NATIONAL SECURITY SCIENCE

How People Become TERRORISTS

Also in this issue

- Defeating Foreign Nuclear Weapons
- Producing Plutonium Pits for the W88
- Battling the Las Conchas Wildfire

Los Alamos NATIONAL LABORATORY EST. 1943

About the Cover

September marked the 10th anniversary of the 9/11 terrorist attacks. LANL provides the science and technology needed to better understand, defend against, and defeat acts of terrorism.

LANL Is Essential to National Security

CHARLES McMILLAN

In 1992, the United States ceased full-scale testing of nuclear weapons. We hoped for a future in which deterrence without testing was possible—but the need for a credible nuclear deterrent remains as great as it ever was. Without testing, what gives credibility to our deterrent? How can we reassure the public and our allies, and convince our opponents, that the stockpile can serve this purpose?

Proving the capability of the U.S. nuclear deterrent—and the safety, security and effectiveness of the stockpile—depends in large part upon Los Alamos National Laboratory. LANL maintains a broad range of experimental expertise, including computer modeling, hydrodynamic testing, radiography, and materials science, used to prove the U.S. nuclear deterrent is safe and secure and will perform as designed.

Science, technology, engineering, creativity, and innovation are inexorably linked and at the core of how we accomplish our national security mission. Our value is in our ability to use these core strengths to solve the most difficult problems in national security; it is the reason we exist. Without our contributions, the United States could not deter its adversaries and assure its allies and other security partners that they can count on America's commitment to nuclear deterrence. The same is true for arms control verification, nonproliferation, counterterrorism, and energy security.

The Laboratory's core strengths provide the foundation from which the United States will be able to address the national security challenges over the next century. This is why LANL is so important to the nation and why LANL must protect and maintain its reputation as a premier national security science laboratory. We must continue to meet the following goals:

- *Build better teams from across our broad scientific and professional capabilities. Teamwork is a core principle for ensuring success in solving the most difficult problems. Everyone at the Laboratory contributes to our successes.*
- *Keep the highest standards in our science, work, safety, and ethics to ensure the Laboratory's integrity. Our integrity is key to our scientific credibility and that of the nuclear deterrent. Our responsibilities to the nation demand nothing less.*
- *Recruit and retain the brightest and best scientists and engineers. To continue attracting and training the very best, we need the nation to invest in us so that we can build next-generation science facilities such as the Chemical and Metallurgy Research Replacement (CMRR) and the Matter-Radiation Interactions in Extremes (MaRIE) facilities.*

We know what is needed, and we are on the right path. I will work hard to ensure the Laboratory maintains its place as the nation's premier, unbiased laboratory for solving the toughest problems of national security.

How People Become TERRORISTS

Modeling Pathways toward Radicalization

What conditions lead an individual or group toward committing political violence? Is it possible to accurately forecast who will become radicalized or even estimate *when* they might resort to violence?

These and similar questions weigh heavily on the minds of security specialists and decision makers around the world. At Los Alamos National Laboratory, scientists in the International Research and Analysis Group (IAT-1) are merging social, economic, political, cultural, and media data with social science in computer models to better anticipate terrorism and political violence. IAT-1's work aids the U.S. Department of Defense and the U.S. Intelligence Community in analyzing the indicators and warnings of political violence.

What Is a Terrorist?

A terrorist is one who practices terrorism, but terrorism itself is difficult to define. "Terrorism" is an emotionally and politically charged term, thus making it difficult to provide a precise definition.

"I associate the term 'terrorism' with politically motivated violence intended to instill fear in a population so the population will then *influence* policy and decision makers," says Edward P. MacKerrow, director of IAT-1.

MacKerrow explains that terrorist groups have a *violence target* and an *influence target*. The violence target is the population the group attacks, but that population may or may not be considered the enemy. A suicide bomber may attack a government office because he or she actually sees the staff members inside as enemies. But in some cases, terrorists destroy civilian locations, such as restaurants and markets, without seeing the civilians there as enemies. In that situation, the terrorist group hopes the targeted civilians will, out of fear, pressure the government (the influence target) to acquiesce to the terrorist group's cause. The underlying goal of this tactic is to co-opt an unwilling population into helping the terrorist organization achieve its stated goals.

An example of an attack meant to influence policy took place in Madrid, Spain, in March 2004. Three days before Spain's general elections, an al-Qaeda–inspired terrorist cell carried out a series of bombings against Madrid's Cercanias (commuter train) system. The ruling party, Prime Minister José Maria Aznar's Partido Popular, supported the U.S.

On July 22, 2011, a car bomb exploded in the executive government quarter of Oslo, Norway, shown above. The explosion killed eight people and wounded several others.

Prime Minister (1996–2004) Jose María Aznar of Spain (right) converses with President George W. Bush (2001–2009) and Prime Minister Tony Blair of Britain (1997–2007). Aznar's relationship with the United States and Britain, particularly his early support of the Iraq War, may have inspired an al-Qaeda sympathizer cell to execute a series of terrorist bombings against Madrid's commuter train system. –Photo by Staff Sgt. Michelle Michaud

invasion of Iraq, but this was a very unpopular policy with most Spaniards. Assuming the bombings would be viewed as al-Qaeda's retaliation for Aznar's support of Bush, Blair, and Operation Iraqi Freedom, the terrorists hoped the Spanish, fearing additional attacks, would vote Aznar's party out of office.

In fact, Aznar's party *did* lose the election, but ironically, Spanish political analysts think the loss was caused as much by Aznar's actions after the bombings as by the bombings themselves. The Aznar government sought to obscure the connection to al-Qaeda until after the election and so misrepresented the attack as the work of the Basque separatist organization, the ETA (Euskadi Ta Askatasuna). That deception was uncovered.

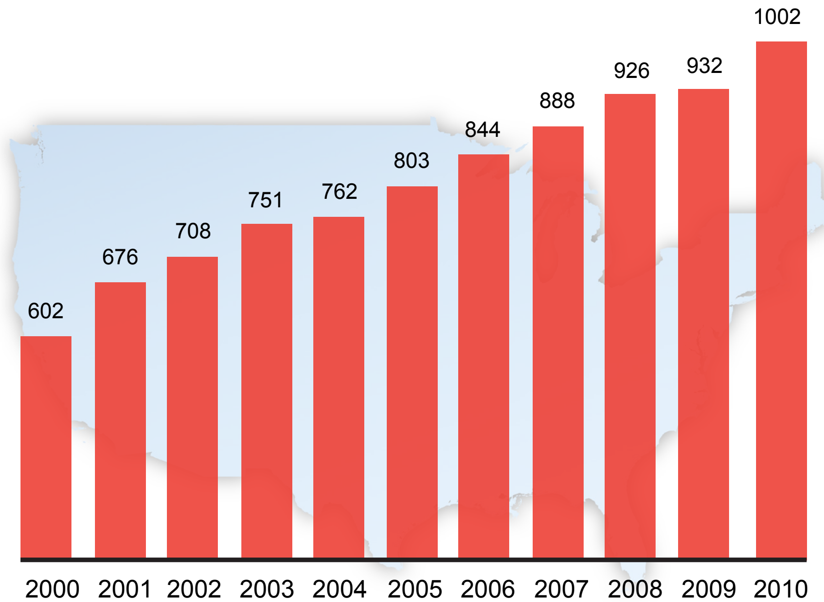
The Making of a Terrorist

One condition that can lead to the making of a terrorist is the lack of political means to have complaints heard and addressed. Such barriers are common even in democracies, where the suspicion that one's views are being ignored can lead to political violence.

> *"We have lots of kids graduating college who can't find jobs. That's what happened in Cairo. That's what happened in Madrid. You don't want those kinds of riots here."*
>
> *–Michael Bloomberg, mayor of New York City*

For example, in early 2011, a series of riots took place in the United Kingdom protesting the government's new fiscal austerity policies. On March 26 British education secretary Michael Gove said, "Of course people will feel a sense of disquiet, in some cases anger, at what they see happening, but the difficulty we have as the government inheriting a terrible economic mess, is that we have to take steps to bring the public finances back into balance." However, the difficulty was not only in the stringent nature of the government's economic response but also in the process by which it was constructed and implemented. Various organizations, including some trade unions, argued that the British government was pushing deep spending cuts too rapidly and without consulting the public—they thought the public's opinions were not listened to and considered. Political violence was a result, and such a situation could, in turn, lead to a terrorist response: fighting "a broken system."

"If political channels are open, so *everyone* can participate equally in the process, the chances of a radical group having to resort to violence in order to be heard are lower," says MacKerrow. "However, if such channels limit who can participate, then those who are excluded from the process will feel great humiliation, which triggers deep emotions such as anger and hate—especially if they are rejected as a result of their group identity."



According to the Southern Poverty Law Center, the United States has seen an alarming increase in the number of known domestic hate groups, from 602 in 2000 to 1,002 in 2010. Many of these groups seek to return to an idealized "golden age" in which ethnic relations reflected a more clearly defined dominant majority.

One way to assess the trajectory of a given group is to first understand why its members are together—what their core issues and concerns are. How and to whom have they communicated their issues and complaints, and how have the issues been received? Have they been acknowledged and perhaps addressed? For example, have these groups petitioned the government or marched in public events? And what have the government and the public done as a result of such activities?

"If people are not given an equal opportunity to express their opinions and issues, they can feel they are not respected because of *who they are*—their group identity," says MacKerrow. "An important indicator of potential violence is when we see a given group splinter into factions, where some new factions form because they feel the peaceful approach is not working and the political system is broken. Since the current political process has not worked for them, some of the factions may increase their potential for violent strategies of influence."

As an example, MacKerrow points to the recent tragedy in Norway. On July 22, 2011, Anders Behring Breivik, disguised as a police officer, opened fire on participants of a youth event sponsored by the ruling Norwegian Labour Party. Breivik killed 69 people. He was also responsible for a car-bomb explosion in Oslo earlier the same day, which killed eight people and wounded several others.

