

Petroleum and Refinery gases (C1-C4): Human health tier II assessment



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Chemicals in this assessment

Chemical Name in the Inventory	CAS Number
Gases, petroleum, C2-3	68477-70-3
Gases, petroleum, catalytic reformed naphtha stripper overheads	68477-77-0
Natural gas	8006-14-2
Tail gas, petroleum, propane propylene alkylation feed prepdeethanizer	68308-11-2
Gases, petroleum, C2 return stream	68477-84-9
Gases, petroleum, deethanizer overheads	68477-86-1
Gases, petroleum, deisobutanizer tower overheads	68477-87-2
Gases, petroleum, deethanizer overheads, C3 rich	68477-88-3
Gases, petroleum, dry sour, gas concentration unit off	68477-92-9
Gases, petroleum, gas concentration reabsorber distillation	68477-93-0
Gases, petroleum, gas recovery plant depropanizer overheads	68477-94-1
Gases, petroleum, hydrogen absorber off	68477-96-3
Gases, petroleum, hydrogen rich	68477-97-4
Gases, petroleum, isomerized naphtha fractionator, C4 rich,hydrogen sulfide free	68477-99-6

Chemical Name in the Inventory	CAS Number
Tail gas, petroleum, catalytic cracker refractionation absorber	68478-25-1
Gases, petroleum, C3-4	68131-75-9
Natural gas, dried	68410-63-9
Alkanes, C1-2	68475-57-0
Alkanes, C2-3	68475-58-1
Alkanes, C3-4	68475-59-2
Fuel gases	68476-26-6
Fuel gases, C6-8 catalytic reformer	68476-28-8
Fuel gases, crude oil distillates	68476-29-9
Hydrocarbons, C2-4, C3 rich	68476-49-3
Hydrocarbons, C4, ethylene manufactured by product	68476-52-8
Fuel gases, hydrotreater fractionation, scrubbed	68513-11-1
Fuel gases, thermal cracked catalytic cracking residue	68513-13-3
Gases, petroleum, catalytic reformed straight run naphtha stabilizer overheads	68513-14-4
Gases, petroleum, hydrocracking depropanizer off, hydrocarbon rich	68513-16-6
Gases, petroleum, reformer effluent high pressure flash drum off	68513-18-8
Gases, petroleum, reformer effluent low pressure flash drumoff	68513-19-9
Hydrocarbons, C1-4	68514-31-8
Hydrocarbons, C1-4, sweetened	68514-36-3
Hydrocarbons, C1-3	68527-16-2
Gases, petroleum, secondary absorber off, fluidized catalytic cracker overheads fractionator	68602-84-6
Hydrocarbons, C2-4	68606-25-7
Hydrocarbons, C3	68606-26-8
Petroleum products, refinery gases	68607-11-4

Chemical Name in the Inventory	CAS Number
Gases, petroleum, hydrocracking low pressure separator	68783-06-2
Gases, petroleum, refinery	68814-67-5
Gases, petroleum, platformer products separator off	68814-90-4
Gases, petroleum, distillate unifier desulfurization stripper off	68919-01-7
Gases, petroleum, fluidized catalytic cracker scrubbing secondary absorber off	68919-03-9
Gases, petroleum, platformer stabilizer off, light ends fractionation	68919-07-3
Gases, petroleum, straight run naphtha catalytic reforming off	68919-09-5
Gases, petroleum, tar stripper off	68919-11-9
Gases, petroleum, unifier stripper off	68919-12-0
Gases, petroleum, fluidized catalytic cracker splitter overheads	68919-20-0
Tail gas, petroleum, catalytic cracked distillate and naphtha stabilizer	68952-77-2
Tail gas, petroleum, catalytic hydrodesulfurized naphtha separator	68952-79-4
Gases, petroleum, sponge absorber off, fluidized catalytic cracker and gas oil desulfurizer overhead fractionation	68955-33-9
Gases, petroleum, straight run naphtha catalytic reformer stabilizer overhead	68955-34-0
Hydrocarbons, C4-unsaturated	68956-54-7

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

NICNAS has made every effort to assure the quality of information available in this report. However, before relying on it for a specific purpose, users should obtain advice relevant to their particular circumstances. This report has been prepared by NICNAS using a range of sources, including information from databases maintained by third parties, which include data supplied by industry. NICNAS has not verified and cannot guarantee the correctness of all information obtained from those databases. Reproduction or further distribution of this information may be subject to copyright protection. Use of this information without obtaining the permission from the owner(s) of the respective information might violate the rights of the owner. NICNAS does not take any responsibility whatsoever for any copyright or other infringements that may be caused by using this information.

