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The year was 1992. At 10 a.m. on a balmy September morning in the desolate Nevada desert, a countdown began. And for a few brief moments, the ground violently shook.

In a NASA-esque control room at the Nevada Test Site (NTS), Lawrence Livermore National Laboratory (LLNL) engineer Jack Cutting watched as monitors and oscilloscopes began sending back data collected on the blast, the result of an underground nuclear test. The test, codenamed "Hunters Trophy," was the 36^{th} of Cutting's long career, and the seventh in a series of tests called Operation Julin. It also would be Cutting's—and Lawrence Livermore's—last.

Unbeknownst to many of the participants at the time, they were witnessing the tail-end of nuclear weapons testing in the U.S., and the swan song for LLNL of a legacy that had begun 35 years prior, almost to the day, with the Lab's first underground test. To some, the news was a complete shock, but not to Cutting, who was aware that discussions were ongoing on Capitol Hill that could spell the end of nuclear testing forever.

"It was pretty clear to us that the Senate would shut everything down," Cutting recalled of the morning. "It wasn't a surprise to us. We thought 'well, we'd better run it today, because we might not be able to do it tomorrow.'"

Up to that point, the NTS (renamed in 2010 as the Nevada National Security Site) had seen more than 1,000 nuclear tests since 1951, most of them of the underground variety. Hunters Trophy marked the 22nd to be conducted in the U12n — also known as "N" Tunnel — since 1967. It took place in a massive horizontal "drift" tunnel complex mined deep below the surface of the Rainier Mesa.

Requiring more than two years of preparation, Hunters Trophy's purpose was to study weapons effects, as opposed to weapon performance, which were commonly done in vertical shafts. Experiments were situated along the tunnel in an 850-foot "line-of-sight" vacuum connecting the device to a test chamber. With data from optical and fiber optic sensors and detectors, the scientists would use the experiments to study ground shock, the impact of nuclear weapon outputs like x-rays, gamma rays and neutrons on military hardware, and to collect vital data needed to research survivability in the event a weapon encountered an anti-missile system.

LLNL was responsible for the test diagnostics as well as the device — which had a modest yield of less than 20 kilotons and was developed especially for studying weapon effects. The Department of Defense's (DOD) Defense Nuclear Agency (DNA) sponsored the test and was responsible for measuring the effects. Periodically, over the course of 11 months, Cutting and other LLNL engineers and physicists would visit the test site to walk the tunnel, examining test chamber and the experiments, which would be installed in July and August of that year. Overall, the test required as many as 100 personnel to conduct.

LLNL physicist Todd Hoover was working with DNA to support the effects test. Beginning in early 1992, he made several trips to the N Tunnel, checking to make sure the "big vacuum cone filled with experiments" was set up properly. Hunters Trophy was the fifth for Hoover, who started working on underground tests for LLNL in 1987, but his first (and only) horizontal line-of-sight test.

The test itself, which occurred on Sept. 18, 1992, went off without a hitch. According to Hoover, the blast was “underwhelming” to witness because of its small size, but scientifically, was a success. The sensors and detectors transmitted important data to recording stations in real time, the containment systems worked as designed, and researchers collected film inside the tunnel, which was recovered a few days after the event.

“The diagnostics performed as required and we were happy with the results,” Hoover said. “Everything worked quite well. We got a lot of good data on it.”

Having stayed up all night, as per usual for underground tests, where final checks began well before dawn, Cutting was tasked with ensuring that the power and all systems were functioning properly to allow the test controller to make the go/no-go decision. When the device detonated, Cutting didn’t hear or feel the shockwave from his spot in the control room, but he did feel that somehow, with the potential end of testing looming, everything had changed.

“You kind of get numb to it after a dozen or so of these [tests], but Hunters Trophy was a momentous experience,” Cutting said. “We really didn’t know what to do next. Folks were concerned about their jobs going away, and a lot of them did go away.”

The end is the beginning

With the fall of the Berlin Wall heralding the end of the Cold War in 1991, calls for turning existing limited nuclear weapons test ban treaties between the U.S. and former Soviet Union into a more comprehensive ban began to ramp up.

During preparations for Hunters Trophy, the U.S. Congress was in the midst of debating a bill that would impose a temporary moratorium on all nuclear testing. Just five days after Hunters Trophy, the “Divider” test conducted by Los Alamos National Laboratory at the NTS would prove to be the nation’s last, marking the end of an era of atmospheric and underground tests spanning a combined 47 years.

Congress passed the bill, and on Oct. 2, 1992, President George H.W. Bush signed the legislation, establishing a unilateral testing moratorium. Negotiations for what would become the Comprehensive Test Ban Treaty (CTBT) followed soon in earnest, and the remainder of the Operation Julin series was immediately scrubbed, never to be completed. The U.S. signed the CTBT in 1996, however, it was never ratified by the Senate.

Hoover and Cutting had been preparing for the follow-on to Hunters Trophy, dubbed “Mighty Uncle” and scheduled for 1993, when the moratorium was announced.

“We were talking with the design group in Livermore about what we could do in the future, so we were quite surprised, to put it mildly,” Hoover said. “I thought, well, you could still do useful things at the lowest yields. But nobody at the lab, I think except for a handful of people, foresaw it coming.”

While it seemed a pedestrian test at the time, with the benefit of three decades of perspective, Hunters Trophy in fact marked a turning point for the future of the nuclear deterrent. The end of underground testing meant that LLNL needed to look at new ways of assessing the nuclear stockpile.