"When you look at Norway in terms of its socioeconomic and political systems, it is the best place in the world," says MacKerrow. "It has a very high quality-of-life index and is very democratic. And yet we have the tragic incident that just happened—a 'lone-wolf' terrorist incident. Although this type of incident is nearly impossible to predict, there were conditions before the event that could have been used to anticipate the potential for violence. For example, would it have been possible to sense that some people in Norway felt that their country was losing its identity because of too many immigrants? Could some have felt a sense of invasion?"

Indeed, Breivik did feel that way, and on the day of the attacks, he posted a 1,518-page manifesto, "2083—A European Declaration of Independence," outlining his militant anti-immigration and anti-Islam far-right ideology. But he had never hidden his views. He had been expressing them for years on Internet forums.

"Radical groups are not shy about stating their goals, claims, and objectives," says MacKerrow. "These are often publicized in the open on websites and blogs and in videos. It is well known that there are some groups in Western Europe (and in the United States) who are strongly against immigration. But just because groups make such claims or are against a given policy or social condition does not mean all will pursue violence. The challenge is to know which ones will. To address this challenge, we use years of political-violence research to develop computerized models of indicators and warnings: checklists of observables to look for. As evidence is collected about these observables, the forecast indicators are adjusted."

Much like cults, terrorist groups encourage or intimidate people to abandon their families and adopt the terrorist organization as their new family. The organization can use its family-like roles and relationships to focus a great amount of peer pressure on its members, compelling them to do acts of terrorism.

In some instances, terrorist organizations target specific types of people who have characteristics that make them receptive to the organization's ideas. For example, some may look for university students who are close to dropping out and are disgruntled over their efforts to forward political or societal change.

The existence of such vulnerable people, coupled with the growth of groups that think they cannot engage in conventional societal and political processes, are the first conditions society must be aware of when attempting to identify a possibly violent or hate-driven group.

A high rate of unemployment is also a condition for creating hate groups and political violence. "I am concerned about the large numbers of unemployed recent college graduates with significant student loan debt in this country," notes MacKerrow.

In a *New York Daily News* article dated September 16, 2011, New York City Mayor Michael Bloomberg voiced his concerns that student unemployment could lead to riots if Washington fails to create more jobs, saying, "We have lots of kids graduating college who can't find jobs. That's what happened in Cairo. That's what happened in Madrid. You don't want those kinds of riots here."

In Cairo, rioting Egyptians demanded the ousting of President Hosni Mubarak. Among the grievances that led to protests and riots were economic issues, such as high unemployment. In Madrid, protesters blamed the Spanish government for spending millions on the recent visit of Pope Benedict XVI instead of allocating more funds to address the country's widespread unemployment. In March 2011, the youth unemployment rate in Spain stood at 43.5 percent, the highest in the European Union.

MacKerrow points out that there are other, rapidly increasing conditions in the United States that could lead to violence. "Economic downfall, polarization between different identity groups, the increasing GINI index [a measure of income inequality], unpopular wars, corruption, and immigration issues are very important indicators of the potential for political violence. We have seen a huge increase in the number of known hate groups here, from 602 in 2000 to 1,002 in 2010. Many domestic terrorist groups seek to return to an idealized 'golden age' in which ethnic relations reflected a more clearly defined dominant majority."

Members of the American Nazi Party demonstrate outside the U.S. Capitol. Economic downfall, polarization between different identity groups, unpopular wars, and immigration issues are very important indicators for political violence.

In early 2011, a series of protests took place in the United Kingdom, with demonstrators confronting police. Various organizations, including some unions, argued that the government was pushing deep spending cuts too rapidly, without consulting the public.

Preventing Terrorism

MacKerrow believes it is possible to prevent violence, but only if society is open to the democratic process, even for radical or extreme ideas.

"When a group perceives that a societal or political process is not addressing its needs, society must work to ensure that the group is at least heard," says MacKerrow. "Now, such a spectrum of opinion is huge, and there will be organizations that will feel they can never participate in a societal or political process on equal footing. In such cases, we must be vigilant and watch for warning signs of violence, such as their acquisition of and training with weapons. Another warning sign is estrangement. For example, has a group begun to ostracize some people and indoctrinate others, as cults do?"

MacKerrow says, "Understanding what can drive a group to violence, and possibly preventing that violence, comes down to social awareness, and to the idea that, as much as possible, society must be accepting of other cultures and customs. A lack of integration can lead to humiliation and polarization. But integration is a two-way street, an immigrating culture wishes to keep some of its customs and mores, but it should also be willing to integrate with the other cultures of that area."

Computer Modeling for Simulating the Behaviors of Terrorist Groups

To further our understanding of violent groups and how they may act, LANL scientists are turning to the computer for help. They are developing computer models to simulate terrorist behavior. But simulating human behavior is much more difficult than simulating physics problems.

One method being used for the terrorist problem, a social science problem, is known as agent-based modeling, which contrasts with the equation-based modeling commonly used in physics. Equation-based modeling simulates physical systems, either natural (like ocean currents) or man-made (like industrial machinery). The variables that affect the system (for example, material content or temperature and pressure over time) are identified and represented in sets of equations, which are then solved and their results compared with data gathered from real-world measurements.

Agent-based modeling simulates complex social systems made up of interacting "agents," which represent either individuals or groups. The researcher gathers information on how people or groups have behaved over time and encodes that information into the model's algorithms, then performs simulations to see the patterns of system behavior that might play out under possible future situations.

"Computational social-science methods such as agent-based modeling are a more natural way to model social systems than is an equation-based approach," says MacKerrow. "The end result is a computer-generated ensemble of scenarios we can, in principle, analyze to try to anticipate and mitigate potential future events."

Scenario analysis is much different than prediction; that is, it can tell us something about the *possibility* of something happening but not give us a definitive *probability*—exactly how likely it is for something to happen and when it might happen.

According to MacKerrow, the difficulty lies in the lack of data from controlled experiments. "We can compensate by looking at historical events," he says. "For example, we look at the conditions of a country before a time of revolution. Perhaps a certain group blew up a building because (1) the group petitioned the government on a certain political issue and was ignored, (2) the group then marched in protest and several of its members were arrested and mistreated, and (3) the main group disbanded, but a splinter group with more-aggressive tactics emerged."

The National 9/11 Memorial at Ground Zero in New York City. The World Trade Center Building One is in the background.

Such causal relations can be built into models for simulating a scenario with given initial conditions. Comparing the simulation results with historical events known to have involved similar conditions allows for a very crude "validation" approach. The computer simulations are run thousands of times and compared with key historical events. Counterfactual analysis must also be considered though—would those key events have occurred, and what other events might have occurred, if the historical conditions had been slightly different?

"The trouble is that the real-world history of any event is singular; so we really have only one historical scenario to benchmark against," says MacKerrow. "We do not have a set of different, controlled, system-wide social experiments to validate against. However, controlled experiments on how decisions are made under uncertainty, how reciprocity and cooperation occur, and how cross-cultural interactions occur are increasing. We're learning from experimental and behavioral economics, and that's a good start."

Experimental economics is a field that *does* do controlled experiments, putting humans in a controlled setting to measure social and behavioral processes, testing and challenging existing social science axioms.

A Science of Radicalization

MacKerrow and his team are working to help decision makers understand how social, economic, and psychological factors can be used to anticipate social violence and terrorism. With such knowledge, decision makers will be better equipped to assess the behavior of groups as they begin to escalate their level of aggression.

But key questions remain: Can we predict violence before it happens? Can we know who will become a terrorist and when that will happen? Social science still can't explain why one particular person would choose violence, but more people's attitudes are becoming available—for example, on the Internet—providing unique new data for researchers. The direct drivers behind violent choices will continue to be studied at LANL as new data become available.

"I firmly believe that we need to look at *why* some people decide to resort to violence when others do not—as much as we look at the social conditions that create the possibility for violence. That will be necessary if we're to reduce political violence in the long run," MacKerrow says. "Computer modeling of social phenomena is challenging the social sciences to come up with improved theories of human behavior. The end goal is not the computer model, but a better scientific understanding of the radicalization pathways and how to create nonviolent options for groups and individuals."

–Octavio Ramos Jr.

PIT PERFECT

LANL Meets Plutonium Pit Production Goal

Test launch of a Trident II D5 missile from the Ohio-class fleet ballistic-missile submarine USS Nevada off the coast of southern California. The D5 missile is capable of carrying the W76 and W88 warheads, both designed by LANL.

– U.S. Navy photo by Seaman Benjamin Crossley/Released

On August 17, Los Alamos National Laboratory's Plutonium Sustainment Program presented the National Nuclear Security Administration (NNSA) with the 29th—and final—plutonium pit for replacement in existing W88 warheads. The W88 is a thermonuclear weapon designed by LANL in the late 1980s for the U.S. Navy and deployed on Trident II submarine-launched ballistic missiles. Undeployed W88s are stored in the U.S. nuclear stockpile. The plutonium pit is the core of the W88. It initiates the weapon's nuclear chain reaction when imploded (explosively compressed) into a supercritical mass.

The Laboratory's achievement demonstrates the United States' re-established capability to produce plutonium pits for weapons, and it completes a requirement for NNSA and the Department of Defense.

"For 19 years, the United States was the only nuclear superpower unable to build a pit and put it in a stockpile. That ended in 2007," notes Robert Putnam, director for the Plutonium Sustainment Program, which is responsible for pit manufacturing.

Since 2007, the Laboratory has manufactured new pits to replace pits destroyed as part of the U.S. Stockpile Stewardship Program (SSP). The goal of the SSP is to provide, without underground testing, high confidence in the safety, security, effectiveness, and reliability of the U.S. nuclear deterrent. After production and acceptance by the Department of Energy (DOE) and NNSA, the NNSA's Office of Secure Transportation ships these pits to the Pantex Plant outside of Amarillo, Texas. At Pantex the new pits are installed in disassembled W88 weapons, making the weapons once again fully assembled ("full up") and ready for deployment.

