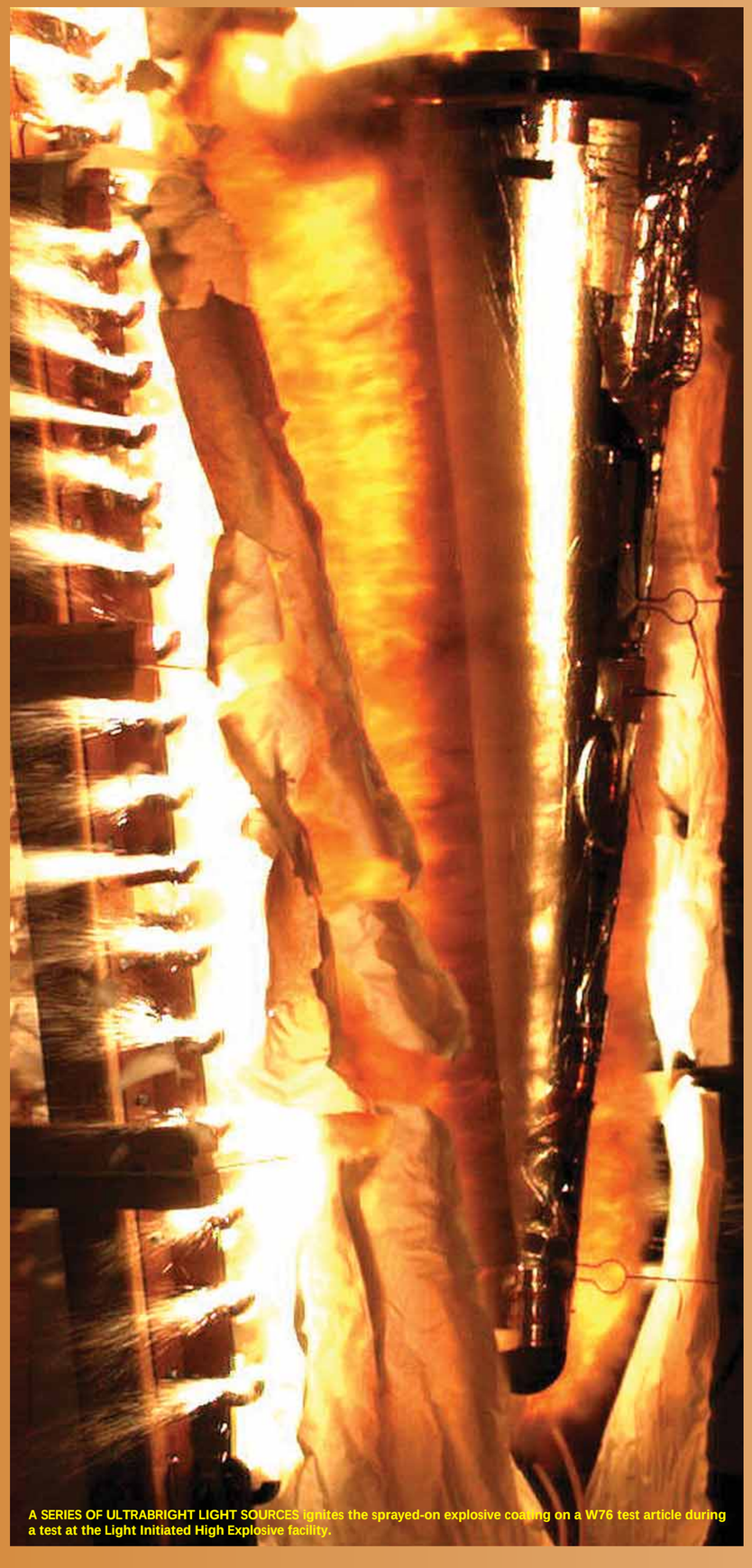


A SERIES OF ULTRABRIGHT LIGHT SOURCES ignites the sprayed-on explosive coating on a W76 test article during a test at the Light Initiated High Explosive facility.

