Sensitivity Studies of Modular High-Temperature Gas-Cooled Reactor (MHTGR) Postulated Accidents

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ABSTRACT

The results of various accident scenario simulations for the two major Modular High-Temperature Gas-Cooled Reactor (MHTGR) variants (prismatic and pebble-bed cores) are presented. Sensitivity studies give indications of the uncertainties involved in the predictions of accident outcomes. The studies make use of ORNL's Graphite Reactor Severe Accident Code (GRSAC), which can be used to study a wide spectrum of core transient and heatup accident scenarios. GRSAC employs a moderately detailed (~3000 nodes) 3-D thermal-hydraulic model for the core, plus models for the reactor vessel, shutdown cooling system (SCS), and reactor cavity cooling system (RCCS). Neutronic (point kinetics) models allow anticipated transients without scram (ATWS) accident investigations, and oxidation models accommodate air ingress accidents. Typically the accident initiator is assumed to be a long-term loss of forced circulation (LOFC). Sensitivity studies attempt to account for uncertainty ranges in some of the more crucial system parameters as well as for occurrences of equipment and/or operator failures or mishaps. Both of the MHTGR designs studied—the 400-MW(t) Pebble Bed Modular Reactor (pebble) and the 600-MW(t) Gas-Turbine Modular Helium Reactor (prismatic)—show excellent accident prevention and mitigation capabilities because of their inherent passive safety features. The large thermal margins between operating and "potential damage" temperatures, along with the very slow accident response times (~days to peak), significantly reduce concerns about uncertainties in the models, the initiating events, and the equipment and operator responses.