

New Nevada experiments aim to improve monitoring of nuclear explosions

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The Physics Experiment 1-A field team outside the entrance to P-tunnel at Nevada National Security Site. Credit: Lawrence Livermore National Laboratory

On an October morning in 2023, a chemical explosion detonated in a tunnel under the Nevada desert was the launch of the next set of experiments by the National Nuclear Security Administration, with the goal to improve detection of low-yield nuclear explosions around the world.

Physics Experiment 1-A (PE1-A) is the first in a series of non-nuclear

experiments that will compare [computer simulations](#) with high-resolution seismic, tracer gas, acoustic and electromagnetic data gleaned from underground explosions and atmospheric experiments, said Lawrence Livermore National Laboratory researcher Stephen Myers at the Seismological Society of America (SSA)'s [2024 Annual Meeting](#).

The 18 October explosion—the equivalent of 16.3 tons of TNT—took place in Aqueduct Mesa "P Tunnel" at the Nevada National Security Site (NNSS). Seismic, acoustic and [electromagnetic waves](#) from the shock were recorded by instruments near the explosion and with regional seismic networks, while gas tracers and chemical byproducts released into the resulting cavity and boreholes also were sampled by a dense instrument array. Seismic signals were recorded at least 250 kilometers away from the explosion.

"All of this is to help further our goal of monitoring [nuclear explosions](#) better and understanding the source physics of how those explosions generate seismic waves," Myers said.

Physics Experiment 1 (PE1) is the latest research program at NNSS, where atmospheric nuclear tests took place between 1951 and 1962, and underground testing occurred between 1961 and 1992. More recently, programs like the Source Physics Experiment looked at a range of non-nuclear chemical explosions in different rock environments, collecting data to learn more about explosion physics.

The seven new experiments planned as part of PE1 include more underground chemical explosions under different emplacement conditions, as well as atmospheric experiments that attempt to track underground and atmospheric transport of gases produced in these types of explosions.

The program will also use a large electromagnetic coil, about four meters

wide, to generate pulses of electromagnetic energy inside the tunnel that can be measured at the ground surface, to determine how much of the electromagnetic signal from an underground nuclear test would be affected by traveling through the earth.

"There's no one experiment that can generate all the signals that are produced by a nuclear shot, so we're doing this series of seven to try to piece together all of those signals," Myers explained, "so that we can validate our full [physics](#) codes that we use to simulate what all of those signals would be like from a nuclear explosion."

Significant improvements in [high-performance computing](#) have allowed researchers like Myers to create increasingly realistic and complex explosion simulations, but "then the question is, 'are they correct?' And the only way we can be confident about that is to compare them to these high-resolution data sets from the experiments," he said.

The new experiments are more heavily instrumented than older NNSS experiments, he noted, which helps to validate the computer code simulations.

Atmospheric simulations, for example, must account for complex variables such as temperature changes and air turbulence under different topographic conditions.

With the experiments, Myers said, "We're trying to get an idea if tracers came out of the ground after a nuclear test, exactly what some of these very local conditions, topography and other aspects, would affect the transport of those radionuclides and other telltale gases that could be released by an underground test."

Myers said the seismic and acoustic data from PE1 will be released to a public seismic database after two years. "We want this to be a resource

for the community as a whole."

Provided by Seismological Society of America

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