measures to dermal exposure is implemented. The chemical should be appropriately classified and labelled to ensure that a person conducting a business or undertaking at a workplace (such as an employer) has adequate information to determine the appropriate controls.

The data available support an amendment to the hazard classification in the HCIS (Safe Work Australia) (refer to ***Recommendation*** section).

Sensory irritation and respiratory symptoms are reported in humans following exposure to mixed monoterpenes. Exposure standards to minimise the potential for these effects have been established overseas. An exposure standard encompassing the total level of monoterpenes may be beneficial to mitigate the risk of adverse effects.

NICNAS Recommendation

Assessment of the chemicals is considered to be sufficient, provided that the recommended classification is adopted, and labelling and all other requirements are met under workplace health and safety and poisons legislation as adopted by the relevant state or territory.

It is recommended that Safe Work Australia consider whether introduction of controls are required to adequately minimise the risk to workers. A Tier III assessment may be necessary to provide further information about whether exposure controls are needed to offer adequate protection to workers.

Regulatory Control

Public Health

Products containing the chemicals should be labelled in accordance with state and territory legislation (SUSMP, 2018).

Work Health and Safety

The chemicals are is recommended for classification and labelling aligned with the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) as below. This does not consider classification of physical hazards and environmental hazards.

For mixtures containing the chemical the aspiration hazard classification should only be applied if the kinematic viscosity criteria for aspiration classification in the GHS is met.

From 1 January 2017, under the model Work Health and Safety Regulations, chemicals are no longer to be classified under the Approved Criteria for Classifying Hazardous Substances system.

Hazard	Approved Criteria (HSIS)[a]	GHS Classification (HCIS)[b]
Acute Toxicity	Not Applicable	May be fatal if swallowed and enters airways - Aspi. Cat. 1 (H304)
Irritation / Corrosivity	Not Applicable	Causes skin irritation - Cat. 2 (H315)
Sensitisation	Not Applicable	May cause an allergic skin reaction - Cat. 1B (H317)

[a] Approved Criteria for Classifying Hazardous Substances [NOHSC:1008(2004)].

[b] Globally Harmonized System of Classification and Labelling of Chemicals (GHS) United Nations, 2009. Third Edition.

[*] Existing Hazard Classification. No change recommended to this classification

Advice for consumers

Products containing the chemicals should be used according to the instructions on the label.

Advice for industry

Control measures

Control measures to minimise the risk from dermal and inhalation exposure to the chemicals should be implemented in accordance with the hierarchy of controls. Approaches to minimise risk include substitution, isolation and engineering controls. Measures required to eliminate, or minimise risk arising from storing, handling and using a hazardous chemical depend on the physical form and the manner in which the chemical is used. Examples of control measures that could minimise the risk include, but are not limited to:

- using local exhaust ventilation to prevent the chemical from entering the breathing zone of any worker;
- health monitoring for any worker who is at risk of exposure to the chemicals, if valid techniques are available to monitor the effect on the worker’s health;
- air monitoring to ensure control measures in place are working effectively and continue to do so;
- minimising manual processes and work tasks through automating processes;
- work procedures that minimise splashes and spills;

- regularly cleaning equipment and work areas; and
- using protective equipment that is designed, constructed, and operated to ensure that the worker does not come into contact with the chemical.

Guidance on managing risks from hazardous chemicals are provided in the *Managing risks of hazardous chemicals in the workplace—Code of practice* available on the Safe Work Australia website.

Personal protective equipment should not solely be relied upon to control risk and should only be used when all other reasonably practicable control measures do not eliminate or sufficiently minimise risk. Guidance in selecting personal protective equipment can be obtained from Australian, Australian/New Zealand or other approved standards.