"For 19 years, the United States was the only nuclear superpower unable to build a pit and put it in a stockpile. That ended in 2007."

–Robert Putnam, director for the Plutonium Sustainment Program

Better, Faster, and Cheaper

Putnam attributes the program's success to a solid and definitive production model that helps the program define costs and process improvements to increase efficiency and efficacy. "We've gotten significantly better at what we do. The program has achieved a significant reduction in overall cost for capability, demonstrating the program's commitment to manufacturing better, faster, and cheaper pits."

In 1993, NNSA gave LANL the mission to re-establish the nation's capability to manufacture pits for the stockpile. This mission followed the closure of the Rocky Flats Plant (near Denver, Colorado), the plant where pits were manufactured from 1952 to 1989. Under this mission, Putnam states, the Laboratory would "capture the technologies, methods, and procedures to build pits." At the time, Technical Area 55, the Laboratory's plutonium science and manufacturing facility, was—it still is—one of the few fully functional plutonium facilities in the DOE complex and the only one capable of taking on this mission.

The Ohio-class ballistic submarine USS Alabama returns to Naval Base Kitsap from a deterrent patrol. The USS Alabama is one of 14 Ohio-class submarines, which are currently armed with the W88 nuclear warhead. –U.S. Navy photo by Ray Narimatsu/Released

The casting furnace used for the last W88 plutonium casting.

In 2003, LANL produced the first pit with the requisite quality pedigree, Qual-1, needed for quality control and testing purposes. Before LANL's pits could enter the stockpile, the Laboratory needed to verify that the quality and performance of its pits equaled or exceeded the quality and performance of those from Rocky Flats—a daunting task in the era of no nuclear testing. This requirement was driven, in large measure, by one of the Laboratory's new pit manufacturing processes—casting—whereby the plutonium is melted and poured to make a pit. At Rocky Flats, pits were manufactured using a wrought process—the plutonium was rolled flat and then pressed into a pit. The wrought process requires significantly more time, labor, and facility space.

Following the production and certification of Qual-1, the Laboratory developed and nondestructively evaluated its next Qual pits to ensure consistency in their structural, chemical, and metallurgical quality. In the end, the quality and performance of LANL's cast pits were deemed to be on par with pits manufactured at Rocky Flats. After nearly a decade of development, Qual-1 and the Qual pits that followed repeatedly demonstrated the Laboratory's ability to manufacture fresh plutonium pits.

By 2007, the Laboratory produced its first production pit: Prod-1. Prod-1 was the first pit incorporated into the nuclear stockpile as a replacement pit for a W88 warhead.

In 2007, the program had also achieved a 10-pits-per-year capacity, as required by the NNSA and Congress. In that same year, the program manufactured 17 Prod pits, of which 12 met LANL's and NNSA's quality standards—a 70 percent success rate**.** The pits that did not meet all the quality standards were recycled.

Pit manufacturing is a "use it or lose it" endeavor precisely because it requires constant production to maintain quality and increase efficiency.

By 2009, the program achieved a 100 percent success rate—an increase in efficiency of 30 percent—with every pit produced demonstrating the quality standards required for incorporation into the stockpile. In addition to improving efficiency, the Laboratory decreased the cost of its 10-pits-per-year capacity by nearly 30 percent.

Perfect Pits from Lessons Learned

The Plutonium Sustainment Program has learned two major lessons.

First, "practice makes perfect pits," says Putnam. Significant interruptions to the production cycle increase the risks of introducing deviations into the manufacturing process, which can lead to production errors, resulting in a considerable increase in the scrap rate, that is, a higher number of unusable pits. In addition, efficiency is lost. Pit manufacturing is a "use it or lose it" endeavor precisely because it requires constant production to maintain quality and increase efficiency.

Says Tim George, acting associate director for Plutonium Science and Manufacturing, "Making pits is a process and an exercise in capability. If that capability is not used, it atrophies—becomes 'rusty.'"

Furthermore, manufacturing is needed to provide training opportunities for new staff who replace those who leave or retire.

While it is ideal to manufacture pits start to finish—to complete the process without interruption—it is possible for the program to maintain its manufacturing ability by, for example, building surplus pits and disassembling them. Over the next few years, the program plans to build

Molten plutonium in a crucible. Before LANL's cast pits could enter the stockpile, the Laboratory needed to verify that their quality and performance equaled or exceeded the quality and performance of the wrought pits produced at Rocky Flats.

Pit manufacturing personnel perform an operational check on equipment used in the fabrication of the final W88 pit.

or assemble four to six pits a year for various experiments and later disassemble them to practice production and to maintain a capability for the future.

The second lesson learned, according to Putnam, is that "a risk taken tends to become a risk realized." When risks—or sacrifices—to the pit manufacturing program are taken, unfavorable realities are the likely result. For example, in the spring of 2011, temporary cuts to the equipment maintenance budget led to a temporary failure of the plutonium casting furnaces, costing five weeks of production time and $1 million for recovery efforts.

Pit Manufacturing Process

"Pit manufacturing is an art," Putnam asserts. By learning from experienced subject-matter experts at Rocky Flats, LANL, and Lawrence Livermore National Laboratory, the Plutonium Sustainment Program was able to learn the process and then improve it.

To manufacture a single pit, the program today relies on nearly 700 employees, of which approximately 300 are dedicated full time to pit manufacturing. These employees, from scientists and administrators to technical and clerical support, bring their unique knowledge, skills, and experiences to the process. For example, practiced operators craft the pit using processes of plutonium purification, casting, machining, welding, assembly, and nondestructive evaluation, including radiographic testing and chemical and metallurgical analyses.

Future of Pit Manufacturing

Following the completion of the 29th pit, the Plutonium Sustainment Program will maintain the capability to development other types of pits and weapons components for future stockpile stewardship endeavors. These new pits will be used to support SSP activities and to develop and demonstrate the ability to manufacture different pit designs that are represented in the current stockpile. "We've broadened our portfolio. We're not just pit manufacturing anymore. We're involved in many aspects of sustaining the capability to work with significant quantities of plutonium and manufacture other weapons components that require plutonium," says Putnam.

The Laboratory will reach a future production capacity of 50 to 80 pits per year by maintaining the physical infrastructure and capability to produce pits, modifying the program's equipment, and obtaining the right levels of skilled staff and an appropriate budget. LANL will already be in the pit-development cycle when NNSA issues the next order for pits. At that time, the Plutonium Sustainment Program will have the staff, systems, and equipment required to produce what NNSA wants.

"It's the highly committed, highly dedicated people doing this work who have made the program so successful. Their trade skills, education, and attention to detail make the LANL pit manufacturing staff one of the country's most valuable assets," says George.

–Marisa Sandoval

NUCLEAR FACILITIES SAFETY

Los Alamos National Laboratory senior managers meet at LANL's Emergency Operations Center during the Las Conchas wildfire.

On Sunday, June 26, 2011, a 75-foot-tall aspen tree in the Santa Fe National Forest fell on a power line, igniting the Las Conchas fire, which quickly became the largest wildfire in New Mexico history.

The fire exploded to over 40,000 acres by Monday, threatening Los Alamos National Laboratory and the nearby town. In response, the Laboratory shut down, mandating that all nonessential personnel not come to work on Monday. By Monday afternoon, the fire danger had grown so great that Los Alamos County officials ordered a mandatory evacuation for the town. Ultimately, the fire consumed more than 156,000 acres across 244 square miles of forest. By comparison, the Cerro Grande fire in 2000 burned 48,000 acres and several hundred homes in the town of Los Alamos. It also destroyed several outlying Laboratory structures, none of which contained nuclear materials.

This time, because of the Laboratory's advanced preparedness, lessons learned from the Cerro Grande fire, the valiant work of hundreds of firefighters and other responders, and the accommodating winds, the Las Conchas fire did not burn Laboratory facilities, or the town. Even if the fire had burned across Laboratory property, "there was never any danger to our nuclear facilities during the Las Conchas fire," emphasizes Chris James, the Laboratory's deputy associate director for Nuclear and High Hazard Operations. "Our nuclear facilities are intentionally hardened [robust], enough that even if the wildfire had engulfed them, they wouldn't have burned. The wildfire would have burned around them like it would around a pile of stones. The fire wouldn't have found anything to burn; it would have moved on. Furthermore, we shut down our facilities, following precise plans that ensured these facilities would pose no danger to the public or the environment during our absence. In addition, we kept essential personnel onsite to maintain safety and security while the fire raged."

"Our nuclear facilities are intentionally hardened, enough that even if the wildfire had engulfed them, they wouldn't have burned. The wildfire would have burned around them like it would around a pile of stones."

—Chris James, deputy associate director for Nuclear and High Hazard Operations

To counter the threat of wildfires and other threats to the Laboratory, Los Alamos works with the National Nuclear Security Administration (NNSA) and the Department of Energy (DOE) to put in place rigorous orders, policies, and procedures designed to ensure the safety and security of all structures, not just those that handle nuclear materials.

"When it comes to the robustness of the nuclear facilities at Los Alamos, our effort is analogous to the rigor of building and maintaining aircraft versus automobiles," explains James. "If an automobile breaks down while on the road, there's a good possibility the driver will be able to pull off the road safely. However, if an aircraft breaks down while in flight, the chances of landing it safely are much less likely. Our goal in constructing and maintaining nuclear facilities is to minimize all possible threats as much as possible."

WETF: Weapons Engineering Tritium Facility

Scientists and engineers at WETF perform experiments with tritium, a radioactive isotope of hydrogen. Tritium is used, for example, in nuclear weapons, laser fusion, and accelerator research and for basic research in materials science. The 5,000-square-foot WETF is located at Technical Area 16 at the southwestern border of the Laboratory. This area was directly in the path of the Las Conchas fire.

