Coal Liquefaction Less costly technologies can be used to control the toxic side effects of coal liquefaction processes while still meeting health standards likely to be established for the direct coal liquids industry. The carcinogenic and mutagenic activities of coal-derived liquids from numerous liquefaction processes occur only in a fraction of the liquid product and can be reduced through process modifications.

History In the early 1970's, interest in producing liquids from coal as a means of reducing United States dependence on foreign oil sources was heightened. However, the possibly deleterious effects (e.g., lung, skin, and scrotal cancers) of coal processing and, perhaps, products were known to both industry and Government agencies interested in developing coal liquefaction processes. Great care was taken in research and development (R&D) facilities to minimize the exposure of workers to process stream materials. In addition, careful medical surveillance programs were carried out to monitor the health of workers in pilot plants. Concern by industry and Government regulatory agencies led to preliminary commercial plant designs that would reduce the exposure of workers to all process stream materials and fugitive emissions. However, there were lingering concerns that excess costs were being incurred in safety systems and that equal or better worker safety could be obtained in a more cost-effective way.

To obtain the data necessary to evaluate the potential health impacts of coal liquefaction, a broad-based research program was undertaken to examine materials from a number of different coal liquefaction processes. Substantial effort was directed toward using simple tests to screen for possible carcinogens and mutagens. Other studies investigated the oral toxicity and teratogenic potential, or the ability to cause fetal malformations, of the materials.

Benefits The tests demonstrated that coal liquefaction products with boiling points below approximately 650°F were not active biologically. This was true when the tests measured mutations in microbial changes in cells taken from mammals. Further examination showed that both the mutations and cancers observed resulted from fractions boiling above the 650°F to 700°F range. Moreover, the rates of occurrence increased markedly in fractions that boiled above 800°F.

It appeared, therefore, that mitigating procedures might be applied to a more limited set of materials than had been previously thought possible, with corresponding cost savings. For example, for a SRC-II (Solvent-Refined Coal) fuel oil blend (with boiling points ranging from 350°F to 900°F), materials boiling above 700°F represent about 25 percent of the total mass of material in the blend, and materials boiling over 800°F represent less than 10 percent. Thus, only the heaviest 10 to 20 percent of the product stream required treatment. It also appeared that hydrotreatment, a common petroleum-refining industrial process of hydrogenation using catalysts, might be effective in neutralizing the biologically active materials. Studies using the Ames assay or mammalian cell transformation assays indicate that hydrotreatment is effective in reducing the biological activity of coal-derived liquids. Skin-painting studies demonstrated that hydrotreatment dramatically reduces the potential for causing cancer.

This research also led to the definition of components acting as potential agents causing skin cancer. These are tentatively identified as compounds known as polyaromatic amines (PAA) and polynuclear aromatics (PNA). Although test data are incomplete, they provide a basis for more specific monitoring and the development of more reliable criteria for preventing worker exposure to potentially cancer-causing materials.

Research results also have an influence on the conceptual marketing strategy for coal liquids. An initial approach was to market the high-boiling materials as boiler fuels. As a result of the research, a second strategy has been identified, namely to market products with boiling points below 750°F for use without further treatment. Under this approach, the higher boiling materials would be considered for use as in-plant energy sources or as candidates for hydrotreatment to lower their boiling points.

The substantial difference between the capital and operating costs of hydrotreating all versus part of the material with high boiling points (heavy distillate) provides the basis for quantifying a portion of the potential benefits associated with OHER research. Four sets of capital and annual operating costs developed by the Chevron Research Company for the SRC-II process (a nominal 50,000-barrels/day plant) were studied, including hydrotreating the whole heavy distillate and hydrotreating only that fraction of the heavy distillate boiling above 750°F. For the Phase Zero design, SRC-II produces about 11,000 barrels/day of heavy distillate product. Material boiling above 750°F amounts to 2700 barrels/day. The estimated cost savings per year for a single SRC-II plant vary from $98 to $174 million for capital costs and from $7 to $14 million for annual operating costs. The projected cost savings per barrel of product produced are in the range of $0.69 to $1.14.

Risk Analysis Risk analysis is a system of principles, practices, and procedures that uses the information generated in scientific experiments to estimate the potential health and environmental consequences of man's activities. It is this measure, a probability or chance of an effect occurring, that is needed by policymakers, regulatory bodies, and insurance groups to formulate goals, criteria, and standards. Such estimates have proved particularly useful where atmospheric particles pose the principal concern, as in the exhausts of automotive diesels and