SULFOLANE TECHNICAL ASSISTANCE AND EVALUATION REPORT
EXECUTIVE SUMMARY

This report summarizes research of sulfolane's physical and chemical properties, industrial applications, corrosivity, breakdown and attenuation processes, and case histories involving sulfolane spills. The information included in this report is intended for readers to better understand how sulfolane is used in the oil and gas industry, its potential to cause corrosion in process equipment and piping, sulfolane regulations, and case histories of sulfolane spills and any clean-up that was completed.

Sulfolane is an organic compound that is readily soluble in water; it prefers to dissolve in water rather than stay in its pure form or attach to soil particles. It is also soluble, although to a lesser extent, in hydrocarbons (components of fuel). In its pure form, sulfolane is a clear, colorless liquid that is heavier than water. It does not readily evaporate like other solvents do, such as paint thinners or benzene. Nor does it like to adsorb – stick to – soils, the way benzene does.

The high solubility of sulfolane in water means that when it is released into the environment, it tends to move toward groundwater. Once in groundwater, it spreads out and becomes diluted as it travels with the groundwater flow.

Sulfolane is a man-made industrial solvent used in a wide variety of applications including oil refining, natural gas production, the production of insecticides, herbicides, and fungicides, lithium batteries, pharmaceuticals, printer ink, circuit board cleaning solutions, semiconductors, and soap.

At Flint Hills, sulfolane is used as the primary solvent in a sulfolane extraction unit that removes the aromatics such as benzene, toluene, and xylenes from refined oil so that they can later be added at very specific concentrations for each type of gasoline produced at the refinery. Sulfolane extraction units are closed-loop systems so pure sulfolane does not typically go down drains; however, some residual sulfolane can remain in the final gasoline product and in the wastewater from the units because of some mixing of these fluids during the extraction process. Flint Hills' wastewater stream goes through the company's wastewater treatment plant and is regulated through its wastewater discharge permit.

Corrosion is a concern in sulfolane extraction units, yet – based on research internationally, and responses from companies and regulatory agencies – corrosion has never become severe enough to cause a sulfolane leak or spill. That is because corrosion causes inefficiencies in the system, so any instances of corrosion were discovered long before they could cause leaks or spills.

Sulfolane extraction units, including the piping, are made of steel. Sulfolane itself does not corrode steel; instead, sulfolane's acidic by-products cause the corrosion. Those by-products occur when sulfolane degrades – from high temperatures or if oxygen or other impurities get into extraction units through leaks. (Most sulfolane extraction units have sulfolane recycling systems, where the by-products are removed before the sulfolane is used again. The sulfolane is usually recycled as much as possible.)

The research done for this report indicated that there is sparse government regulation of sulfolane. The U.S. Environmental Protection Agency does not regulate sulfolane. The transportation of sulfolane is also not regulated in the United States as a hazardous material or a dangerous good. Texas is the only state that has established statewide clean-up levels for sulfolane.

Internationally, Environment Canada, Canada's equivalent to the U.S. Environmental Protection Agency, is the most progressive regulatory authority in establishing environmental quality guidelines for sulfolane-contaminated soil and groundwater. Its level for drinking water is 90 parts per billion. Sulfolane-contaminated sites exist in Canada near sour-gas processing complexes that use sulfolane in the natural-gas sweetening process. (Natural gas that has carbon dioxide and other compounds is called "sour gas"; when sulfolane is used to remove those compounds, it is called a "sweetening" process.)

In the early 1980s, responding to the increased use of sulfolane in both the oil and natural gas industries, Shell Oil Company researchers performed the foundational work on remediating sulfolane from spills at natual gas processing facilities. Since Shell's work, independent contractors and university researchers worldwide, as well as the Canadian government, have worked to develop regulatory clean-up levels and design remediation systems for sulfolane-contaminated sites.

Findings from the research on sulfolane remediation processes indicate that the primary attenuation mechanism – the ability to break down the contamination into non-hazardous components – is biodegradation in an aerobic environment, where the sulfolane is broken down by bacteria in soil or water, in contact with the air.

Case studies in Canada show that an effective remediation option for sulfolane-contaminated groundwater is through biological wastewater treatment processes. Those systems are functional in Alberta and have proven to reduce sulfolane concentrations in groundwater to well-below the established clean-up levels.

Overall, there are more than 150 sulfolane extraction units licensed throughout the world. Despite that number, only a few countries have established clean-up levels for sulfolane in the environment.

Since sulfolane is generally not considered by governments to be highly toxic and is often not regulated as a water or soil contaminant, limited case studies of sulfolane spills and their remediation have been reported in the United States and internationally. The findings from the research contained in this report will provide a better understanding of the chemical and its background for addressing sulfolane contamination in the environment.

For the full report, on the Web go to http://dec.alaska.gov/spar/csp/sites/north-pole-refinery/documents.htm#sulfo.