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Investigation of HTGR Reactor Building Response to a Break in Primary Coolant Boundary

PI: Shripad T. Revankar, Purdue University

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Collaborators: Karen Vierow Kirkland-Texas A&M University
Farshid Shahrokhi-Framatome,
Simon Walker and Raad Issa- Imperial College London, UK.

ABSTRACT:

An accident of interest in safety study of the HTGR is a break in the primary coolant boundary which leads to depressurization of the reactor vessel and loss of forced cooling of the core. In this hypothesized scenario, although most of the air in the reactor cavity and surrounding building is initially swept out by exiting helium, any remaining air in this space and the air re-entering from the surrounding building cavities can enter the primary coolant circuit through the break and cause severe damage to the graphite structures via oxidation. To address this issue an experimental facility is proposed to study the HTGR building response and obtain data on the oxygen concentration distribution in a scaled test facility simulating an HTGR reactor building during the later phase of a depressurization accident caused by a break in the primary coolant boundary. It is proposed to conduct experiments in a well-scaled test facility at pressure and temperature conditions of HTGR reactor building cavities and obtain spatial distributions of oxygen concentration for different system conditions including vent locations, flow paths, and break sizes and locations. To support the experimental program, it is proposed to perform analysis with 1-D thermal hydraulics code of the system response complimented and supported by CFD for detailed localized predictions. The unique features of the proposed experiments are: (i) testing with different locations and sizes of the breaks, (ii) design based on scaling for helium and air inventory, vent paths, flow paths, energy balance, and heat loss by cavity walls, (iii) the use of heated primary helium for blowdown, (iv) flexibility in the reactor building cavity internals to simulate venting pathways in different HTGR building geometries, and (v) measurements of local oxygen concentrations. A team led by two US universities with decades of thermal hydraulics experimentation and system code expertise, a leader in nuclear industry with HGTR design and expertise, and a UK partner with extensive nuclear thermalhydraulics and CFD expertise will carry out this project.