To protect this facility, its contents, and its ongoing experiments, WETF is constructed of reinforced concrete and has numerous safety systems to protect the facility in the event of a wildfire or other emergency. For example, WETF is engineered to be protected against an internal fire, lightning, and seismic threats. The facility includes racks specially engineered to safely store containers (also specially engineered) of tritium gas during a seismic event. WETF's gloveboxes are engineered to ensure hazardous materials are safely contained during emergencies. Gloveboxes are sealed containers that staff use for work with hazardous materials. Gas handling operations and gas waste treatment processes are monitored throughout the facility. Concrete barriers are in place to protect from vehicular assaults.

In addition to these engineered safety controls, WETF has in place numerous administrative safety controls. For example, to ensure that the engineered controls will function as needed, Los Alamos inspectors conduct—according to procedures—daily, weekly, monthly, semiannual, and annual reviews and evaluations of their systems. There is a limit placed on the amount of combustible and flammable materials kept onsite. Strict operating requirements and maintenance programs are maintained.

Security measures at WETF ensure that only cleared employees are allowed access to the facility. An employee must hold an active Q clearance from DOE and have completed specific training to enter. Additional clearances and training are required before an employee can enter hazardous material storage areas like WETF.

The Las Conchas wildfire burned more than 156,000 acres of forest. Although the fire threatened to engulf the town of Los Alamos, firefighters managed to thwart its progress.

How the Laboratory Shuts Down WETF during an Emergency

"We follow emergency operating procedures that provide guidance based on the type of emergency," says Raeanna Sharp-Geiger, LANL's the director of Weapons Facility Operations. "At WETF, we first ensure that all employees and co-located workers are safe. If it is safe to do so, we secure any operations that are in process (from both safety and security standpoints), place all at-risk material in the safest condition, and determine if additional actions are required. Concurrently, we notify affected organizations and managers about the emergency and assess the need for additional resources, as needed."

Once a facility like WETF is shut down, even more-restrictive controls are put in place, starting with dedicated evacuation and response plans. Personnel begin remote-monitoring capabilities, and trained and qualified emergency responders assess and control the site. Depending on the type of incident, personnel may continue to perform daily inspections, much like they did during the Las Conchas fire. Personnel may also continue to conduct required surveillance and in-service inspections to support administrative and engineering controls.

How the Laboratory Restarts WETF after an Emergency

Restarting WETF after an emergency is also a complex process. "We follow a restoration process that involves reviewing the facility's status at the start of the incident and throughout the response," says Sharp-Geiger. "Once we have completed that task, but before re-entry, we remotely monitor the environment of the facility and then conduct disciplined walkthroughs to evaluate its systems, structures, and components. Personnel note items that need further evaluation by trained and qualified engineers and operations specialists. These activities occur before any general re-entry into the facility and before workers resume routine work activities."

CMR: Chemistry and Metallurgy Research Facility

Originally constructed in 1952, CMR's primary purpose was to house research and experimental activities involving analytical chemistry; plutonium and uranium chemistry and metallurgy; and related engineering design, electronics, and support functions. Today, CMR continues to serve as an analytical chemistry laboratory that supports a wide variety of national security missions carried out by Los Alamos. The CMR facility contains hot cells, used to enable safe handling of highly radioactive materials. Hot cells are

Like WETF, CMR is hardened so it cannot catch fire and burn in a wildfire and has restrictions on quantities of combustibles inside and outside the facility. Note the lack of flammable vegetation close to the facility.

shielded nuclear radiation containment chambers, whereas gloveboxes are sealed containers designed to enable workers to manipulate objects in a separate atmosphere (such as inert or low pressure).

For CMR, the Laboratory adheres to the requirements in an approved Documented Safety Analysis (DSA), a document that stipulates how Los Alamos will operate the facility and will manage risks to on- and off-site personnel, the facility, and the environment. Safety measures at CMR include ventilation systems with HEPA filters, a fire-suppression system, fire partitions and doors, and walls designed to prevent fire from spreading from one wing to another. There are restrictions on the quantities of combustibles (both inside and outside the facility), flammable gasses, and other hazardous materials onsite. As part of the DSA, engineers performed calculations that showed a wildfire would not cause CMR to catch fire.

During the Las Conchas fire, concerns were expressed in the media about radiation possibly escaping if a nuclear facility like CMR went up in flames. Such a scenario would not be possible at CMR. Like WETF, CMR is hardened so it cannot catch fire and burn in a wildfire. In addition, "We have TSR [Technical Safety Requirement] controls on all combustibles around and in the CMR facility," says Paul Sasa, director of CMR Facility Operations. "For example, at nuclear facility sites, including the CMR site, any radioactive materials stored outside are in approved containers that are robust enough to resist fire."

Many fires have threatened the region, including the La Mesa fire (1977), the Dome fire (1995), and the Oso fire (1998). With each fire, the Laboratory and neighboring communities learn more, increasingly effective fire-prevention techniques.

How the Laboratory Shuts Down CMR during an Emergency

There are special procedures for shutting down CMR, depending on the type of emergency.

"For a facility fire, our emergency procedures require immediate evacuation first—personnel safety is first priority," says Sasa. "We have training and a set of procedures on how to respond to anticipated emergencies. In the case of the Las Conchas fire, we brought personnel in on Monday—the fire started on Sunday—and turned down the ventilation systems to their 'minimum ventilation' mode. This means we turned off the air supply fans to the facility, which minimized the smoke intake that could plug air filters, and ran one exhaust fan at slow speed, which meant that air was continuously being removed from the gloveboxes. This procedure kept the gloveboxes at negative pressure, as in a vacuum, and kept the contamination inside the glovebox."

Doug Tucker, fire chief for the County of Los Alamos, now retired, oversaw the county's emergency response to the Las Conchas wildfire. Tucker, along with Police Chief Wayne Torpy, was honored with a special plaque for his leadership during the fire.

Other safety measures include drills throughout the year that involve facility evacuations and the establishment of Facility Incident Commands (FICs), a national process designed to address emergencies. Factors to consider during an emergency include the following: determining wind direction to decide which assembly area evacuees must go to, accounting for all personnel within 30 minutes, and collecting information from employees regarding equipment or processes or other factors that are, or can become, safety issues. This information is passed on to the emergency responders. Safety measures are very detailed, for example, closing streets if conditions warrant and providing water and chairs for employees who may have medical conditions.

"CMR has a formal FIC," explains Sasa. "Personnel have been trained for specific positions, such as in incident command, accountability, radiation protection, communications with the LANL Emergency Operations Center and responders, and safety. We have an FIC war room in the facility and store all needed supplies in trailers at both the primary and secondary assembly areas."

Learning from Past Wildfires

Many fires have threatened the region, including the La Mesa fire (1977), the Dome fire (1995), and the Oso fire (1998). With each fire, the Laboratory and neighboring communities learn more, increasingly effective fire-prevention techniques.

For example, after the Cerro Grande fire, Los Alamos received funding to build the Emergency Operations Center, which was used to manage operations around the clock during the Las Conchas fire. Los Alamos received $24 million for firefighting equipment, some of which was donated to neighboring communities that, in turn, helped Los Alamos fight the Las Conchas fire.

"We removed incredible amounts of brush and fuel from the technical sites," says James, "and built additional fire roads and constructed 186 miles of fuel breaks. Key buildings now have safe zones devoid of flammable vegetation."

"We will continue to learn from the Las Conchas fire," says Tony Stanford, the Laboratory's lead emergency director during large-scale crises. "Whenever we find new ways to improve our response to any emergency, we will adopt them."

–Octavio Ramos Jr.

PROTECTING THE LABORATORY'S WASTE STORAGE SITE

from the Las Conchas Wildfire

Emergency preparations safeguarded Area G, the Laboratory's storage area for low-level radioactive waste, in case the recent Las Conchas wildfire moved toward any of the area's waste domes, as shown above.

From late June and through July, the Las Conchas wildfire—the largest fire in recorded New Mexico history— burned more than 156,000 acres near Laboratory property in Los Alamos County and the surrounding region. The wildfire burned an area three times larger than the scorched acreage of the Cerro Grande fire in 2000.

After the devastation of the Cerro Grande wildfire, few people expected a second major wildfire. But personnel responsible for protecting stored radioactive waste at the Laboratory take nothing for granted—they continued to prepare for the possibility of fire.

Area G

This intentional vigilance by Laboratory emergency response and safety personnel paid off by protecting Laboratory property, including Area G, the Laboratory's radioactive waste storage area.

Of great concern to the public and media during the fire, the 63-acre site is the main waste storage and handling area for Laboratory-generated low-level and transuranic radioactive waste. Transuranic ("beyond uranium") refers to man-made elements with atomic numbers on the periodic table are greater than the atomic number for uranium. Currently, Area G stores 10,000 55-gallon drums and other various-sized containers of waste above the ground, under 10 domes made of fabric stretched on metal ribbing. Another 6,000 are buried in underground storage. The waste consists of such things as contaminated clothing, tools and other work equipment, rags, soil, and debris from Laboratory technical sites.

> *"Since Area G was never at risk during the fire, it was never necessary to deploy a Task Force to protect the site."*
>
> *– Doug Tucker, Los Alamos County fire chief*

Safe Storage

"Area G was not endangered by the Los Conchas wildfire. It was secured by many layers of protection," says Doug Tucker, fire chief for the County of Los Alamos. Tucker oversaw the county's emergency response to the wildfire. In addition, at its closest, the Las Conchas fire was more than three miles from Area G.

Emergency preparations were made over the past decade, including extensive fire mitigation work. In addition, LANL has reduced the amount of waste stored at Area G.

"We do anything that's reasonably possible to ensure that none of our facilities get caught up in a fire of any kind—Area G being no exception," says Tony Stanford, the leader of the Emergency Operations Division, who oversaw LANL's emergency response to the wildfire.

In a word, the emergency preparations to safeguard the radioactive waste storage area were "excellent," according to Stanford. "Since the Cerro Grande fire in 2000, the Laboratory has improved its emergency response capabilities. We have spent a great deal of effort on preparing for any type of emergency."