ACRONYMS & ABBREVIATIONS

Grouping Rationale

The chemicals are gases produced in petroleum refineries (light end fractions on numerous distillation or cracking processes) or gas plants (separation processes). These chemicals exist as substances in closed systems and are typically consumed or undergo further processing before leaving the site under a different CAS number (refer to **Import, manufacture and use** section).

The chemicals are UVCBs (unknown or variable compositions, complex reaction products and biological materials) comprising of paraffinic and olefinic hydrocarbons in the carbon range C1–C4 (US EPA 2010; US EPA 2011; NCI). The chemical composition depends on both the original source of the chemical and on the process used during manufacture.

The C1–4 components consist mainly of alkanes such as methane, ethane, propane, 2-methylpropane, and butane and mono-alkenes such as ethene, 1-butene, 2-butene, 1-propene, 2-methylpropene. Based on available data, these major components (C1–C4 alkanes and mono-alkenes) are not expected to pose an unreasonable risk to human health (NICNASa). The toxicity of the chemicals in this group is dependent on the content of a small number of hazardous constituents.

The chemicals could contain the C4 hydrocarbon 1,3-butadiene—CAS No. 106-99-0 (reported concentrations up to 60 % but typically <4 %); which has a number of hazardous properties (NICNASb). The chemicals are not expected to contain benzene—CAS No. 71 43-2 and isoprene—CAS No. 78-79-5 which could be present in C1-C6 petroleum gases (US EPA 2010; US EPA 2011, Government of Canada 2013a).

The chemicals may also contain varying amounts of non-hydrocarbon components. The toxicity profile of the chemicals in this group is considered to be dictated by some of these components including:

- ammonia—CAS No. 7664-41-7 (reported concentrations up to 15 %);
- carbon monoxide—CAS No. 630-08-0 (reported concentrations up to 30 %); and
- hydrogen sulfide—CAS No. 7783-06-4 (reported concentrations up to 45 %) (US EPA 2010; US EPA 2011).

Import, Manufacture and Use

Australian

The following Australian industrial uses were reported under previous mandatory and/or voluntary calls for information.

The chemicals identified by the CAS numbers, 68477-94-1 and 68476-26-6, have reported commercial use as fuel and oil. Use as a fuel in mining and metal extraction was also identified for CAS number 68477-94-1. These chemicals are listed on the 2006 High Volume Industrial Chemicals List (HVICL) with a total reported volume of 100000–999999 tonnes.

International

The following international uses have been identified through:

- Galleria Chemica;
- Substances and Preparations in the Nordic countries (SPIN) database;
- the European Commission Cosmetic Ingredients and Substances (CosIng) database;
- United States (US) Personal Care Product Council International Nomenclature of Cosmetic Ingredients (INCI) Dictionary;
- OECD High Production Volume chemical program (OECD HPV);
- US) Personal Care Product Council Household Products database; and
- various international assessments (US EPA 2010; US EPA 2011, Government of Canada 2013a, Government of Canada, 2014).

The chemicals have reported uses as fuel gases. The chemicals might also undergo further refinement to recover valuable components (i.e. manufacture other chemicals). The chemicals are either site-limited or can be transferred to other petroleum processing facilities such as a fractionation plant.

Some of the chemicals listed in the SPIN database have reported domestic use such as adhesives, binding agents, paints, lacquers and varnishes. However, it should be noted that SPIN does not distinguish between direct use of the chemical or use of the materials that are produced from its chemical reactions. There are no reported domestic uses of these chemicals in international domestic product databases.

Restrictions

Australian

Industry facilities that introduce or process the chemicals would be expected to meet the criteria for major hazard facilities (MHFs) due to the quantities of chemicals such as methane, natural-gas and liquefied petroleum gas stored, handled or processed.

Operators of determined MHFs have obligations to:

- Identify all major incidents and major incident hazards for the facility;
- Conduct and document a safety assessment in relation to the operation of the facility that involves a comprehensive and systematic investigation and analysis of all aspects of risks to health and safety that could occur in the operation of the MHF;
- Implement control measures that eliminate or minimise the risk of a major incident occurring at the MHF;
- Prepare an emergency plan;
- Establish a Safety Management System (SMS) for the operation of the MHF;
- Prepare a Safety Case for the MHF that demonstrates that the MHF's SMS will control risks arising from major incidents and major incident hazards and demonstrates the adequacy of the measures to be implemented by the operator to control risks associated with the occurrence of major incidents' (Safe Work Australia).

