Nuclear triggers get subcritical scrutiny

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Experiments in Nevada will not only increase our understanding of nuclear explosions, but should also help secure the future of the test site.

Five years after the last of 880 nuclear weapons tests shook the Nevada Test Site, scientists are preparing experiments there involving small underground explosions that they hope will yield useful information about the behaviour of the plutonium triggers in existing nuclear weapons.

Like the National Ignition Facility (NIF) at Lawrence Livermore National Laboratory in California, these so-called subcritical experiments will feed information into the new nuclear weapons codes being developed under the US Science-based Stockpile Stewardship (SBSS) programme (see *Nature* **387**, 541; 1997).

And also like NIF, the experiments have a political purpose: they will give Nevada a share in the SBSS programme and reassure local politicians that the end of testing will not mean the end of the test site, whose operation brings more than $300 million of federal money into Nevada each year.

The subcritical experiments may lack NIF's lustre, but they have at least shared in the controversy that surrounds it. The first such experiment, called Rebound and conceived at Los Alamos, is now ready. But, like NIF construction, it is being held back until at least 27 June by court action against the SBSS programme.

Advocates of the subcritical experiments — which produce no measurable fission yield — say that they are vital to stockpile stewardship and also in keeping with both the spirit and the letter of the Comprehensive Test Ban Treaty. They worry that the public confuses them with two other classes of experiment, now abandoned by the United States — hydronuclear experiments and low-yield nuclear tests, which could respectively produce fission yields equivalent to 2 kg and 250 kg of high explosive.

Activists' critical questions

Critics — including local activists who were arrested trying to block a coachload of journalists taken to the site by the energy department last month — ask why, if the experiments are so harmless, they are being conducted in secure caverns 960 feet below the desert.

But according to Robin Staffin, deputy assistant secretary for weapons research at the Department of Energy (DoE), foreign governments are satisfied that they fall within the remit of the test ban treaty, and have not asked to send observers.

The Rebound experiment will ignite three blocks of 15, 25 and 40 kg of high explosives next to plastic rigs containing several matchbox-sized blocks of plutonium. Sensors will optically measure the speeds of shock and sound waves through the samples, providing equation-of-state data on plutonium, for use in the new weapons codes.

The total amount of plutonium in the chamber will be 1.5 kg — not far short of the secret amount needed to produce a fission reaction under ideal conditions. The plutonium is, however, divided into more than a dozen samples, and a neutron detector on the roof is expected to confirm that there is no detectable fission yield from Rebound.

The next subcritical experiment planned at Nevada is a Livermore one called Holog, which will use holography to photograph the tiny fragments that fly off the surface of a plutonium coin when it is punched with 50 grams of detonating high explosive. Asked what the experiment is for, Mike Dunning, one of its designers, gives an old-fashioned answer not quite in keeping with the new spirit of openness at the DoE: "I can't go into the programmatic reasons why we're doing this," he says. "The fact that we're doing it ought to tell you that it matters."

But the surface behaviour of plutonium is a critical factor in the operation of any nuclear weapon. The Livermore team, explains Dunning's colleague Dick Lear, wants to know how it will change as plutonium ages: in 40 years, one plutonium atom in a thousand will decay, changing its already complex properties. Although they do not say so, they may also want to know how surface behaviour will be affected if machined weapons pits are remanufactured as castings.

The energy department cites a 1995 study by the Jason group of scientists as independent evidence that these experiments are worthwhile. Sidney Drell, deputy director of the Stanford Linear Accelerator Center, who led the study, says that "the knowledge gained from them is going to be critical" to the maintenance of the stockpile.

Economic role for Nevada

They are also important to the economy of Nevada. They will be used as rehearsals to keep the test site prepared for any resumption of weapons testing, and will become the main function of a piece of desert that costs more than $300 million a year to run.

"I'm still not convinced that they are needed for the maintenance of the stockpile," says Suzanne Jones, a physicist at Frank von Hippel's Center for Energy and Environmental Studies at Princeton University, New Jersey. "I think they want to appease the laboratories, which need stuff to do, and the Nevada senators. They think if they don't do the experiments, the Senate won't ratify the Comprehensive Test Ban Treaty." □

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Going underground: the Nevada test site will host experiments to gather data on nuclear triggers.