Gold used to test reactor beam quality, intensity after upgrade

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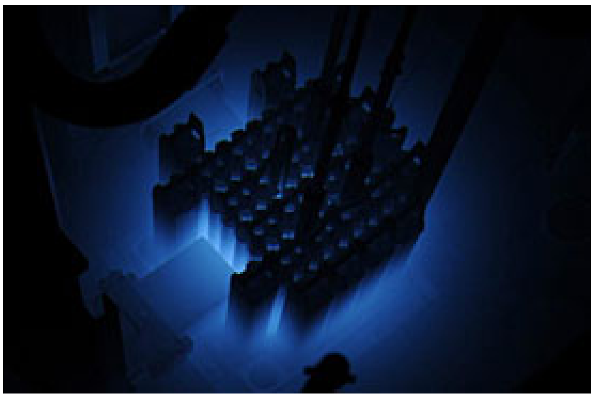
INL's NRAD reactor allows researchers to examine the insides of nuclear fuel and other materials similar to the way X-rays are used. Here, a technician poses above the reactor when its cover had been removed for a maintenance outage in 2010.

(Phys.org) —A little engine work is a nice excuse to take a roadster for a spin and see how it performs. Similarly, a recent upgrade to a nuclear research workhorse at Idaho National Laboratory is driving verification of the quality and intensity of the reactor's neutron beam. The work will verify that the beam meets a national quality standard while also providing researchers with a detailed map of the beam's intensity to help inform scientific studies.

Researchers and operations staff are working to complete a study of the beam generated by INL's Nuclear Radiography (NRAD) reactor at the lab's Materials and Fuels Complex (MFC). They will also recertify the beam after a core upgrade was completed earlier this year. Gold foil targets were used for the final beam mapping, along with two separate image quality indicator targets. This will verify that NRAD's neutron beam still meets the Category I standard specified by the American Society for Testing and Materials (ASTM).

"The study is important because NRAD provides one of INL's most important nondestructive examination capabilities," said Aaron Craft, a postdoctoral researcher in INL's Materials Science and Engineering Department. "We wanted to make sure we still met ASTM's Category I standard after the core upgrade, but we realized that other researchers wishing to conduct examinations here would find a precise map of the beam's intensity very useful. Testing with an array of gold foil targets was the best way to do that."

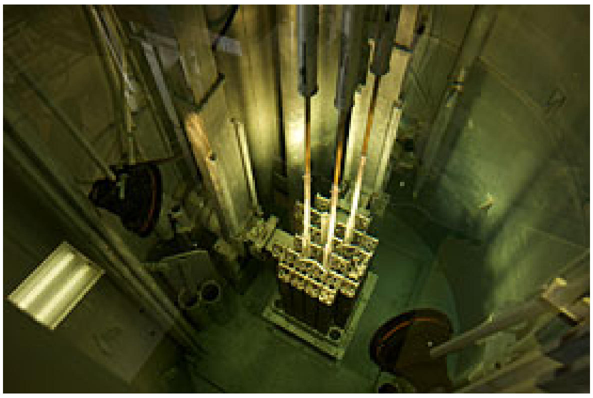
Gold is the most commonly-used material for measuring the intensity of neutron beams because of its short half-life and how it reacts to exposure to the neutron flux in a reactor. Unlike most other elements, gold as it is found in nature—gold-197—contains no traces of its radioactive isotopes. But, when exposed to a neutron beam, a small percentage of a given sample of gold will turn to gold-198, which has a half-life of 2.7 days.



INL's NRAD reactor, shown here during operation, enables non-destructive examination of nuclear fuels and materials.

"The percentage of gold-198 created is directly proportional to the intensity of the neutron beam that hits each sample in the array. Using the half-life of 2.7 days for gold-198, and the data from the sample counts done in MFC's Analytical Lab, I then have everything I need to create a precise map of NRAD's beam intensity," Craft said. "Such a map can help attract other researchers who need to examine or test samples after exposure to a neutron flux that matches NRAD's profile."

The core assembly for the NRAD reactor was upgraded in March 2013 with four additional fuel assemblies, bringing the total from 60 to 64 elements. This relatively minor upgrade paid out large dividends in terms of research capacity using the small 250-kW research reactor. Since its conversion in 2010 to use low-enriched fuel, NRAD was limited to two- to four-day operation cycles before requiring a few days of down time due to the buildup of xenon-135, which absorbs neutrons and inhibits the fission process.



NRAD is a small, water pool-type 250-kW Training, Research, and Isotope reactor designed and manufactured by General Atomics (TRIGA).

"Adding four more LEU elements to the core eliminated that problem, but we still needed to make sure this change didn't make any changes to the quality of the neutron beam," said Glen Papaioannou, facility engineer for NRAD. "This study helped us confirm that. We ended up with precisely what we wanted—xenon buildup is no longer an issue. We could conceivably run 24/7 for weeks or even months at a time now. This is a big increase in capacity for us, and that could attract more research."

Located underneath the main cell in the basement of INL's Hot Fuel Examination Facility, NRAD provides the capability for neutron radiography and irradiation of small test components. NRAD is a small, water pool-type 250-kW Training, Research, and Isotope reactor designed and manufactured by General Atomics (TRIGA). It is slated for an update of its control console some time in Fiscal Year 2014 to help maintain MFC's nondestructive examination capabilities well into the future.

Provided by Idaho National Laboratory