Never in Danger

Fortunately, the Las Conchas fire burned only one acre on Laboratory property, and while those flames were quickly extinguished, preparations were already in place should the winds turn the fire toward Area G. During the blaze, firefighters set 130 acres of backburn. A backburn is a controlled fire intentionally set to burn fuels in front of a wildfire to slow or stop its approach.

Also helping in the fire protection, most of Area G is paved, and ground fuels, such as vegetation and small trees, have been removed to create fire breaks to eliminate any threat of fire. The fire breaks, 50-foot-wide barriers devoid of fuels, are a buffer zone around the waste storage area. Because Area G sits at the top of a low mesa with two canyons dissecting it "these canyons have been mitigated on at least three occasions, the most recent being during the Las Conchas fire," says Tucker. "Since prescribed burning is not allowed within Laboratory boundaries, mitigation entails not just thinning fuels but cutting trees and branches and removing them off the site." Crews used industrial-sized mowers and large-vegetation mulching machines known as "masticators" to reduce grasses, shrubs, and small trees around Area G.

But perhaps the best and most effective way to eliminate any fire threat, or other threat, to the radioactive waste stored at Area G is to remove the waste entirely and demolish the storage domes—and indeed, the Laboratory has been doing just that.

There are no combustible materials located within the structures at Area G. Metal waste containers are stored on metal pallets. The domes, made of fire-resistant fabric, are equipped with sprinkler systems, as are other structures onsite, and crews can quickly foam the area with fire retardant if needed.

During the Las Conchas fire, the Los Alamos Fire Department deployed Task Forces to protect at-risk structures, but "since Area G was never at risk during the fire, it was never necessary to deploy a Task Force to protect the site," says Tucker.

Lessons Learned

After the Cerro Grande fire, which burned about 7,000 acres on Laboratory property, the Laboratory implemented a multi-year fire safety improvement program. Starting with an emergency Congressional appropriation, the Laboratory

Most of Area G is paved, and ground fuels, such as vegetation and small trees, have been removed in a buffer zone around the facility to stop or slow encroaching fire.

built its Emergency Operations Center (EOC), a two-story, multi-agency facility that spans 38,000 square feet and has space for 120 people. The EOC became the nerve center of the Las Conchas fire response, allowing Laboratory and government agencies to manage operations onsite, even while the fire blazed in the wooded hills directly across the road.

Forest thinning took top billing in the fire safety program after Cerro Grande, with $20 million used for thinning trees, clearing ground fuels, and constructing fire breaks across Laboratory property. The thinning work continued as the Las Conchas fire burned. Crews removed fuels and improved existing fire roads at five locations on Laboratory property.

The Laboratory also purchased more than 35 new fire trucks, service vehicles, and heavy equipment to fight fires. “After the Cerro Grande fire, all Los Alamos Fire Department apparatus were replaced with equipment specifically designed for wildland-urban interface firefighting, which included increased water tank size and compressed-foam capabilities, with bumper and mid-ship turrets on trucks to throw a water-foam mix,” says Tucker. To help prevent flash floods and any contaminants from flowing down canyons after a fire, the Laboratory also improved stormwater runoff and erosion controls, including building structures and planting more than 10,000 willows to slow down and channel the runoff.

Hazards Analyses

Fire is just one of numerous potential dangers scrutinized by Laboratory safety personnel. Documents called safety basis documents, hundreds of pages thick, comprise extensive studies of worst-case scenarios that could result from fires or other natural disasters. Using these scenarios, safeguards are put into place before a disaster occurs.

“The people who write those documents and our safety designers are paid to be pessimists,” says Dan Cox, deputy associate director for Environmental Programs, which oversees waste storage at Area G. “We’ve invested a significant amount of effort in analyzing fire events and ensuring the necessary controls are in place to protect the waste.”

Future Mitigations

But perhaps the best and most effective way to eliminate any fire threat, or other threat, to the radioactive waste stored at Area G is to remove the waste entirely and demolish the storage domes—and indeed, the Laboratory has been doing just that.

“We’ve taken aggressive actions to reduce the inventory,” says Cox.

In the last two years, as part of a multiyear plan to close Area G by 2015, the Laboratory has ramped up its waste shipments to the Waste Isolation Pilot Plant (WIPP) in Carlsbad, N.M., with more than 300 shipments completed since 2009. The waste, sent to WIPP in more than 750 shipments since 1999, has amounted to several hundred pounds of low-level radioactively contaminated gloves, lab equipment, and protective clothing.

In May this year, the Laboratory surpassed 100,000 plutonium-equivalent curies of transuranic waste shipped to WIPP, about one-third of the Laboratory’s total. A curie is a measure of radioactivity for a given element. About 190,000 plutonium-equivalent curies remain to be shipped in the waste stored at Area G.

As the remaining drums are shipped, the Laboratory is demolishing unused storage structures. So far, three storage domes have been taken down, with 10 still remaining.

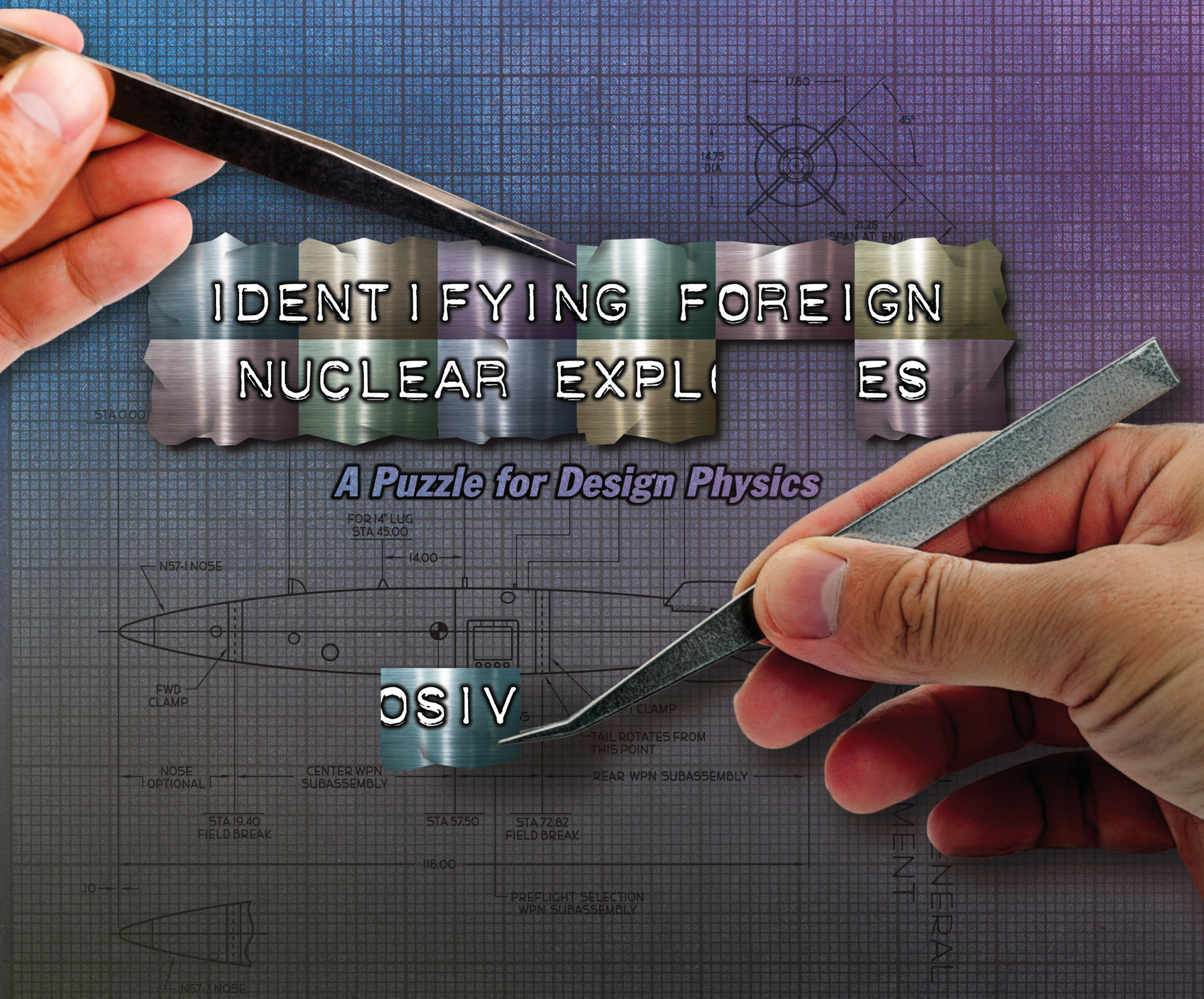
Taken together, these fire mitigation efforts should instill confidence in the nation in the Laboratory’s ability to defend its nuclear facilities and hazardous material sites from wildfire. “These efforts will help us continue our national security mission,” says Laboratory director Charles McMillan.

– Caroline Spaeth

Waste drums from Area G are trucked to WIPP inside huge TRUPACT containers, made impact-safe with inner containment walls, thick insulation, and a stainless steel outer skin.

IDENTIFYING FOREIGN NUCLEAR EXPLOSIVES

A Puzzle for Design Physics



National defense programs need special knowledge to disable and defeat a foreign or terrorist nuclear device. LANL has that knowledge.

After more than 60 years of development, nuclear weapons technology has become a global commodity. The technology's distribution is still somewhat limited, but it is growing, and the size and sophistication of foreign nuclear arsenals is increasing.

Since late 1992, the United States has chosen to maintain its existing nuclear weapons stockpile without supercritical testing (achievement of a sustained nuclear chain reaction), although there are no international legal prohibitions against such testing. Furthermore, it has embarked on a policy of reducing the size of its nuclear stockpile. Since the height of the Cold War, the United States has reduced its nuclear weapons stockpile by over 90 percent.

