Columbia Basin Consulting Group
partnered with
Pacific Northwest National Laboratory

GA-17PN020110, Lead-Bismuth Small Modular Reactor (SMR) Licensing Development
RFA-17-14597, Methodology for Meeting Containment System Principal Design Criteria for Heavy Metal Fast Reactor Systems

YEARS AWARDED: 2016, 2017

TOTAL COMBINED PROJECT VALUE: $788K (DOE funding, $630K; awardee cost share, $158K)
2016: $313K (DOE funding, $250K; awardee cost share, $63K)
2017: $475K (DOE funding, $380K; awardee cost share, $95K)

STATUS: Completed

PRINCIPAL LAB INVESTIGATOR: Ron Omberg (ron.omberg@pnnl.gov)

DESCRIPTION: A Gateway for Accelerated Innovation in Nuclear voucher in 2016 paired Columbia Basin Consulting Group (CBCG) with Pacific Northwest National Laboratory (PNNL) to review CBCG's design concept for a lead-bismuth-cooled fast reactor. The review was based on typical licensing evaluations and was aimed at helping CBCG develop an initial licensing position for its plant design. This review was essential in gaining investor confidence. The parties ultimately concluded the technology is licensable under current Nuclear Regulatory Commission rules. From there, CBCG and PNNL turned their attention to how the design might benefit from the functional containment concept, which allows the designer to take credit for a sequence of barriers to contain or confine radionuclides. Light-water and pressurized-water reactors are essentially required to have leak-tight buildings. With high levels of passive safety characteristic of a liquid-metal reactor, the parties determined that the CBCG lead-bismuth-cooled fast reactor (LBR) design would benefit from the functional containment concept. This study identified a concern with the activation product polonium-210, but the incorporation of a cleanup system to minimize its presence should preclude the need for leak-tight containment.

BENEFIT: The conclusions of this effort represented the first affirmation from an authoritative, independent source that the technology can be licensed under current NRC rules, providing significant safety improvement opportunities at dramatically a reduced cost with regard to structure requirements.

IMPACT: CBCG elected to proceed with the design development based on PNNL's assessment of safety, performance, and cost. They anticipate that this validation from an independent, authoritative source will reassure potential investors of the project's design integrity and financial viability.

LESSONS LEARNED: The main lesson learned was that it is worthwhile to reassess preconceived notions about regulatory requirements under the 1970s licensing system. If leak-tight containment is waived as a licensing requirement, the waiver will have a positive effect on overnight costs, construction duration, and operations costs, due to the very expensive, integrated leak-rate testing required of commercial power reactors.

SIGNIFICANT CONCLUSIONS: An assessment that a leak-tight containment may not be required with a polonium capture system demonstrates the inherent safety of this technology and the opportunity for cost reductions needed by clean energy providers to be competitive with other energy sources.

NEXT STEPS: The first Gateway for Accelerated Innovation in Nuclear project addressed the licensing question. The second affirmed the cost reduction opportunities. Next steps are to evolve the design, incorporating other innovative features and developing the safety and cost basis for a commercial small modular reactor.