This Product Stewardship Summary document has been prepared by the American Chemistry Council's Higher Olefins Panel\(^1\) to provide a general overview about product safety and end use information about the Higher Olefins Category. This document is not intended to provide emergency response, medical or treatment information, or to provide a discussion of all safety and health information, or intended to replace product Material Safety Data Sheets.

Higher Olefins Category Rationale

Due to similarities of the six individual internal olefins (C\(_6\)-C\(_{10}\) and C\(_{12}\)), a C\(_{10}\)-C\(_{13}\) internal olefins blend and two linear alpha olefins 1-hexadecene and 1-octadecene (C\(_{16}\) and C\(_{18}\)), all of which are mono-olefins, a category approach was developed for these compounds. The internal olefins are predominantly linear, but may contain small amounts of branched materials. For the purposes of the Organization for Economic Cooperation and Development (OECD) High Production Volume (HPV) Chemicals Programme, the category was defined as "Higher Olefins." The category designation was based on the rationale that, within the C\(_6\) to C\(_{18}\) boundaries identified, internalising the location of the carbon-carbon double bond, increasing the length of the carbon chain, and/or changing the carbon skeleton’s structure from linear to branched is not anticipated to change the toxicity profile, or may change the toxicological profile from lower to higher carbon numbers.

This expectation is supported by a large amount of existing data for alpha and internal olefins with carbon numbers ranging from C\(_6\) to C\(_{24}\), including data from the OECD Screening Information Data Set (SIDS) Alpha Olefins Category (1-hexene, 1-decene, 1-dodecene, and 1-tetradecene), which was reviewed and approved at the SIDS Initial Assessment Meeting (SIAM) 11 in Berlin, Germany. The category as defined is from C\(_6\) to C\(_{18}\) mono-olefins (sponsored chemicals) with data from C\(_{20}\) to C\(_{24}\) being used as supportive data. The American Chemistry Council’s (ACC) Higher Olefins Panel included surrogate data from the mixed stream containing C\(_{20}\)-C\(_{24}\) linear and branched internal olefins in the SIDS Initial Assessment Report (SIAR). See the Hazard Assessment section of this document for more information about the Higher Olefins Category SIAM and SIAR. While the ACC Higher Olefins Panel realize that sufficient data exist to support the category without the data on the C\(_{20}\)-C\(_{24}\), the ACC Higher Olefins Panel believe these data provide additional support and strengthen the hypothesis that changing carbon number, location of the double bond or addition of branching does not measurably alter the mammalian health and biodegradation endpoints. Because there appears to be no critical difference across category members for biodegradation and health endpoints, the category approach is justified.

\(^1\) Members of the ACC Higher Olefins Panel include Chevron Phillips Chemical Company, ExxonMobil Chemical, Sasol North America, Inc. and Shell Chemical LP
The Higher Olefins Category consists of 9 primary members:

- CAS No. 25264-93-1 hexene
- CAS No. 25339-56-4 heptene
- CAS No. 25377-83-7 octene
- CAS No. 27215-95-8 nonene
- CAS No. 25339-53-1 decene
- CAS No. 25378-22-7 dodecene
- CAS No. 85535-87-1 alkenes, C_{10-13}
- CAS No. 629-73-2 1-hexadecene
- CAS No. 112-88-9 1-octadecene

This category also includes an additional 23 CAS numbers, encompassing a non-continuous range of odd and even numbered mono-unsaturated olefins (C6-C54) to provide additional support to the 9 primary members.

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General Information
General information about the physical/chemical properties of the Higher Olefins Category, health effects and environmental information is provided below.

Physical/chemical properties: The members of the Higher Olefins Category are colorless liquids. Vapor pressure and water solubility decrease with increasing chain length, while melting point, boiling point, and octanol:water partition coefficients increase with increasing chain length. The characteristic feature of the alkene structure is the C=C double bond. The characteristic reactions of an alkene are those that take place at the double bond, the most typical being an electrophilic addition reaction.

Health effects: The Higher Olefins Category does not indicate any significant adverse effects in standard toxicity tests. Mild skin, eye and respiratory irritation have been identified in the literature.

Environmental Information: C_{6-10} category members may be moderate to highly toxic to aquatic organisms. However, Category members above C_{10} did not demonstrate acute toxicity within the limits of water solubility and, therefore, are a low environmental hazard. A significant spill of C_{6-10} material may cause long-term adverse effects in the aquatic environment. Exposures to the environment from manufacturing and use activities should be minimized. Consideration of degradation processes supports the assessment that these substances will degrade relatively rapidly in the environment and not persist. Limited environmental exposure is expected due to volatility, biodegradability and low water solubility.

Use and Exposure Information
The Higher Olefins Category consists of C_{6}, C_{7}, C_{8}, C_{9}, C_{10}, C_{12} and C_{10-13} internal olefins and C_{16} and C_{18} linear alpha olefins. The internal olefins are predominantly linear, but may contain a small amount of branched material as impurities. Members of the Higher
Olefins Category are produced commercially in closed systems and are used primarily as intermediates in the production of other chemicals (including polymers, fatty acids, mercaptans, plasticizer alcohols, surfactants, additives for lubricants, amine oxides and amines, detergent alcohols and nonionics, and hydraulic fluids and additives). C\textsubscript{12} to C\textsubscript{20} olefins are blended with other chemicals for use as drilling fluids for off-shore oil exploration. C\textsubscript{20} to C\textsubscript{50} olefins are used in a variety of wax applications as well. As major petrochemical building blocks, their use in the development of new chemical products is virtually unlimited. Typical Higher Olefins Category uses are shown in the table below.