In addition, activities on these facilities are covered by a number of state and territory legislation and licensing requirements and reporting requirements under the National Environment Protection (National Pollutant Inventory) Measure, where reporting thresholds are met.

International

The majority of the chemicals are listed on the following (Galleria Chemica):

- EU Cosmetics Regulation 1223/2009 Annex II—List of substances prohibited in cosmetic products;
- New Zealand Cosmetic Products Group Standard—Schedule 4: Components cosmetic products must not contain; and
- ASEAN Cosmetic Directive Annex II Part 1: List of substances which must not form part of the composition of cosmetic products.

The majority of the chemicals are restricted under Annex XVII to REACH Regulations. 'The chemical cannot be used in substances and preparations placed on the market for sale to the general public in individual concentrations $\geq 0.1\%$ ' (European Parliament & Council 1999; European Parliament & Council 2006; European Parliament & Council 2008).

Existing Worker Health and Safety Controls

Hazard Classification

The majority of the chemicals are classified as hazardous, with the following risk phrases for human health in the Hazardous Substances Information System (HSIS) (Safe Work Australia):

R45 Carc. Cat. 1 (carcinogenicity);

R46 Muta. Cat. 2 (mutagenicity).

These classifications are subject to notes H and K.

Note H: The classification and label shown for this substance applies to the dangerous property(ies) indicated by the Risk Phrase(s) in combination with the category(ies) of danger shown. The manufacturers, distributors and importers of this substance shall be obliged to carry out an investigation to make themselves aware of the relevant and accessible data which exists for all other properties to classify and label the substance.'

'The classification as a carcinogen or mutagen need not apply if it can be shown that the substance contains less than 0.1% w/w 1,3 butadiene (EINECS no. 203-450-8). If the substance is not classified as a carcinogen or mutagen, at least the Safety Phrases (2-)9-16 should apply. This note applies to certain complex oil-derived substances in Annex I.'

The following chemicals (CAS Nos) are not classified:

8006-14-2

68477-88-3

68410-63-9

68476-28-8

68476-52-8

68513-11-1

68513-13-3

68956-54-7

Exposure Standards

Australian

No specific exposure standards are available for the chemicals. A number of exposure limits apply for the hazardous components (NICNAS, 2001; NICNASb; NICNASc; NICNASd; Safe Work Australia—HSIS).

International

No specific exposure standards are available for the chemicals. A number of exposure limits apply for the hazardous components (NICNAS, 2001; NICNASb; NICNASc; NICNASd).

Health Hazard Information

Limited data are available for the chemicals; therefore, toxicity information has been included for the components of the chemicals (refer to **Grouping rationale** for more information). Data have also been included for liquefied petroleum gases (LPG—CAS No. 68476-85-7). This chemical is a complex combination of hydrocarbons produced by distilling crude oil. It consists of hydrocarbons with carbon numbers predominantly in the range of C3 through C7 and boiling in the range of approximately -40°C to 80°C (-40°F to 176°F). The chemical is therefore considered a suitable analogue for the hydrocarbon components of the chemicals in this group although the overall toxicity of the chemicals will depend on their chemical composition. Based on the physical properties of the chemicals, inhalation is considered to be the most significant route of exposure.

Acute Toxicity

Oral

No data are available.

Dermal

No data are available.

Inhalation

No data are available for the chemicals in this group. In general, alkanes and mono-alkenes (C1–C4) are of low toxicity by inhalation exposure, although asphyxiation and effects on the central nervous system can occur at high doses (US EPA, 2010; US EPA 2011, Government of Canada 2013a). Acute toxicity might be caused due to the presence of certain components. Classification could be warranted (refer to **Recommendation** section).

The component chemicals, carbon monoxide and ammonia are classified as hazardous with the risk phrase 'Toxic by inhalation' (T; R23) in HSIS (Safe Work Australia). The component chemical hydrogen sulfide is classified as hazardous with the risk phrase 'Very toxic by inhalation' (T+; R26) in the Hazardous Substances Information System (HSIS—Safe Work Australia).

