

Exelon Corporation
partnered with
Oak Ridge National Laboratory

NE-18-16146, Plasma Separation Process Feasibility Study for the Commercial Enrichment of Gadolinium-157

YEAR AWARDED: 2018

TOTAL PROJECT VALUE: \$600K (DOE funding, \$480K; awardee cost share, \$120K)

STATUS: Completed

PRINCIPAL LAB INVESTIGATORS: Mehdi Asgari (asgarim@ornl.gov)

DESCRIPTION: With the U.S. nuclear power fleet under pressure to stay economically competitive, utilities are actively working on innovative initiatives to reduce total fuel cycle and operational costs. Under this Gateway for Accelerated Innovation in Nuclear voucher, Exelon Corporation and Oak Ridge National Laboratory (ORNL) investigated the use of enriched gadolinium in the fuel designs of the boiling-water reactor fleet and, to a lesser extent, the pressurized-water reactor fleet. Exelon evaluated advancements in plasma separation process (PSP) related technology and design enhancements to develop a modern business case for building and operating a PSP facility for gadolinium-157 enrichment. The PSP is drawn from ORNL's nuclear fusion and plasma science programs, which are heavily invested in these same technologies.

BENEFIT: The availability of enriched gadolinium has a potential \$100 million per year impact on the cost of fuel for the existing United States nuclear fleet. This project is to determine if currently available technology can be used to modernize the PSP to a level of cost effectiveness to realize the potential cost saving in the nuclear fuel cycle.

IMPACT: Although this initiative has broad market impacts, the largest economic benefit will be realized by the boiling-water reactor fleet.

LESSONS LEARNED: The analysis and modeling conducted for this report predicts that a PSP facility optimized for gadolinium-157 is feasible at ton scale and could economically benefit the U.S. nuclear power industry.

SIGNIFICANT CONCLUSIONS: A PSP-based enrichment facility with three units could meet the U.S. demand for enriched gadolinium oxide at better than 70% gadolinium-157 enrichment and up to 2,700 kg of oxide enriched annually. Based on the predicted fuel cost savings, the point-estimate operating and capital cost assumptions predict a simple capital payback period—without escalation and without cost-of-money—of as soon as six years.

NEXT STEPS: The availability of enriched gadolinium-157 would reduce the fuel costs of the U.S. nuclear power industry (well over half of the plants in the U.S. would benefit) and have additional benefits throughout the nuclear fuel cycle (e.g., reduction of spent fuel for disposal). Enriched gadolinium-157 also improves the economic viability of the high-assay low-enriched uranium and high burnup program. Exelon expressed continued interest and industry needs to the Department of Energy Isotope Program on November 17, 2020. With their support, the construction and testing of a smaller scale production demonstration unit is recommended prior to the full-scale facility to verify the operating performance and operating cost assumptions determined from the Gateway for Accelerated Innovation in Nuclear sponsored research and development.