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A FLEXIBLE BASE-LINE DESIGN FOR THE ADVANCED HIGH-TEMPERATURE REACTOR UTILIZING METALLIC REACTOR INTERNALS (AHTR-MI)

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ABSTRACT

The Advanced High Temperature Reactor (AHTR) is a novel reactor concept that uses clean liquid fluoride salts as a primary coolant for conventional graphite matrix coated particle fuels. The very large volumetric heat capacity and excellent natural circulation heat transfer provided by liquid salts allows the design of reactors with passive safety features and thermal powers ranging from 2400 to 4000 MW(t), providing the potential for very low capital costs.

The current development plans for the AHTR include separate effects and electrically-heated integral experiments to qualify modeling codes, followed by the construction of a 35 to 75 MW(t) pilot reactor. U.C. Berkeley is currently developing a new low-risk, extensible AHTR design based upon the use of existing, ASME code-qualified metallic materials for the AHTR reactor vessel and internals (AHTR-MI). The design uses a closed primary-salt loop, immersed in a larger pool of a separate buffer salt that provides a controlled temperature environment for the primary loop components and a large heat sink for loss-of-forced-cooling (LOFC) transients. A third, separate intermediate salt loop transports heat from the primary salt intermediate heat exchangers (IHXs) to the power conversion systems. The primary loop is designed to minimize the primary salt volume, to provide rapid temperature response and shutdown by negative temperature feedback upon LOFC.

The baseline 2400-MW(t) AHTR-MI design has a core outlet temperature of 740°C. It uses Alloy 800H for metallic components exposed to the core outlet temperature and Hastelloy N for other metallic components. The 1100 MW(e) baseline design can be compared to current pressurized water reactors, and is shown here to have potential for significantly reduced electricity production costs. The baseline design and pilot reactor then enable multiple upgrade paths. For *electricity production*, the upgrade path includes increased reactor thermal power to 4000 MW(t) to further reduce electricity production costs. For *hydrogen production*, the pilot-plant upgrade path involves the use of improved IHX materials to allow the core outlet temperature to be increased, and improved IHX thermal design to reduce the pinch-point temperature difference between the core outlet and the hydrogen process compared to a gas-cooled Very High Temperature Reactor, to create a LS-VHTR. For *actinide management,* the upgrade path involves reducing the core outlet temperature to 620°C, to allow the

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use of fast-spectrum fuel with ODS HT9 metallic cladding to create a Liquid Salt Fast Reactor (LSFR). A backup upgrade path for actinide management, that could not be tested in the AHTR pilot plant, would involve alteration of the baseline design to use graphite moderator blocks and a liquid fuel to create a Molten Salt Reactor (MSR).