Reported concentrations of these components (US EPA 2011) are, in some cases, above the cut-off concentrations for classification (Safe Work Australia, 2004; GHS, 2009). Therefore classification for acute toxicity could be warranted for some of the chemicals in this group (refer to **Recommendation** section).

Corrosion / Irritation

Respiratory Irritation

No data are available for the chemicals in this group. Based on the limited data available, alkanes and mono-alkenes (C1–C4) do not appear to cause respiratory tract irritation (US EPA, 2010; US EPA 2011, Government of Canada 2013a). Respiratory irritation could be caused by certain components, particularly ammonia.

The component chemical ammonia is classified as hazardous with the risk phrase 'Causes burns' (R34) in HSIS (Safe Work Australia). Accidental exposure to ammonia (as a gas or pressurised liquid) has resulted in damage to the respiratory tract such as stripping the epithelial lining from the bronchial walls. Respiratory irritation has been observed in workers exposed to low concentrations, down to 50 ppm (35 mg/m³) (NICNASc). Reported concentrations of ammonia (US EPA 2011) are, in some cases, above the cut-off concentrations for classification (Safe Work Australia, 2004; GHS, 2009). Therefore, classification for respiratory irritation could be warranted for some of the chemicals in this group (refer to **Recommendation** section).

Skin Irritation

No data are available for the chemicals in this group. In general alkanes and mono-alkenes (C1–C4) are, at the most, slight skin irritants (US EPA, 2010; US EPA 2011). Skin irritation could be caused by certain components being present, particularly ammonia.

The component chemical ammonia is classified as hazardous with the risk phrase 'Causes burns' (R34) in HSIS (Safe Work Australia). Accidental exposure to ammonia (as a gas or pressurised liquid) has resulted in full thickness burns on the skin. Reported concentrations of ammonia (US EPA 2011) are, in some cases, above the cut-off concentrations for classification (Safe Work Australia, 2004; GHS, 2009). Therefore, classification for skin irritation could be warranted for some of the chemicals in this group (refer to **Recommendation** section).

Eye Irritation

No data are available for the chemicals in this group. In general, alkanes and mono-alkenes (C1–C4) are, at the most, slight eye irritants (US EPA, 2010; US EPA 2011). Eye irritation could be caused by certain components being present, particularly ammonia.

The component chemical ammonia is classified as hazardous with the risk phrase 'Causes burns' (R34) in HSIS (Safe Work Australia). Accidental exposure to ammonia (as a gas or pressurised liquid) has resulted in temporary blindness, corneal abrasions, and sustained corneal damage. Ocular irritation has been observed in workers exposed to low concentrations, down to 50 ppm (35 mg/m³) (NICNASc). Reported concentrations of ammonia (US EPA 2011) are, in some cases, above the cut-off concentrations for classification (Safe Work Australia, 2004; GHS, 2009). Therefore classification for eye irritation could be warranted for some of the chemicals in this group (refer to **Recommendation** section).

Sensitisation

Skin Sensitisation

Based on the data available for alkanes and mono-alkenes (C1–C4) and the other component chemicals, the chemicals in this group are not considered to be skin sensitisers (US EPA, 2010; US EPA, 2011; NICNASb; NICNASc; NICNASd).

Observation in humans

Alkanes are reported to be weak cardiac sensitizers at high concentrations and have been linked to sudden deaths (ACGIH, 2011).

Repeated Dose Toxicity

Oral

No data are available.

Dermal

No data are available.

Inhalation

No data are available for the chemicals in this group.

In general, minimal systemic effects have been observed in animals following repeated exposures to various alkanes and mono-alkenes (C1–C4). Inflammation of the nasal cavity has been reported following exposures to relatively high concentrations (US EPA, 2010; US EPA 2011, Government of Canada 2013a).

In a 13-week repeated dose inhalation toxicity study in male and female Sprague Dawley (SD) rats, the no observed adverse effect concentration (NOAEC) for the analogue chemical (LPG—CAS No. 68746-85-7) was reported to be 10,000 ppm (highest concentration tested). There were no reported treatment-related effects in any of the parameters evaluated including viability, clinical observations, body weights, feed consumption, functional observation battery and motor activity, oestrus cycles, sperm assessments, micronucleus assessment, clinical pathology, organ weights, and macroscopic and microscopic observations (US EPA, 2010; REACH).

