—Abstract—

Goals, Requirements, and Design Implications for the Advanced High-Temperature Reactor

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The Advanced High-Temperature Reactor (AHTR), also called the liquid-salt-cooled Very High-Temperature Reactor, is a new reactor concept that has been under development for several years. The basis for the selection of goals and requirements, the preliminary goals and requirements, and some of the design implications are described.

The AHTR uses a liquid-fluoride-salt coolant with a boiling point near 1400°C and graphite-matrix coated-particle fuel (the same type used in high-temperature gas-cooled reactors). Depending upon goals, the peak coolant temperatures can vary from 700 to 1000°C. The AHTR can be built in large sizes while achieving the same safety goals as modular helium-cooled high-temperature reactors. The large size reduces the capital costs per unit power output relative to those of other high-temperature reactors.

The choice of fluoride salt coolant, decay-heat-removal system, and other plant features depends upon goals and requirements; thus, preliminary goals and requirements must be defined early in the research and development program. For electric generation, the goal is a long-term, lower-cost, passively safe replacement for light-water reactors (LWRs). The electric-power output goal is to enable construction of plants with outputs up to 2000 MW(e)─the projected size of new large LWRs in 2025─and the likely earliest date for large-scale AHTR commercial deployment. Preliminary economic assessments indicate significantly lower capital investments than for similar-sized LWRs. Because of the projected water shortages in major electrical markets in the United States, the goals include the option of dry cooling. The higher-temperature operations reduce the heat rejection per kW(e) to half that of current LWRs, a requirement for a cost-competitive dry-cooling system. The goals for hydrogen production are not as well defined, because of uncertainties in the markets. Alternative hydrogen market scenarios are defined.

The safety goals are chosen to match those of modular helium-cooled high-temperature reactors. These goals include the capability to maintain fuel integrity under extreme conditions (including the failure of certain passive cooling systems). These safety goals may eliminate the technical need for evacuation zones and reduce security requirements based on potential release of radionuclides under accident conditions; but, the goals also have major implications on the choice and design of various safety systems.