Other countries, however, have taken a different path. Three nations, Pakistan, India, and North Korea, have conducted overt nuclear testing and presumably evolved their nuclear weapon technologies as a result of lessons learned from those tests. Russia has publicly stated its intent to develop and field new nuclear weapons, and Iran is widely believed to be developing its first ones. Moreover, the danger has spread to the subnational level: some terrorist groups are actively working to obtain nuclear explosives.

A Critical Technical Discipline

The National Nuclear Security Administration (NNSA) relies upon many different technical capabilities that can be applied to understanding the threat posed by nuclear explosives. Los Alamos National Laboratory provides many unique capabilities, including the ability to interpret various foreign nuclear explosives tests and development activities and to diagnose whether full-scale nuclear yields are achieved during those activities.

But special knowledge is also needed to field viable mechanisms for pre-detonation intervention, that is, disabling and defeating the physics package (the nuclear explosive, apart from attendant systems) of a foreign or terrorist nuclear device. Intervention requires a sufficiently detailed understanding of foreign nuclear weapons design, and the Laboratory is the NNSA's prime source for a technical discipline critical to that understanding: nuclear explosives design physics.

Beyond Stockpile Stewardship

Since the United States ended nuclear testing, the design physics community (composed of staff at the Los Alamos and Lawrence Livermore national laboratories) has helped steward the U.S. nuclear weapon stockpile, with a focus on developing, assessing, and maintaining it. But as concerns about nuclear proliferation have grown, it has become increasingly apparent that the design physics community's expertise should be applied to broader national security concerns and projects, for example, to understanding non-U.S. nuclear explosive designs. For a long time, nuclear explosives design physics of foreign devices was conducted at only an individual level, perhaps best described as "hobby-like." Now, however, a more concerted and concentrated effort is necessary.

Consequently, in 2006, LANL formed the X Theoretical Design (XTD) Division's Improvised and Foreign Designs group (XTD-4) to allow the weapon design physics community to coherently and deliberately engage in applied research and mission support for design physics topics not specifically related to stockpile stewardship. Today, XTD-4 has unique assets, including 12 nuclear design physicists, who are the nation's top experts in both foreign nuclear weapons and improvised nuclear explosives, and access to 2 of the world's fastest supercomputers. XTD-4 develops and maintains the nuclear-explosives-design-physics knowledge that can be applied to improvised nuclear devices and foreign nuclear weapons. This knowledge is critical to many national security programs; indeed, they could not be successfully conducted without integrating XTD-4 expertise.

Nuclear-explosives-design physicists train for years to become established in their science, so they are a precious national resource. They understand how to integrate a broad range of physics disciplines, assisted by computational tools and validated by small- and large-scale physics experiments needed to assess the performance, safety, and detailed operation of nuclear explosive packages. This expertise

In nuclear device disablement work, scientists establish what is called a "working point" to evaluate and disable a potential nuclear threat. In this case, the threat is hidden in the pipe labeled with the number 5.

enables them to recommend how, where, and when to introduce "upsets" into a nuclear explosive package in order to neutralize it. This operation can be employed against a nuclear explosive that is static (just sitting there, but perhaps with a timer running). Or it can be used against one that is dynamic (in the middle of its detonation process), a procedure that requires perfect timing.

Nuclear Forensics

Nuclear-explosives-design physicists are also best positioned and qualified to develop post-detonation forensics signatures—the physical, chemical, and isotopic characteristics that reveal the integrated effects associated with specific nuclear device designs. To do this, XTD-4 works with LANL radiochemists who are specialists in all details concerning radioactive materials and their physical analysis. Developing and documenting nuclear forensics signatures will enable investigators to analyze radioactive debris from a nuclear explosion and identify what nuclear materials were used and what industrial processes produced them. Ultimately, the signatures could enable attribution of the materials to the originating reactor or enrichment facility. Effectively assigning attribution can serve as a contingency against acts of nuclear terrorism. If nuclear states know that the United States can trace their nuclear material back to them, they should be less likely to cooperate with terrorists.

Understanding the materials used in foreign-designed systems is another challenge LANL's design physicists are tackling. This knowledge could improve the United States' post-detonation forensics science. For example, the presence or absence of materials that either moderate neutron energy or absorb neutrons can affect the neutron-induced changes found in structural materials after a detonation. So, assessing those changes, found in post-detonation debris, could lead back to the perpetrators of a nuclear terrorist act.

Understanding Foreign Design

XTD-4 also takes on the challenge of understanding the designs and technology used in foreign nuclear devices. One challenge lies in determining whether some action or defeat mechanism used by counterterrorism responders could inadvertently produce a nuclear yield. LANL's design physicists can make that determination. They have spent years studying the problem from all angles, conducting thousands of computer simulations to inform their intuition and judgment and participating in the design, prediction, execution, and analysis of relevant experiments.

In addition, LANL is working to understand the hydrodynamic (fluid-like) and nuclear properties of explosive and nonexplosive materials to better predict how they might perform in a foreign system.

During a training exercise, the Los Alamos nuclear forensics team consults with military personnel and gives them recommendations before these personnel disable and dismantle a mock nuclear device.

Developing and Testing Design Physics Capabilities

XTD-4's capabilities support several national programs, including the National Technical Nuclear Forensics (NTNF) program and the Nuclear Counter Terrorism (NCT) program. For the NTNF program, XTD-4 applies its nuclear forensic capabilities to infer nuclear explosive technology from analyzed weapon debris. XTD-4 understands numerous nuclear explosive technologies, ranging from the most basic improvised nuclear explosive to the most sophisticated nuclear weapon systems. The group stays abreast of developments made in the modern U.S. Weapons Program while also using data from historical nuclear testing of less sophisticated, intermediate-technology nuclear explosives.

While the Stockpile Stewardship Program provides the resources and impetus for applied science at the high end of the nuclear technology spectrum, the NCT program focuses on the low end: understanding improvised nuclear devices. XTD-4 also studies low-technology nuclear explosives and is designing and executing experiments to test hypotheses about how these explosives may perform—as predicted by the Advanced Simulation and Computing program's weapon design codes. Identifying the successes and failures in those predictions permits the refining and retesting of physics models to correct deficiencies in the hypotheses.

Using this experimental data, the NCT program also fosters an environment in which "what-if" design scenarios can be tested, through physics simulations, to determine if a specific combination of materials, engineering conditions, and design philosophy could be used to construct a viable nuclear explosive. The results of these theoretical simulations are used in conjunction with real-world intelligence to inform decision makers in the U.S. government.

Using ever-improving confidence in the predictions of how nuclear weapons designs will perform, XTD-4 can also apply this knowledge to forensics signatures from a wide range of nuclear explosive devices, across the entire technology spectrum, to NTNF program needs.

The results of XTD-4's research efforts are also applied directly to the training and operation of the national Joint Technical Operations Team program. This program provides the technical capability to respond to nuclear threats from foreign nuclear states and to terrorists' improvised nuclear explosives.

Applying XTD-4 Expertise to Nuclear Threats

In addition to using the scientific approach to broaden LANL's physics knowledge of nuclear explosives, the group's design physicists seek to understand nuclear threats based on information collected by the U.S. Intelligence Community.

XTD-4 staff members collaborate with intelligence analysts, some of whom also work at the Laboratory, to interpret, contextualize, and assess U.S. intelligence information. When information pertains to nuclear explosives, intelligence analysts usually request support from the XTD-4 physics designers to assess the credibility, vulnerability, safety, and potential yield of these nuclear explosives. Responding to those requests is a primary role of the XTD-4 design physicists.

By working with the Intelligence Community, XTD-4 group members learn how to better focus their capabilities to provide the best technical support to national interests. The expertise provided by XTD-4 to the intelligence analysis process also helps inform LANL's other technical program offices about evolving technical priorities, based on evolving foreign nuclear explosives technology.

Through research managed across the Laboratory, XTD-4 continually improves the United States' ability to develop the gamut of nuclear counterterrorism measures, including the interdiction and disablement of improvised and foreign nuclear devices and the use of post-detonation forensics.

–Matt Kirkland, XTD-4 group leader

Department of Defense (DoD) and FBI personnel assess hazards at the working point during an exercise. They rely on technical advice from NNSA team members who recommend ways to disable a potential nuclear threat.

XTD-4's **AMY**BAUER

LANL staff member Amy L. Bauer is without question extraordinary. With a background in finance and mathematics, she has found ways to apply her skills and education to problems such as cancer, tuberculosis (TB), AIDS research, and national security.

Bauer grew up in Chicago and attended the University of Illinois. There she earned her B.S. and M.B.A. in finance and M.S. in mathematics. In 2007, she graduated with her Ph.D. in mathematics from the University of Michigan.

Her education in mathematics proved to be the most useful in real-life situations. According to Bauer, "I have a passion for applying mathematics to real-world high-impact problems."

Her passion led her initially to apply mathematics to biology and to a biology-related internship with LANL as a graduate student. In the Theoretical Division's Applied Mathematics and Plasma Group, Bauer worked on a mathematical model for angiogenesis, a process whereby new blood vessels form in a tumor in response to signals from some of the tumor's own molecules. Those signals tightly coordinate and regulate the cellular processes of angiogenesis.

Understanding how cells make biochemical signals can lead to new hypotheses for cancer treatments. Bauer's research suggested a way to combat cancer by reducing angiogenesis, thereby starving a tumor of its blood flow and rendering it harmless.

Bauer continued to focus on biology as a LANL postdoctoral researcher. In addition to her work on anti-angiogenesis, Bauer studied blood flow through the carotid artery, which provides the brain's main blood supply, and the co-infection of HIV (the AIDS-causing virus) and TB. Although TB is a contagious infection of the lungs, it can spread to other organs and has become a leading cause of death when linked with the HIV virus. Most people who have TB will recover from the disease, but it can stay suppressed for years. If a person with suppressed TB also contracts HIV, the TB can be reactivated.

Understanding how the TB-HIV co-infection works can help researchers design drug and vaccine therapies. Bauer made a mathematical model of an adaptive immune response to better understand how HIV induces TB's reappearance.