The component chemical, carbon monoxide, is classified as hazardous with the risk phrase 'Toxic: Danger of serious damage to health by prolonged exposure by inhalation' (R48/23) (Safe Work Australia). The primary targets for toxicity are the heart and cardiovascular system, the central nervous system (see **Neurotoxicity**), and the foetus and neonate (see **Reproductive and developmental toxicity**) (NICNASd).

Reported concentrations of this component (US EPA 2011) is, in some cases, above the cut-off concentrations for classification (Safe Work Australia, 2004; GHS, 2009). Therefore, classification for repeated dose toxicity could be warranted for some of the chemicals in this group (refer to **Recommendation** section).

The other component chemicals are not classified for effects observed in repeated dose toxicity studies (NICNASb; NICNASc; Safe Work Australia).

Genotoxicity

The majority of the chemicals are classified as hazardous, Category 2 mutagenic substances, with the risk phrase 'May cause heritable genetic damage' (T; R46) in HSIS (Safe Work Australia). This classification need not apply if it can be shown that the substance contains less than 0.1 % w/w 1,3-butadiene. The available data support this classification.

Limited data are available for the chemicals in this group. The analogue chemical, CAS No. 68476-85-7, did not induce micronuclei in rats in vivo in a 13-week repeated dose inhalation study (refer **Repeated dose toxicity: inhalation**) (US EPA 2010; REACHa).

In general alkanes and mono-alkenes (C1–C4) are not considered to have genotoxic potential based on the weight of evidence of results in several in vitro and in vivo test assays (US EPA, 2010; US EPA 2011, Government of Canada 2013a; REACHa; REACHb).

The component chemical, 1,3-butadiene is classified as hazardous, Category 2 mutagenic substance, with the risk phrase 'May cause heritable genetic damage' (T; R46) in HSIS (Safe Work Australia). The chemicals are not expected to contain benzene—CAS No. 71 43-2 and isoprene—CAS No. 78-79-5 which could be present in C1-C6 petroleum gases.

Reported concentrations of 1,3-butadiene (US EPA 2010; US EPA 2011) are in some cases above the cut-off concentrations for classification (Safe Work Australia, 2004; GHS, 2009). Therefore a classification for genotoxicity could be warranted for some of the chemicals in this group (refer to **Recommendation** section).

Carcinogenicity

The majority of the chemicals are classified as hazardous, Category 1 carcinogenic substances, with the risk phrase 'May cause cancer' (T; R45) in HSIS (Safe Work Australia). This classification need not apply if it can be shown that the substance contains less than 0.1 % w/w 1,3-butadiene. The available data support this classification.

No data are available for the chemicals in this group.

Based on the limited data available, alkanes and mono-alkenes (C1–C4) are considered to have a low potential for carcinogenicity, although effects cannot be ruled out if chronic exposures to high concentrations take place (US EPA 2010; US EPA 2011; Government of Canada 2013b; REACHa).

The component chemical, 1,3-butadiene, is classified as hazardous, a Category 1 carcinogenic substance, with the risk phrase 'May cause cancer' (T; R45) in HSIS (Safe Work Australia). The chemicals are not expected to contain benzene—CAS No. 71 43-2 and isoprene—CAS No. 78-79-5 which could be present in C1-C6 petroleum gases.

Reported concentrations of 1,3-butadiene (US EPA 2010; US EPA 2011) are, in some cases, above the cut-off concentrations for classification (Safe Work Australia, 2004; GHS, 2009). Therefore, classification for carcinogenicity could be warranted for some of the chemicals in this group (refer to **Recommendation** section).

Reproductive and Developmental Toxicity

No specific reproductive toxicity studies are available for the chemicals. An increased incidence in the percentage of abnormal sperm was observed at 10000 ppm, in a 13-week inhalation study with the analogue chemical (LPG—CAS No. 68476-85-7) (refer **Repeated dose toxicity: inhalation**). No effects were observed on sperm count and motility or on the length of the oestrus cycle (US EPA, 2010; REACHa).

In an inhalation prenatal developmental toxicity study in rats, exposure to the analogue chemical (LPG—CAS No. 68476-85-7) resulted in no maternal and developmental toxicity effects. The NOAEC for maternal/developmental toxicity was established as 19 mg/L (highest concentration tested) (US EPA, 2010).

In general for alkanes and mono-alkenes (C1–C4) there is no evidence of reproductive toxicity and the developmental effects are only observed secondary to maternal toxicity (US EPA, 2010; US EPA 2011, Government of Canada 2013a).