Two years after the ban, in response to the National Defense Authorization Act, the U.S. Congress established the Stockpile Stewardship Program. Under the program, the national laboratories would take a science-based approach to ensuring the safety, security and reliability stockpile — one that relied on the combination of experiments and high performance computing to model and simulate weapon performance and physics in the absence of test data.

“While the data from Hunters Trophy are important in their own right, the broader implications of it as the last full nuclear test of a Livermore-designed device are of more significance,” said LLNL Director Emeritus George Miller, who was associate director of Defense and Nuclear Technologies at the time.

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An underappreciated impact, Miller said, was the fact that LLNL’s weapons program was organized and structured around nuclear testing and the associated nuclear weapons development programs, which were eliminated at the same time.

“These two activities provided both the organizational framework and the mechanisms by which people were trained in the essential elements of nuclear weapons design and engineering, as well as important skills like project management, teamwork, integration and innovation,” Miller said. “The Stockpile Stewardship Program, a bold and risky attempt to retain confidence in the country’s nuclear deterrent without full scale nuclear testing, had to deal with this full range of complicated technical, organizational and personnel issues.”

Like the more than 1,000 underground tests that preceded it, Hunters Trophy would provide valuable data that were unobtainable otherwise and prove essential for validating computer codes used to model and predict weapon performance and effects.

For Hunters Trophy, Hoover performed a full modeling of the device’s performance and outputs, which were used at Sandia National Laboratories to perform computer modeling to better understand the results and compare them to existing codes.

“[An underground test] provides data you can't see anywhere else,” Hoover said. “We learned a lot over a broad range of physics regimes.”

In subsequent years, Hoover and other physicists would conduct an analysis of the Hunters Trophy data. Being one the first instances where LLNL was able to apply modern modeling and simulation tools to an experimental weapon regime that was “out of the comfort zone” for many Lab physicists, Hunters Trophy laid the groundwork for performing survivability assessments using modern tools, serving as a “stress test” for the predictive capability of existing models, according to LLNL physicist Georgios Papadimitriou.

“The importance of Hunters Trophy is that such data are scarce but very valuable for our modeling capabilities,” Papadimitriou said. “Today, we utilize modern platforms to collect necessary data, but it would be very difficult to reach the densities and pressures of experiments such as Hunters Trophy. Until we are able to do that, we have to try to bridge the gap between old and new with modern computational tools, quantification of margins and uncertainties and with modern experimental platforms that will help us constrain our physics models.”

In their analysis, the group determined the Hunters Trophy data were good enough to allow them to compare two different codes and distinguish between them, shedding light on which model was the better fit for the Hunters Trophy physics regime.

“This gave confidence for the computational pedigree that we followed,” Papadimitriou said.

Additionally, said Lab physicist Willy Moss, Hunters Trophy showed that radiation drove the experiment in an unanticipated way, which was later verified across multiple codes. The simulations using Hunters Trophy data also sparked interest in performing modern experiments at the National Ignition Facility and Z-Sandia, the team said.

Results from the Hunters Trophy test are still "very relevant indeed," explained LLNL Design Physics Group Leader Joe Wasem. Researchers "are still updating the modeling of both the device itself, as well as the various test articles that we exposed during the test," to use as a baseline for modeling radiation effects at LLNL, Sandia and the Defense Threat Reduction Agency, he added.

'Where do we go now?'

In the immediate aftermath of Hunters Trophy, many LLNL physicists and weapons designers were uncertain of what the future held for their careers.

Hoover had been working on plans for a reusable, low-yield nuclear testbed, and held out hope that officials in Washington could be convinced to agree to low-yield testing to ensure survivability of the deterrent. But the possibility "got stepped on very quickly," Hoover said, and hope slowly faded over the next two years.

"There were folks at the Lab really wondering what they were going to do," Hoover said. "We thought, 'Is anybody going to have a need for us?' There was real concern about things shrinking down to almost nothing."

After working in Washington D.C. for several years, Hoover returned to the Lab to continue working on weapon outputs and effects. He "retired" in 2013, but came back as a contractor, where he resumed his career until retiring again in Aug. 2021.

Looking back at Hunters Trophy 30 years later, Hoover said the test helped scientists gain a better understanding of ground shock and improved general understanding of survivability of equipment under extreme conditions. Now living in Pennsylvania, Hoover said he has mixed feelings about being a part of Lab history.

"I was pleased to be a part of Hunters Trophy," he said. "I think there were a lot of valuable things learned, but I was sad to see the end of testing, especially horizontal line-of-sight testing (for survivability purposes). But I was proud to have worked on it. It was good working relationship with everybody; it was a great crew. They knew what they were doing and what was expected of them, and they got it done."

After Hunters Trophy and the end of testing, Cutting's job at LLNL didn't fundamentally change, although his once-frequent forays to the Nevada desert rapidly tailed off. He held various positions at the Lab and consulted on sub-critical experiments. Semi-retired, Cutting still works out of his office in the High Explosives Applications Facility several days a week. He is proud of his involvement in Hunters Trophy and his participation in the three dozen underground tests that preceded it, and feels it provided assurances that will likely never be replicated and are still valuable today.

"It was very important," Cutting said of Hunters Trophy. "It helped us ensure that our weapons survived extreme conditions … It was part of a progression of experiments; it proved the reusable vehicle system design was a good one, and it helped inform future experiments. It meant a different way of doing business."


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