Let there be LIHE

Stories by Stephanie Holinka • Photos by Randy Montoya and LIHE team

Sandia brings the Light Initiated High Explosive facility back online for stockpile surveillance

The Light Initiated High Explosive facility lies next to the much larger Thermal Test Complex. It looks small from the outside, but big things are going on inside.

The LIHE Facility supports nuclear weapons development and qualification testing for DOE/NNSA. It also provides test data for validation of computer models developed for the nuclear weapons Stockpile Stewardship Program. The facility was recently resurrected after the original facility was mothballed in the early 1990s, when testing activities slowed down at the Labs (see "Collective memory, great planning, textbook mothballing process helped revive unique test facility" below).

LIHE's tests simulate some of the specific conditions that occur when a nuclear device is set off near an asset such as a weapons system or a satellite. Using a thin, sprayed-on explosive coating that can be ignited by a high-intensity light flash, LIHE generates an impulse that elicits the proper structural response of the test item (see "About LIHE" below).

The LIHE facility is the only high-fidelity test technique available for the impulse testing of nuclear weapons. Nuclear underground testing used to be the best way to do this type of impulse response experiments, but the US has not done underground testing since 1992 and has no plans to resume.

Every major nuclear weapons system fielded in the US has been tested, in some capacity, at LIHE. The customer base for the LIHE facility now includes most of the nuclear weapons systems groups, computer modeling groups, and some work for others groups outside Sandia.

The LIHE facility is operated by a team of five from Explosive Projects/Diagnostics Dept. 2554, including the project lead and test engineer Gary Rivera, test engineer Tim Covert, instrumentation specialist Ed Mulligan, spray operator Dan Dow, and high-voltage operator John Liwski. It's an integral part of the Explosive Technology Group, which also operates the Explosive Component Facility.

Ed Mulligan, LIHE's current lead instrumentation technologist, was the LIHE high-voltage operator team member who mothballed the facility when it was deemed that there were not enough customers to keep the facility open 100 percent of the time. LIHE is the only Sandia facility he knows of that has been completely shut down and then brought back more than a decade later.

Before an LIHE test, the explosives are remotely formulated on site in an environmentally controlled spray booth. LIHE uses the primary explosive silver acetylide-silver nitrate (SASN), which is highly sensitive and can be initiated with a bright flash of light. SASN is so sensitive that it's not widely used and is carefully controlled throughout its life cycle at LIHE.

After the explosive is made, a remote-controlled robot arm holding a modified spray gun carefully sprays thin layers of explosive onto the surface of complex structural shapes. Depending on the complexity of the shape and the desired explosive characteristics required, the spray process can last up to 13 hours.

After spraying and conditioning, the test unit is remotely moved to a test cell in front of a light array of tungsten wires enclosed in quartz tubes.

The explosive is simultaneously detonated over the sprayed surface by exposing it to an intense flash of light generated by a 40,000-volt capacitor bank discharged through the tungsten wires to create a bright electrical arc in each quartz tube. A state-of-the-art instrumentation system, capable of recording up to 160 channels of strain, acceleration, and pressure data, captures the effects of the test. Those data are provided to LIHE customers for system validation.

After the test, excess explosive is safely disposed of at an on-site, New Mexico Environmental Department-permitted treatment facility.

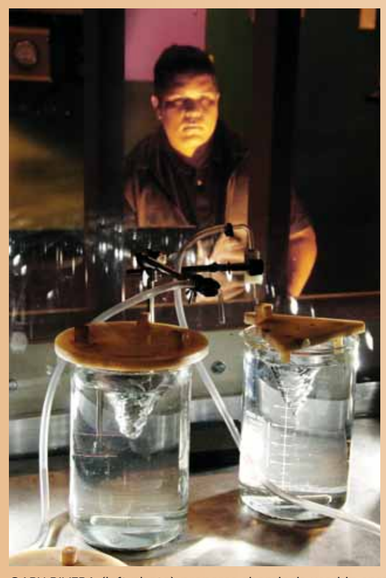
Gary says he hopes to expand the LIHE customer base to groups such as satellite purveyors and materials investigators to take advantage of the expertise at the LIHE facility for any structure that gets put into space or undergoes similar endoatmospheric impulse loading.

