

# Nuclear Fuel Reprocessing

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## **Executive Summary**

A nuclear reprocessing facility takes the spent fuel from nuclear power sources and regenerates the fuel into a usable form once again. There is not a nuclear reprocessing facility currently operating in the United States. However, countries such as France and Japan are developing more and more dependence on reprocessing cycles. With foreseeable increases in the nuclear power market over the next few decades, it will become imperative that the United States develop a spent fuel reprocessing infrastructure. Most reprocessing today uses the PUREX process. This process can be inefficient at times. Another drawback is that it produces high levels of potential weapons grade material. Because of this, it is proposed that a new and more efficient process can be developed for nuclear reprocessing cycles.

In order to facilitate the need for a new reprocessing technique, crown ethers were evaluated for their economic feasibility as well as their overall nuclear fuel reprocessing capabilities. Through the use of experimental data, it was determined that crown ethers were indeed capable of extracting uranium out of the spent nuclear fuel. An analysis was done using various crown ethers while varying the hydrobromic acid concentration. Once this data had been evaluated, it was determined that the Dibenzo-24-Crown-8 crown ether with a hydrobromic acid concentration of 7.5M was optimal for the extraction of uranium from the spent fuel. Once the organic phase containing the uranium had been separated from the rest of the fission products, it is shown that using a hydrobromic acid concentration of .45M is optimal for stripping the uranium away from the crown ether.

With the type of reprocessing method now determined, a site location and economic analysis was needed. Based on current storage numbers of U.S. spent fuel and projections for the coming years, it was estimated that a reprocessing facility with a 7500 metric ton/yr capacity was needed. The site location was determined by analyzing the locations and amount of spent fuel produced by all nuclear power plants in the United States. From this, an idealized location was determined to exist in Metropolis, IL. A rudimentary cost analysis was performed on the proposed reprocessing facility in Metropolis, IL. The estimate placed the total capital investment for the plant at approximately \$50 billion. The yearly operating costs were estimated to be at approximately \$1100/kg of spent fuel reprocessed. This equates to around \$3.3 billion yearly.

