# Thermal Hydraulics Investigation of Horizontally Orientated Layout Micro HTGRs under Normal Operation and PCC Conditions Using Integrated Advanced Measurement Techniques

**PI**: Muthanna H. Al-Dahhan

Missouri S&T

**Program**: Nuclear Reactor Technologies

**Collaborators**:
Vivek Rao – Oak Ridge Laboratory
Prashant Jain - Oak Ridge Laboratory
Farshid Shahrokhi - Framatome, Inc
Brad Rearden – X-Energy
Herman Antwerpen - X-Energy
Mahmoud Taha - University of Science and Technology in Zewail City, Egypt
Ertugrul Erkoc - Bursa Technical University, Turkey

**ABSTRACT:**

Recently, there is growing interest in horizontally oriented layout micro High Temperature Gas Cooled Reactors (HTGRs) where thermal hydraulics studies are lacking. The proposed novel work will make a significant pioneering contribution to advance the knowledge and understanding of horizontal micro-HTGRs. Quantification of metrics will pertain to convective heat transfer coefficients along the channel and gaps, comparative rates of convective and radiative heat transfer, location of peak temperature and its temporal variation, timescales for onset of natural convection, local gas velocities profiles across the diameter of the channels and thickness of the gaps, gas dispersion inside channels and gaps, crossflows through gaps between blocks, and temperature profiles over channel diameter and gap thickness. These will be studied and accomplished in two primary integrated steps: **Step 1**. (1.1) Modify the team's dual-channel natural circulation P2PF and gas dispersion experiment to horizontal orientation, (1.2) Investigate the effect of natural circulation intensity on convective heat transfer coefficient, and temperature and gas velocity profiles, (1.3) Investigate the gas dispersion in the horizontally oriented channels using the tapered tube to mimic local gas velocities inside the channels with the team's well-developed gaseous tracer technique and methodology, (1.4) Compare and discuss the results and findings between horizontally and vertically oriented dual-channel units, (1.5) Implement and further validate computational fluid dynamics (CFD) code and heat transfer calculations, (1.6) Execute uncertainty quantification and sensitivity analysis to the experimental measurements and the computed parameters. **Step 2**. The findings of Step 1 will be used to enable achieving the following: (2.1) Comprehensive literature review, (2.2) Design, manufacture, test and employ scaled down separate and mixed effects multi-blocks and multilayers of prismatic block experiments representing the standard Fort St. Vrain/MHTGR-350 prismatic core that can be operated at pressure up to 5 MPa and temperature up to 1,500°C, (2.3) Design, develop, test, and utilize a novel scaled down block of integrated advanced measurement techniques, (2.4) Perform experimental investigations on the parameters mentioned above under normal operation and PCC conditions and analyzing the results, (2.5) Assess and quantify the contribution of the heat radiation and convection on heat transfer at low-velocity flow regime under PCC conditions and compare the results with those obtained under normal operation conditions, (2.6) Investigate the gas dispersion in horizontally oriented channels and gaps using tapered tube and slabs to mimic local gas velocities inside channels and gaps with the team's well developed gaseous tracer technique and methodology, (2.7) Further validate and implement CFD and heat transfer calculations, and (2.8) Perform uncertainty quantification and sensitivity analysis on the experimental results and computed parameters.