<table>
<thead>
<tr>
<th>CHAIN LENGTH</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>C\textsubscript{4}-C\textsubscript{8}</td>
<td>Intermediates in the production of polymers and polyethylene</td>
</tr>
<tr>
<td>C\textsubscript{6}-C\textsubscript{8}</td>
<td>Intermediates in the production of low-molecular weight fatty acids and mercaptans</td>
</tr>
<tr>
<td>C\textsubscript{6}-C\textsubscript{10}</td>
<td>Intermediates in the production of plasticizer alcohols and surfactants</td>
</tr>
<tr>
<td>C\textsubscript{10}-C\textsubscript{12}</td>
<td>Intermediates in the production of polyalphaolefins and other additives for lubricants, detergent alcohols, amine oxides and amines</td>
</tr>
<tr>
<td>C\textsubscript{10}-C\textsubscript{16}</td>
<td>Intermediates in the production of detergent alcohols and nonionics</td>
</tr>
<tr>
<td>C\textsubscript{16}-C\textsubscript{18}</td>
<td>Intermediates in the production of lube oil additives, surfactants, hydraulic fluids and additives; direct components of drilling fluids for off-shore oil exploration</td>
</tr>
</tbody>
</table>

**Potential Exposure Scenarios**

Based on the uses/applications of the Higher Olefins Category, the public could potentially be exposed through workplace use, consumer use or potential environmental release.

**Workplace use:** This refers to potential exposure to members of the Higher Olefins Category in a manufacturing facility or through evaporation in various industrial applications. Although the Higher Olefins are produced in closed systems, it is a common practice to use personal protective equipment. Occupational exposures that may occur would most likely be by the inhalation or dermal routes.

The potential for exposure via the inhalation route decreases as the carbon number increases due to the subsequent increase in boiling point and decrease in vapor pressure. These Category materials do not normally present an inhalation hazard. However, under certain conditions, (i.e. if engineering controls are not expected to maintain airborne concentrations at a level which is adequate to protect worker health)
the use of respiratory protection equipment suitable for the specific conditions may be necessary. Respirator selection, use, and maintenance must be in accordance with regulatory requirements, when applicable. Where air-filtering respirators are suitable, it is important to select an appropriate combination of mask and filter. When the material is heated, sprayed or mist formed; risk of oxygen deficiency, or confined space, there is greater potential for airborne concentrations to be generated. In situations where airborne concentrations may exceed the occupational exposure limits and work practice or other means of exposure reduction are not adequate, additional respiratory protection is available and an approved supplied-air respirator, operated in positive pressure mode, may be helpful. Supplied air respirators with an escape bottle are sometimes used when oxygen levels are inadequate, when gas/vapor warning properties are poor, or if air purifying filter capacity/rating may be exceeded. Where respiratory protective equipment is required, a full-face mask is recommended by OSHA.

In the case of dermal exposures, the use of protective gloves helps protect against the mildly irritating properties of this Category of chemicals. Common materials used in gloves to reduce risk of incidental contact/splash protection, are PVC, neoprene rubber or nitrile rubber gloves are recommended. Suitability and durability of a glove is dependent on usage (e.g., frequency and duration of contact, chemical resistance of glove material, glove thickness, and dexterity). If prolonged or repeated contact is likely, chemical resistant gloves are recommended by OSHA. If contact with forearms is likely, gauntlet style gloves may offer additional protection. Replacing contaminated gloves helps to reduce risks of accidental contamination and exposure.

**Consumer use**: Consumer exposure is not expected as these substances are not typically used in consumer products.

**Potential environmental release**: ACC’s Higher Olefins Panel members are committed to operating in an environmentaly responsible pursuant to Responsible Care ®.

**Risk Management**

When handling products from the Higher Olefins Category, or products which contain a mixture of higher olefins, make sure to consult the relevant product Material Safety Data Sheet and review applicable OSHA guidelines.

**Hazard Assessment**

The Higher Olefins Category has been assessed by the International Council of Chemical Associations (ICCA) Global Initiative on High Production Volume (HPV) Chemicals Program and recommended a low priority for future work. Consumer exposure to the Higher Olefins Category members is not expected except C_{26-28}, C_{30}, and C_{30+}HA. Acute aquatic toxicity for the C_{6}-C_{10} category members and chronic aquatic toxicity for C_{10} has been demonstrated; category members C_{14} or greater are of low environmental hazard. However, the environmental risk for this entire category of substances was considered acceptable at the SIDS Initial Assessment Meeting (SIAM) in Berlin, Germany (October 2004). More detailed information about the Higher Olefins Category may be found on the OECD and USEPA websites as described below.
Organization for Economic Cooperation and Development (OECD) - ChemPortal web-based search tool (use applicable CAS No):
http://webnet3.oecd.org/echemportal/

U.S. Environmental Protection Agency (USEPA) - High Production Volume Chemical Challenge (Higher Olefins Category):
http://www.epa.gov/chemrtk/pubs/summaries/olefins/c13116tc.htm

Regulatory Information
Regulations exist that govern the manufacture, sale, transportation, use and/or disposal of members of the Higher Olefins Category. These regulations may vary by city, state, country or geographic region. Additional helpful information may be found by consulting the relevant product Material Safety Data Sheet.

Conclusion Statement
Higher Olefins are widely used chemical intermediates in the production of other chemicals (including polymers, fatty acids, mercaptans, plasticizer alcohols, surfactants, additives, etc.). \( C_{20} \) to \( C_{54} \) olefins are used in a variety of wax applications as well. Higher Olefins are low in acute toxicity; however, repeated dermal exposure may cause skin irritation. Higher Olefins have not been shown to cause adverse health or environmental effects at levels typically found in the workplace or environment. Higher Olefins have not been shown to be combustible and have a low vapor pressure.

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Date: December 3, 2008