The component chemicals, 1,3-butadiene, is recommended for classification for reproductive and developmental toxicity as follows:

- Category 3 substance toxic to reproduction—with the risk phrase 'Possible risk of impaired fertility' (Xn; R62) in HSIS; and
- Category 3 substance toxic to reproduction—with the risk phrase 'Possible risk of harm to the unborn child' (T; R63) in HSIS (NICNASb).

The chemicals are not expected to contain isoprene—CAS No. 78-79-5 which could be present in C1-C6 petroleum gases.

The component chemical, carbon monoxide, is classified as hazardous, a Category 1 substance toxic to reproduction, with the risk phrase 'May cause harm to the unborn child' (T; R61) in HSIS (NICNASd; Safe Work Australia)

Reported concentrations of these components (US EPA, 2011) are, in some cases, above the cut-off concentrations for classification (Safe Work Australia, 2004; GHS, 2009). Therefore, classification for reproductive and developmental toxicity could be warranted for some of the chemicals in this group (refer to **Recommendation** section).

Risk Characterisation

Critical Health Effects

The critical health effects of the chemicals are dependent on their chemical composition and in particular levels of:

- 1,3-butadiene;
- carbon monoxide;
- hydrogen sulfide; and
- ammonia.

Effects include systemic long-term effects (carcinogenicity, mutagenicity, reproductive toxicity, developmental toxicity), systemic acute effects (acute toxicity from inhalation exposure) and local effects (corrosivity, respiratory and irritation). The chemical could also cause harmful effects following repeated exposure through inhalation, and skin and eye irritation.

Public Risk Characterisation

Given the uses identified for the chemical, it is unlikely that the public will be directly exposed to the chemicals. Hence, the public risk from the chemicals is not considered to be unreasonable.

Limited general population exposure to unintentional releases of petroleum and refinery gases could occur in the vicinity of the refinery or gas processing facility. These releases are likely to contribute to ambient background levels of hazardous components such as 1,3-butadiene. Levels of 1,3-butadiene have been estimated to be above urban levels and potentially of concern for populations living within 200 m of a refinery (Government of Canada 2013).

Companies introducing and processing the chemicals are likely to implement control measures to reduce fugitive emissions on site as a consequence of several occupational and environmental legislative requirements, such as licence conditions and occupational exposure standards. Based on data reported to the National Pollutant Inventory for Australian refineries, fugitive emissions of volatile organic compounds have generally reduced over the past few years (NPI).

Occupational Risk Characterisation

Given the gaseous nature of the chemicals, the chemicals are anticipated to be transported and processed in closed systems. Therefore, limited occupational exposure is expected.

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

Any air monitoring should include the relevant hazardous components identified in this report.

The data available support an amendment to the hazard classification in HSIS (refer to **Recommendation** section).

NICNAS Recommendation

The assessment of the chemicals is considered to be sufficient, provided that the recommended amendment to the 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.

Companies introducing or processing the chemicals should continually seek to reduce fugitive emissions as far as reasonably practicable.

Regulatory Control

Work Health and Safety

The chemicals are recommended for classification and labelling under the current approved criteria and adopted GHS as below. This assessment does not consider classification of physical hazards and environmental hazards.

The classification will be dependent on the concentration of several hazardous components as follows:

Acute toxicity

The classification should be determined based on the levels of ammonia, carbon monoxide and hydrogen sulfide.

Irritation/Corrosivity

The classification should be determined based on the levels of ammonia.

Repeat dose toxicity

The classification should be determined based on the levels of carbon monoxide.

Genotoxicity

The classification should be determined based on the levels of 1,3-butadiene.

Carcinogenicity

The classification should be determined based on the levels of 1,3-butadiene.

Reproductive and developmental toxicity

The classification should be determined based on the levels of carbon monoxide and 1,3-butadiene.

The classification criteria for mixtures (Safe Work Australia, 2004; GHS, 2009) should be applied to these components based on their concentrations in these UVCB substances. The classifications below represent the highest possible classifications for each endpoint under these rules. Should empirical

data become available for any member of the group indicating that a lower (or higher) classification is appropriate for the specific chemical, this may be used to amend the default classification for that chemical.