About LIHE

The LIHE facility at this time is being used primarily to investigate the structural response of complex test items such as reentry bodies/vehicles to shock-producing events. The tests at LIHE are high-fidelity tests, meaning that the test loading is delivered in the proper time frame and applied over the entire test surface at the same time.

During a hostile encounter — such as a nuclear weapon detonated in space near a reentry vehicle — hot, warm, and cold X-rays are produced. When cold X-rays deposit themselves in a thin layer on the asset's surface, that material heats up nearly instantaneously and vaporizes, sending a shockwave into the structure. This can cause all kinds of problems with external materials and internal components. By knowing the effects of these events on systems and components, designers can take steps to counter them.

LIHE tests for cold X-ray damage, primarily focusing on the structural response internal to the system, which is of greatest interest to DOE. The emerging flyer plate technologies are being developed to address the material response of the external surfaces, which is of high interest to the DoD.



GARY RIVERA (left photo) prepares chemicals used in spray-on explosive coating at the LIHE facility. In photo at right, Dan Dow and Gary (both 2554) prepare a test article for an LIHE test. (Photo by Randy Montoya)

Collective memory, great planning, textbook mothballing process helped revive unique test facility

LIHE first came online in the early 1970s, and was one of many test facilities for the nation's nuclear stockpile. Every major reentry weapons system in the nation's nuclear arsenal came to LIHE for testing. In the early 1990s LIHE closed its doors. The end of the Cold War and a decreasing need for large testing facilities diminished the ongoing need for the facility. Gary Rivera says facilities like LIHE all "were shut down, mothballed, or just plain went away." But it turned out that the need for an impulse test facility remained.

Luckily, the engineers and technicians who worked at LIHE didn't just tear down the facility and walk away. They felt that the nation might require LIHE's capabilities in the future. So when the facility went offline, all the major systems were crated, documented, and carefully stored in the Manzano storage facility with an eye toward returning LIHE to operation if the nation called.

Bob Benham, now retired, packed up the major LIHE systems, many with detailed documentation that allowed it to be resurrected.

"He saved everything," Gary says. "Even the facility computer systems were still there. They were so outdated that we couldn't use them anymore. Fortunately, we were able to retrieve many of the computer files and programs from the computer tapes and rewrite them and implement them in modern code."

As the plans for the W76-1 Life Extension Program got off the ground, the decision was made to re-open the facility, under the direction of then project lead Mike Skaggs, to conduct two full systems tests for both model validation and system certification.

John Tissler, who was the manager for Tech Area 3 at the time of the LIHE's tear-down, wasn't convinced that there'd ever be a need for the LIHE, and did not initially support the careful storage of its equipment. But his experience with LIHE's return changed all that.

In 2002, when Sandia decided to restore LIHE to test the W76-1, the experts who made the LIHE so successful were no longer available, either through retirements or though re-assignment to other long-term projects.

As part of a knowledge preservation project, retired Sandians Bob Benham, Ben Duggins, and Jerry Brock came back as consultants and went through the processes and equipment that made the facility so successful.

"They were able to discuss some of the 'skill of the art,' that doesn't get documented," Gary says. The LIHE veterans began mentoring Sandia personnel on LIHE's principles, processes, and equipment. They also suggested improvements to the old facilities and improvements in capabilities for a new facility.

When the decision to restart the LIHE facility was made, the new facility operators were already in training.

Some of the major features of the facility were simply brought back online. Others were replaced due to modernization of computing equipment, facilities improvements, and updated safety requirements.

After equipment calibration and proof-of-capability testing, the LIHE facility conducted two fully instrumented impulse tests on a WR-quality W76-1 unit. The tests succeeded completely.

— Stephanie Holinka