In 2010, Bauer accepted a position at the Laboratory's Improvised and Foreign Designs Group (XTD-4), where she is learning the physics and design of nuclear weapons. "Amy came to our attention when a search of the LANL postdoctoral database identified her as a mathematician with molecular-level modeling experience," says Matt Kirkland, XTD-4 group leader. Nuclear weapons systems, like biological systems, are highly complex at the molecular and smaller scales. Understanding the behavior of these systems requires mathematical modeling at those levels, so the skills and experience Bauer gained by modeling biological systems at the molecular level would apply to molecular-level, and smaller-scale, physics research in nuclear weapons materials and to the development of better weapon-simulation tools. "Amy has made significant progress learning weapon design physics and is mastering the computational tools used in our group," says Kirkland.

Bauer says that her shift from biology to weapons physics was "an opportunity to learn many fields." She now works on a broad range of nuclear counterterrorism projects, including post-detonation nuclear forensics, in which samples of radioactive debris from detonated nuclear weapons are gathered and studied. She also studies foreign nuclear weapons programs. She and her colleagues analyze information about foreign nuclear weapons to assess the weapons' potential nuclear yields and their vulnerabilities.

Along with her colleagues, Bauer has contributed to better ways of modeling certain foreign nuclear weapons. Kirkland says that her contribution will help refine our understanding of foreign nuclear weapon technology. "Amy will play an increasingly significant role in our nation's defense throughout her career," said Kirkland.

Beyond the Laboratory, Bauer has taken up a number of hobbies such as ski mountaineering, rock climbing, ski patrolling, yoga, photography, and drumming. She has also given back to the community. She is creator of the K2 Women's Weekend at Pajarito Mountain, a charity event that raises money for people diagnosed with breast or cervical cancer.

As for her future, Bauer wants to continue building her expertise in the physics and design of nuclear weapons.

–Ashley Martinez

Russian Lab Directors Tour LANL

On Sunday, June 5, Los Alamos National Laboratory Director Charles McMillan hosted a Laboratory tour for five Russian laboratory directors from the Russian State Nuclear Energy Corporation, Rosatom. The LANL tour followed the Laboratory Directors Meeting (LDM), hosted in California by Lawrence Livermore National Laboratory, June 2–3. The LDM includes the Russian directors and the directors of the three U.S. nuclear weapons laboratories. This was the first LDM held in seven years.

The directors toured LANL facilities that support three of this year's LDM topics, topics that could lead to more cooperation between Russian and U.S. laboratories: energy and environment, technical opportunities in nonproliferation and arms control, and basic science and technology. Moreover, the tour demonstrated LANL's openness and transparency, emphasizing the Laboratory's commitment to cooperation and collaboration in science and technology.

"This was the first time any Russians have toured DARHT," said Nancy Jo Nicholas, program director for Nuclear Nonproliferation and a technical host. "They were very impressed." DARHT, the Dual-Axis Radiographic Hydrodynamic Test facility, supports LANL stockpile stewardship efforts and weapons experimental activities by using x-ray pulses to produce multiple-view radiographic images of full-scale, nonnuclear weapon mockups as they implode.

The Russians also toured the Nicholas C. Metropolis Center for Modeling and Simulation and were given a PowerWall demonstration, where projections of high-resolution, three-dimensional images illustrated LANL's high-performance computing technologies. LANL's computing capabilities are significant and offer potential for lab-to-lab collaboration in nonsensitive missions, such as modeling climate change and the spread of infectious diseases.

Additionally, the group visited the Sigma Complex, LANL's materials processing and modeling facility. "They saw the extensive fuel development and metallurgical capabilities at Sigma—where work on low-enriched uranium fuel development for the Reactor Conversion program is done," Nicholas explained. As many Russian cities rely on nuclear reactors for electricity and heat, the Laboratory's techniques for converting reactors that use highly enriched uranium fuel to use, instead, low-enriched uranium fuel, thus posing a lower threat of proliferation, excited the visiting directors.

The Russians also visited the Los Alamos Neutron Science Center (LANSCE) and its Manuel Lujan Jr. Neutron Scattering Center. "The Russian directors were impressed with the number and quality of Russian researchers at LANSCE," reports Nicholas. The Laboratory employs Russian nationals as staff, visiting researchers, and postdoctoral researchers. "The researchers even gave their presentations in Russian."

The LDM is a key part of the Lab-to-Lab Program, in which U.S. and Russian laboratory directors work cooperatively in nuclear threat reduction efforts; materials protection, control, and accounting (MPC&A); and stockpile safety and security. In the 1990s, then LANL director Siegfried Hecker began the Lab-to-Lab Program and, in 1992, initiated the first LDM and exchange visit. Hecker was a keynote speaker at this year's meeting.

During this year's LDM, the laboratory directors explored the benefits of the previous relationship between the U.S. and Russian laboratories. For example, programs like the MPC&A, which improved policies, protocols, and practices for the security of nuclear materials, and the Warhead Safety and Security Exchange (WSSX), which increased technical cooperation for nuclear weapons safety and security, were created during the 1990s. Together, the directors identified key areas for science and technology cooperation. Hecker stated, "We both face serious challenges for nuclear weapon safety, security, and reliability in a no-test environment. In addition, there are issues with aging, life extension, remanufacturing, and certification of nuclear weapons. Together, we can work to lead the world in nuclear safety and security, reduce proliferation of nuclear weapons in problem states, and promote expansion of nuclear power without nuclear proliferation."

At the LDM, Ivan Kaminskikh, first deputy general director of Rosatom, said, "We are looking forward to a productive collaboration and have identified a number of areas of mutual interest."

Director McMillan (left) greets two of the Russian laboratory directors at LANL on June 5, 2011: Sergey Loparev (center), director of VNIIA (Automatics) and Valentin Kostyukov, director of VNIIEF (Sarov).

With the recent entry into force of the U.S. and Russian Agreement for Cooperation, as well as the New START Agreement, the timing is particularly apropos to revisit long-standing collaborations and consider new opportunities for cooperative Lab-to-Lab Program endeavors.

In the past decade, scientific cooperation between the United States and Russia had dramatically declined, due to factors such as political pressures and restrictions on nuclear weapons engineering. A letter of invitation for a new LDM from the National Nuclear Security Administration (NNSA) to Rosatom rejuvenated the Lab-to-Lab Program.

Anne Harrington, NNSA deputy administrator for Nuclear Nonproliferation, and Don Cook, NNSA deputy administrator for Defense Programs, facilitated the LDM. "This meeting lays the foundation for future cooperation in the years to come," said Harrington. "It reflects tangible progress in meeting President Obama's agenda and his vision for U.S. and Russian cooperation in key areas of nuclear nonproliferation, energy, and science collaboration."

According to Nicholas, the directors' exchange was extremely successful and "all parties viewed the discussions and site tours as constructive and informative." Consequently, each of the laboratories has committed to continue the record of success in cooperative scientific excellence. After the Russian visit, director McMillan noted his appreciation to the LANL employees who were involved in the visit, saying that the result would be "an enduring Lab-to-Lab relationship between our respective countries." The Russians also toured Sandia National Laboratories.

Following the LDM, Steven Chu, U.S. secretary of energy, and Thomas D'Agostino, NNSA administrator, traveled to the Russian Federation and toured Russian facilities where NNSA continues to work with the Russians to improve security. On June 8, Secretary Chu and Rosatom director General Sergey Kiriyenko signed a joint statement on nuclear cooperation, committing both sides to developing "the legal framework, including principles of cooperation, necessary to expand joint activities between nuclear research laboratories, institutes and sites."

–Marisa Sandoval

Students Joshua Engle, Joshua Cerimele, Dale Becker, and mentor B.J. Balasubramaniam (left to right) inspect a camera and gearing system Becker designed for a wind turbine blade. –B.J. Balasubramaniam (LANL)

As the U.S. military grows in technological sophistication, it is fitting that some of its future leaders are getting a four-to-six-week full-immersion experience at Los Alamos National Laboratory. This summer, through the Service Academies Research Associates (SARA) Program, the Laboratory hosted 17 cadets and midshipmen from the military academies at West Point, Annapolis, and Colorado Springs. LANL offers these students hands-on learning with the Laboratory's national security science and technology.

Not What They Expected

While at Los Alamos, the 2011 SARA students worked directly with Laboratory principal investigators, assisting with ongoing research and development projects related to national security.

"There are a lot of summer training programs out there, but most are class-like," said U.S. Air Force cadet Dale Becker, who spent his Los Alamos time with the Physics Division's Extreme Fluids Team. "This was nothing like I expected. It was real life, not just theoretical. I was given a problem and had to come up with an elegant solution."

Jon Ventura of the Laboratory's Principal Associate Directorate, Weapons Programs, and Harald Dogliani of the Principal Associate Directorate for Science, Technology, and Engineering, helped relaunch this year's cadet program after a five-year hiatus. "We put them to work on real problems that have a direct bearing on each student's academic program—and on the work of the Laboratory," says Ventura.

Real Work

The 2011 SARA participants attended classes and lectures at the Laboratory. For example, the eight students assigned to the Computational Physics Division in the Laboratory's Weapons Directorate were instructed in how to use the Monte Carlo N-Particle code. This is the premier computer code for simulating how radiation interacts with matter. It is used to support many applications, including weapons work, fission and fusion reactor design, determination of dosage safety for radiation workers, and medical physics.

Some students also visited the Nevada National Security Site to see firsthand its experimental capabilities and activities, including the Device Assembly Facility that supports the Stockpile Stewardship Program's subcritical experiments.

The students were drawn to the program for the chance to take part in real work. The students' time was spent on genuine research projects across a broad spectrum of disciplines: thermodynamics, materials science, computer modeling, space science, and alternative energy technology, to name just a few.

