Dr. Perfetti and his PhD students at the University of New Mexico: (back row, left to right) Benjamin Murphy, Rowdy Davis, Colin Weaver, Matthew Lazaric, Daniel Timmons, and Ray Fasano; (front row, left to right) Mekiel Olguin, Dr. Christopher Perfetti, Bobbi Merryman, and Melissa Moreno.

'Relic' Reactor Yields New Benchmark Experimental Data for NEUP Project

by Paul Menser for DOE's Nuclear Energy University Program

For a machine that first went critical when "The Love Bug" was tops at the box office, the AGN-201M reactor at the University of New Mexico (UNM) has proven to be a remarkable workhorse. At 5 watts, it generates enough power to charge a cell phone, but in Christopher Perfetti's estimation it offers a priceless research opportunity.

An assistant professor in UNM's Department of Nuclear Engineering, Perfetti has received a Nuclear Energy University Program (NEUP) award to conduct a three-year study of the reactor's unique physics properties. The AGN-201M's full name is the Aerojet General Nucleonics Model 201. A hand-me-down from the University of California at Berkeley, it arrived at UNM's Albuquerque campus in 1966 and was brought to a steady power level in April 1969.

Perfetti's goal with the NEUP project is to enhance nuclear engineering benchmark experiment libraries by evaluating the AGN-201M's unique characteristics. Benchmark experiments provide the reference for the validation of basic nuclear data. In order for an experiment to be classified as a benchmark, the measurements must be performed in a system that facilitates simple calculational modeling, and the results of the measurements must be reliably established and documented.

Because of the graphite reflector around its core, the AGN-201M exhibits a low dominance ratio, resulting in easier "communication" between neutrons. "It is not clear exactly why this graphite-reflected thermal reactor should have a lower dominance ratio than bare metal assemblies, but it suggests that the AGN-201M exhibits unique reactor physics properties

that are worthy of documenting in detail," Perfetti discussed in his NEUP project technical narrative.

Perfetti's intent is in defining benchmarks for High Assay Low Enriched Uranium (HALEU) systems and for TRISO-type (graphite-coated microsphere) fuel. This could help nuclear engineers as they validate and license next-generation reactor designs and nuclear fuel production facilities.

Designed and built by Aerojet General Nucleonics of San Ramon, California, the AGN-201M was widely distributed to universities and laboratories in the 1950s and 1960s. At peak production, AGN built one or two a month and offered a $95,000 package deal that included installation, training, and licensing from the Atomic Energy Commission. Today there are only four AGN-201M reactors in operation at different locations: UNM, Texas A&M University, Idaho State University, and Kyung Hee University in the Republic of Korea.

The AGN-201M is fueled with 20% enriched U-235 in a polyethylene matrix. Its core is roughly 10 inches wide and 10 inches tall. The total fuel load is less than 700 grams. There are four rods: two safety rods, one course control rod of the same reactivity as one of the safety rods, and one fine control rod. The reactor is surrounded by a graphite reflector, a lead shield, and a tank of light water that serves as a neutron reflector and additional shielding.

At 5 watts maximum power, the reactor's fuel is only minorly radioactive and actually safe to handle by hand. "It's impervious to whatever students want to throw at it," Perfetti said. For training, the AGN-201M can be used to demonstrate both the steady state and the kinetic and dynamic behavior of reactor systems. In this sense it is ideal for use in first step training of reactor operators. Students can acquire the feel of typical reactor controls as well as the basic skills and knowledge that will prepare them for operating larger reactors.

Two nuclear engineers had already begun preparing a benchmark evaluation for the reactor. Even when their funding became limited, they continued to investigate pro bono.

Rather than having them continue working nights and weekends to gradually finish their evaluation, Perfetti's project allows them to mentor one of his graduate students to complete the benchmark evaluation.

This is not Perfetti's first NEUP experience. His involvement with the program dates back to 2009, when he was named an Integrated University Program (IUP) Fellow, now the University Nuclear Leadership Program (UNLP). He was a new graduate student at University of Michigan, and the fellowship gave him the freedom to catch up on coursework as he pursued his own research project.

At UNM, he is committed to developing expertise in his students, meeting with them once a week. "I'm definitely still learning to mentor students," he said. "It takes a lot of time and patience, but it's incredibly rewarding seeing their excitement once they get enveloped in their research."

Bob Busch and Ken Carpenter dismantling the AGN-201M reactor in 2019. The fuel from the reactor (which has essentially no burnup and is thus only slightly radioactive) sits on white paper across the center of the picture. The fuel is about the same size as the barbell weights commonly found in gyms. Photo credit, Larry Wetzel.

DOE-NE's Student Series

This profile of Dr. Christopher Perfetti is one in a series of stories highlighting recipients of support from the Department of Energy, Office of Nuclear Energy (DOE-NE). In 2009 DOE-NE established the Nuclear Energy University Program (NEUP), which funds nuclear energy research and equipment upgrades at U.S. colleges and universities and provides educational support to students. In addition to NEUP, DOE-NE administers the University Nuclear Leadership Program (UNLP), formerly the Integrated University Program (IUP), which works to attract qualified nuclear science and engineering (NS&E) students to nuclear energy professions. Through UNLP and NEUP, DOE-NE has supported hundreds of undergraduate and graduate level students in obtaining science, technology, engineering, or math (STEM) degrees.

"The Office of Nuclear Energy's scholarship and fellowship program has been attracting the top students in the U.S. into the nuclear energy field since 2009. It has been the most successful and largest program of its kind, ever. Many former students have attained leadership positions in the academic, industry, and government realms of nuclear energy. " - NEUP Program Director, Dr. John Gilligan

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