Hazard	Approved Criteria (HSIS) ^a	GHS Classification (HCIS) ^b
Acute Toxicity	Very toxic by inhalation (T+; R26)	Fatal if inhaled - Cat. 2 (H330)
Irritation / Corrosivity	Irritating to eyes (Xi; R36) Irritating to skin (Xi; R38) Irritating to respiratory system (Xi; R37)	Causes serious eye irritation - Cat. 2A (H319) Causes skin irritation - Cat. 2 (H315) May cause respiratory irritation - Specific target organ tox, single exp Cat. 3 (H335)
Repeat Dose Toxicity	Toxic: danger of serious damage to health by prolonged exposure through inhalation (T; R48/23)	Causes damage to organs through prolonged or repeated exposure - Cat. 1 (H372)
Genotoxicity	Muta. Cat 2 - May cause heritable genetic damage (T; R46)*	May cause genetic defects - Cat. 1B (H340)
Carcinogenicity	Carc. Cat 1 - May cause cancer (T; R45)*	May cause cancer - Cat. 1A (H350)
Reproductive and Developmental Toxicity	Repro. Cat 2 - May cause harm to the unborn child (T; R61) Repro. Cat 3 - Possible risk of impaired fertility (Xn; R62)	May damage the unborn child. Suspected of damaging fertility - Repr. 1B (H360Df)

^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 industry

Control measures

Control measures to minimise the risk from dermal/ocular/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 which may minimise the risk include, but are not limited to:

- using closed systems or isolating operations;
- 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 chemical 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 assist with meeting 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 chemical 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 the chemicals has not been undertaken as part of this assessment.

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Chemical Identities

Chemical Name in the Inventory and Synonyms	Gases, petroleum, C2-3 Ethane, ethylene, propane, propylene mix
CAS Number	68477-70-3
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, catalytic reformed naphtha stripper overheads Catalytic reforming stripper overhead gas, hydrocarbon stream
CAS Number	68477-77-0
Structural Formula	No Structural Diagram Available

Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Natural gas Synthetic natural gas
CAS Number	8006-14-2
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Tail gas, petroleum, propane propylene alkylation feed prepdeethanizer Alkylation feed prep deethanizer tail gas, hydrocarbon stream
CAS Number	68308-11-2
Structural Formula	No Structural Diagram Available

Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, C2 return stream (C2) Return stream
CAS Number	68477-84-9
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, deethanizer overheads
CAS Number	68477-86-1
Structural Formula	No Structural Diagram Available

Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, deisobutanizer tower overheads Deisobutanizer tower overhead
CAS Number	68477-87-2
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, deethanizer overheads, C3 rich
CAS Number	68477-88-3
Structural Formula	No Structural Diagram Available

Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, dry sour, gas concentration unit off Sour refinery off gas, petroleum
CAS Number	68477-92-9
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, gas concentration reabsorber distillation Gas concentration reabsorber off gas
CAS Number	68477-93-0
Structural Formula	No Structural Diagram Available

Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, gas recovery plant depropanizer overheads Gas, recovery plant depropanizer overhead, hydrocarbon stream
CAS Number	68477-94-1
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, hydrogen absorber off HRI off gas
CAS Number	68477-96-3
Structural Formula	No Structural Diagram Available

Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, hydrogen rich H2 rich gas
CAS Number	68477-97-4
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, isomerized naphtha fractionator, C4 rich,hydrogen sulfide free Isomerization butane isomer, hydrocarbon stream
CAS Number	68477-99-6
Structural Formula	No Structural Diagram Available

Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Tail gas, petroleum, catalytic cracker refractionation absorber Absorber tail gas
CAS Number	68478-25-1
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, C3-4 (C3-4) Mixed stream, petroleum
CAS Number	68131-75-9
Structural Formula	No Structural Diagram Available

Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Natural gas, dried Gas, plant dry gas
CAS Number	68410-63-9
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Alkanes, C1-2
CAS Number	68475-57-0
Structural Formula	No Structural Diagram Available

Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Alkanes, C2-3 Ethane, propane mixture
CAS Number	68475-58-1
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Alkanes, C3-4 Butane and propane mixture
CAS Number	68475-59-2
Structural Formula	No Structural Diagram Available

Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Fuel gases Process off gas, petroleum
CAS Number	68476-26-6
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Fuel gases, C6-8 catalytic reformer Fuel gas, from B reformer
CAS Number	68476-28-8
Structural Formula	No Structural Diagram Available

Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Fuel gases, crude oil distillates
CAS Number	68476-29-9
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Hydrocarbons, C2-4, C3 rich Propane, propylene mix
CAS Number	68476-49-3
Structural Formula	No Structural Diagram Available

Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Hydrocarbons, C4, ethylene manufactured by product Butane, butylene concentrate
CAS Number	68476-52-8
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Fuel gases, hydrotreater fractionation, scrubbed
CAS Number	68513-11-1
Structural Formula	No Structural Diagram Available

Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Fuel gases, thermal cracked catalytic cracking residue Dubbs fuel gas
CAS Number	68513-13-3
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, catalytic reformed straight run naphtha stabilizer overheads
CAS Number	68513-14-4
Structural Formula	No Structural Diagram Available

Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, hydrocracking depropanizer off, hydrocarbon rich Hydrocracking depropanizer off gas, petroleum
CAS Number	68513-16-6
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, reformer effluent high pressure flash drum off High pressure flash drum off gas
CAS Number	68513-18-8
Structural Formula	No Structural Diagram Available

Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, reformer effluent low pressure flash drumoff Low pressure flash drum off gas
CAS Number	68513-19-9
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Hydrocarbons, C1-4 (C1-4) Mixed gases, from polymerization process (C1-4) Mixed hydrocarbons, from crude distillation (C1-4) Mixed hydrocarbons, from thermal cracking
CAS Number	68514-31-8
Structural Formula	No Structural Diagram Available

Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Hydrocarbons, C1-4, sweetened Sweetened mixed C1-4-gases
CAS Number	68514-36-3
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Hydrocarbons, C1-3 (C1-3) Mixed gases from debutanizer
CAS Number	68527-16-2
Structural Formula	No Structural Diagram Available

Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, secondary absorber off, fluidized catalytic cracker overheads fractionator Secondary absorber off gas
CAS Number	68602-84-6
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Hydrocarbons, C2-4 Liquid overheads
CAS Number	68606-25-7
Structural Formula	No Structural Diagram Available

Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Hydrocarbons, C3 (C3-4) Splitter overhead Propane, propene fraction Propane-propylene from catalytic cracking, petroleum
CAS Number	68606-26-8
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Petroleum products, refinery gases Refinery gas
CAS Number	68607-11-4
Structural Formula	No Structural Diagram Available

Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, hydrocracking low pressure separator Low pressure separator gas from hydrocracking process, petroleum
CAS Number	68783-06-2
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, refinery Refinery produced gas, petroleum
CAS Number	68814-67-5
Structural Formula	No Structural Diagram Available

Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, platformer products separator off
CAS Number	68814-90-4
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, distillate unfiner desulfurization stripper off Distillate unfiner stripper off gas
CAS Number	68919-01-7
Structural Formula	No Structural Diagram Available

Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, fluidized catalytic cracker scrubbing secondary absorber off Secondary absorber off gas
CAS Number	68919-03-9
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, platformer stabilizer off, light ends fractionation Platformer stabilizer off gas
CAS Number	68919-07-3
Structural Formula	No Structural Diagram Available

Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, straight run naphtha catalytic reforming off Platformer stabilizer off gas
CAS Number	68919-09-5
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, tar stripper off Tar stripper off gas
CAS Number	68919-11-9
Structural Formula	No Structural Diagram Available

Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, unfiner stripper off Unfiner stripper off gas
CAS Number	68919-12-0
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, fluidized catalytic cracker splitter overheads FCC Propane-propylene stream Hydrocarbons, C3, fluidized catalytic cracker splitter overheads
CAS Number	68919-20-0
Structural Formula	No Structural Diagram Available

Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Tail gas, petroleum, catalytic cracked distillate and naphtha stabilizer
CAS Number	68952-77-2
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Tail gas, petroleum, catalytic hydrodesulfurized naphtha separator
CAS Number	68952-79-4
Structural Formula	No Structural Diagram Available

Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, sponge absorber off, fluidized catalytic cracker and gas oil desulfurizer overhead fractionation Sponge absorber off gas
CAS Number	68955-33-9
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Gases, petroleum, straight run naphtha catalytic reformer stabilizer overhead Reformer stabilizer overhead gas
CAS Number	68955-34-0
Structural Formula	No Structural Diagram Available

Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

Chemical Name in the Inventory and Synonyms	Hydrocarbons, C4-unsaturated Isoprene, C4 products
CAS Number	68956-54-7
Structural Formula	No Structural Diagram Available
Molecular Formula	Unspecified
Molecular Weight	Complex Mixture

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