Obligations under workplace health and safety legislation

Information in this report should be taken into account to help meet obligations under workplace health and safety legislation as adopted by the relevant state or territory. This includes, but is not limited to:

- ensuring that hazardous chemicals are correctly classified and labelled;
- ensuring that (material) safety data sheets ((M)SDS) containing accurate information about the hazards (relating to both health hazards and physicochemical (physical) hazards) of the chemicals are prepared; and
- managing risks arising from storing, handling and using a hazardous chemical.

Your work health and safety regulator should be contacted for information on the work health and safety laws in your jurisdiction.

Information on how to prepare an (M)SDS and how to label containers of hazardous chemicals are provided in relevant codes of practice such as the *Preparation of safety data sheets for hazardous chemicals—Code of practice* and *Labelling of workplace hazardous chemicals—Code of practice*, respectively. These codes of practice are available from the Safe Work Australia website.

A review of the physical hazards of these chemicals has not been undertaken as part of this assessment.

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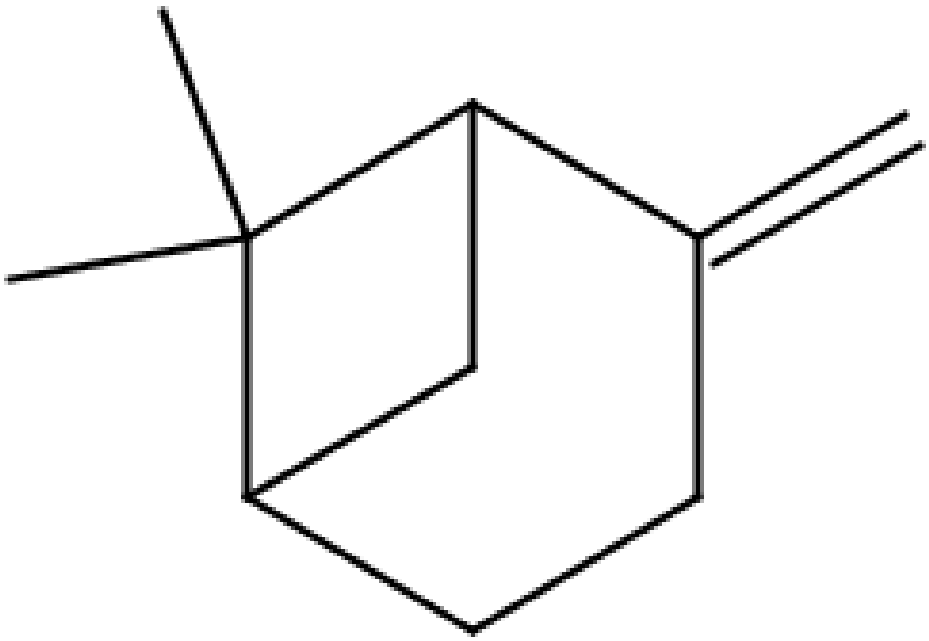
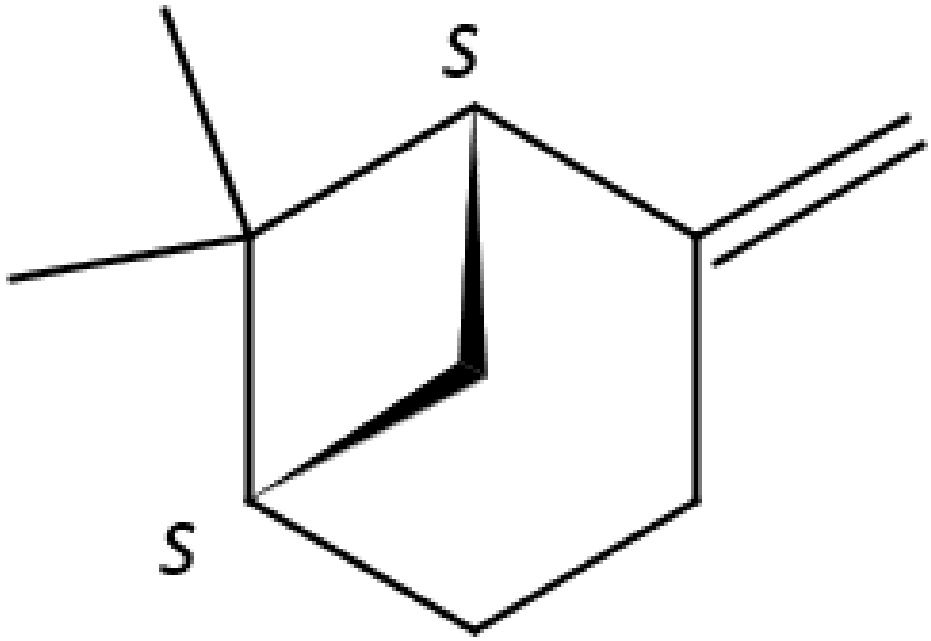
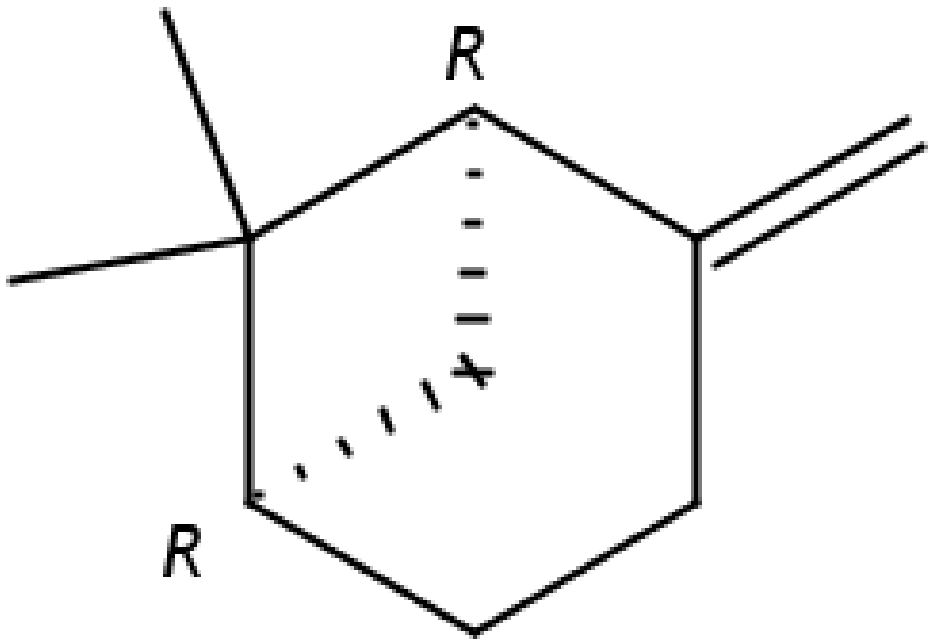
Last Update 29 June 2018

Chemical Identities

Chemical Name in the Inventory and Synonyms	**Bicyclo[3.1.1]heptane, 6,6-dimethyl-2-methylene-** beta-pinene bicyclo[3.1.1]heptane, 6,6-dimethyl-2-methylene-, (.+-.)- terbenthene nopinene rosemarel
CAS Number	127-91-3
Structural Formula	
Molecular Formula	C10H16
Molecular Weight	136.2

Chemical Name in the Inventory and Synonyms	**Bicyclo[3.1.1]heptane, 6,6-dimethyl-2-methylene-, (1S)-** (-)-beta-pinene (-)-nopinene l-beta-pinene
CAS Number	18172-67-3
Structural Formula	

	
Molecular Formula	C10H16
Molecular Weight	136.2

Chemical Name in the Inventory and Synonyms	**Bicyclo[3.1.1]heptane, 6,6-dimethyl-2-methylene-,(1R)-** beta.-pinene, (+)- 2(10)-pinene, (1R,5R)-(P)- d-.beta.-pinene
CAS Number	19902-08-0
Structural Formula	
Molecular Formula	C10H16

Molecular Weight	136.2

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