One student, for example, used Monte Carlo code modeling to investigate neutron flux (a measure of the intensity of neutron radiation) in relation to materials that might be used in a nuclear reactor. Others, also assigned to the Computational Physics Division, worked with the fundamentals of nuclear weapons and learned about high explosives, methods of detection for monitoring nuclear tests, and the effort involved with maintaining and validating the performance of the nuclear weapons stockpile (stockpile stewardship).

One naval midshipman said he was most impressed by the applicable experience gained "outside the classroom," a sentiment expressed by many of his colleagues who were pleasantly surprised by the opportunities the Laboratory offered.

"It was interesting to see how the research aspect works," said another naval midshipman. "Before coming to Los Alamos, I didn't know what researchers actually did. There were so many interests available to us here," a fact that Balakumar (B.J.) Balasubramaniam, who mentored students in the Physics Division's Neutron Science and Technology group, attributes to the Laboratory's multidisciplinary setting. At the Laboratory, SARA students are offered a unique opportunity for interaction with research leaders in many fields. "There is a cross-pollination between multiple areas here," he says, "and that is what makes the Laboratory beautiful."

Students placed in the Physics Division with the Extreme Fluids Team applied high-resolution diagnostics to problems of fluid dynamics in extreme environments. The need for alternative energy sources is considered an aspect of national security, so students with the Extreme Fluids team focused some of their time on ways to predict, mitigate, and control failure rates in wind turbines, thereby improving efficiency in wind-energy generation.

Another student partnered with Los Alamos scientist Tom Vestrand to work with RAPTOR, the Laboratory's robotic optical telescope array that independently scans the universe and can also be used to detect objects orbiting Earth. Others worked on a meteor's potential effect on an urban community or studied optical phenomena and blindness caused by improvised explosive devices.

The Laboratory's Bioscience Division also welcomed SARA students, one of whom, Calla Glavin, worked with developers of the Laboratory's award-winning Ultrasonic Algal Biofuel Harvester, which concentrates the cells of algae so their lipids—fatty, energy-rich molecules—can be extracted and used for making biofuel. Glavin helped further this technology, which was recently featured in *Algae Industry Magazine*, an online publication.

A Parallel Way to Defend the Country

Glavin reported that her Army advisor was a former SARA student who described the program to her as "phenomenal." At the end of her summer tenure, Glavin could freely concur that LANL provides a truly unique setting, and the program is a parallel way to defend her country—through national security science.

The interest in SARA at the Laboratory continues to grow. Tim Goorley, another SARA mentor, wishes the mentor-student relationship could continue past the summer months. "I'd like to see this program develop in a way that allows the students to continue working with us even after they go back to their academies."

Hit the Ground Running

The students were impressed with the research and capabilities of the Laboratory, and in turn, they impressed the staff members who worked with the students. "I was surprised at their level of interest," says Avneet Sood of the Computational Physics Division, speaking of the students he worked with. "We're using gold-standard codes here, and their enthusiasm had everyone bending over backwards to accommodate them."

Calla Glavin (left), a SARA student from West Point, and Taraka Dale, a researcher in the Bioscience Division, working on ways to measure the lipids harvested from algal cells. –L. Sanchez (LANL)

"They were all really passionate and disciplined," says Balasubramaniam. "They got here at 7 a.m. every day."

An often-repeated accolade from the students' Laboratory mentors was that they arrived ready to engage and took initiative, with very little nudging required—even though the problems they took on were new to them.

"We threw them in and told them it'd be a bumpy ride," says Sood, "but these guys are at the top of their class, and they worked very well together." They came to the Laboratory with good skills and hit the ground running.

And they had new ideas. "I had a very specific problem that our student was very capable of working on," noted another mentor. "He had three solutions in mind right from the beginning."

"We benefitted from them, and they'll benefit from their experience here," says Balasubramaniam.

Experiences Will Stay with Them

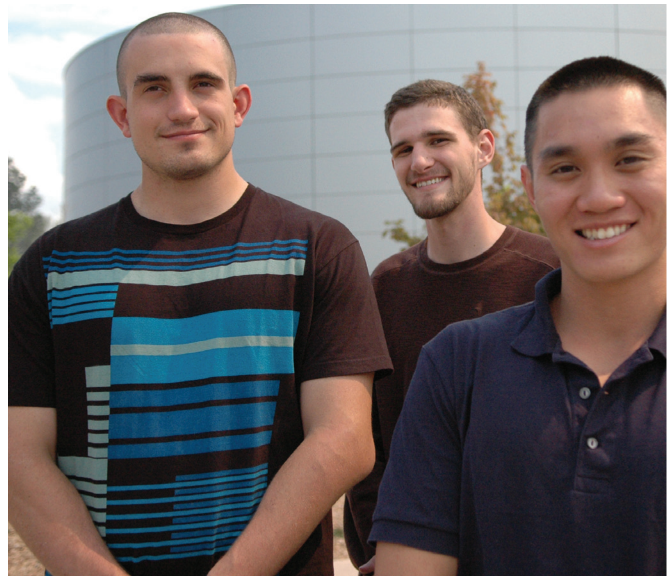
Ventura anticipates that the program will foster a long-term interest in science and technology, but he also thinks it will directly influence how the students approach their military careers. "In the future, many of these students will be officers, maybe even in the military's upper echelon, with a hand in shaping policy and making decisions about how problems get solved. They'll remember what they learned about the Laboratory's diverse capabilities and cutting-edge technology, and they'll know how that expertise can be applied to a host of national security challenges."

Sood agrees. "I've worked in a lot of intelligence programs and thought, these guys don't know what we do. Why not start these interactions as early as possible?" SARA students are "the next generation of leaders. Now they know there are assets and capabilities at LANL that they can rely on."

The Los Alamos experience will stay with them, says Ventura. "Our mentors and managers were deeply impressed and reassured that the next generation of military leaders will be well equipped to deal with whatever national security challenges confront us as a nation."

The students' experience was courtesy of the National Nuclear Security Administration's Military Academic Collaborations (MAC) program. MAC provides some of the funding to support students and faculty from U.S. military academies and ROTC (Reserve Officers' Training Corps) programs in summer assignments at NNSA sites, including the Los Alamos, Sandia, and Lawrence Livermore national laboratories.

–Kirsten Fox



SARA participants Daniel Lehman, Charles Schultz, and Huy Vo (left to right) visit LANL's Pentagon Memorial. -K. Roark, LANL

Laboratory Division	Laboratory Mentor	SARA Student
INTELLIGENCE & SPACE RESEARCH	Tom Vestrand	Will Beason (West Point)
BIOSCIENCE	Murray Wolinsky & Andrew Bradbury	Kelley Cassidy (West Point)
	Lance Green	Christopher Wallace (West Point)
	Babetta Marrone	Calla Glavin (West Point)
COMPUTATIONAL PHYSICS	Tim Goorley & Avneet Sood	Charles Schultz (West Point)
		Huy Vo (West Point)
		Andrew Haines (Annapolis)
		Daniel Watts (Annapolis)
		Brendan Hanlon (Annapolis)
		Robert Simpson (Annapolis)
	John Sarracino & Avneet Sood	Daniel Lehman (West Point)
THEORETICAL DESIGN	Christina Scovel	Graham Miller (Annapolis)
PHYSICS	Kathy Prestridge	Katharin Taylor (Annapolis)
	B.J. Balasubramaniam	Joshua Engle (Annapolis)
	Kathy Prestridge	Dale Becker (Colorado Springs)
		Christopher Luke (Colorado Springs)
WEAPON SYSTEMS ENGINEERING	Mike Murphy	Joshua Cerimele (Colorado Springs)

MY YEAR AT LOS ALAMOS

Lt. Col. **MICHAEL** PORT, USAF

As a career Air Force nuclear operations officer, I saw having a year's fellowship at Los Alamos National Laboratory as the pinnacle of my academic career. For senior Air Force officers, the purpose of this fellowship is to gain a working knowledge of weapons architecture and to experience weapons-complex operations firsthand. After my arrival in July 2010, I quickly appreciated the monumental efforts required of and performed by LANL personnel to help ensure that the president of the United States always has a safe, secure, and effective nuclear deterrent.

To come here 20 years after my career began and learn about the "business end" of our weapons systems refreshed lessons-learned, then took them to the next level. As an intercontinental ballistic missile (ICBM) launch officer, I was also excited to be assigned to the B61 bomb team and to be afforded the opportunity to step outside my "comfort zone."

Prior to coming to LANL, I believed Laboratory operations to be cut-and-dried science and engineering—impressive in and of themselves, but with little room for individuality and creativity. But as I visited the Laboratory's plutonium science and manufacturing facilities (TA-55), the Los Alamos Neutron Science Center, the Laboratory's explosives research facilities, the Sigma Complex, the Dual-Axis Radiographic Hydrodynamic Test facility (DARHT), to name a few, I learned there is much more taking place. There are things a machine can do, but it takes the craftsman behind the controls, or with their hands in the glovebox, to bring an engineering marvel to fruition.

In short, LANL is an amalgamation of science, engineering, and art.

Furthermore, I was impressed and surprised about the length of time required to make someone a weapons artisan. I met many people at LANL who, due to the specialized nature of the tasks they perform, require more than two years of on-the-job training and study before being allowed to work at their specialty. By comparison, the Air Force can take brand-new officers and make them certified deputy missile combat crew commanders in six months. This includes more than four months of intensive training at a specialized school, followed by more than a month of intensive home-unit familiarization training. Once completed, the officers are certified to perform Minuteman weapon-system operations.

Frankly, before my fellowship at LANL, I was skeptical of the science of stockpile stewardship—that it could ensure the longevity, credibility, and robustness of our nuclear deterrent force. Without "seeing the earth move" in Nevada, I couldn't be certain our nuclear stockpile would work. However, the sheer brilliance of what I witnessed at DARHT, for example, and at the Nicholas C. Metropolis Center for Modeling and Simulation, allayed my concerns. This kind of science is a testament to LANL's out-of-the-box thinking.

I was also very impressed with how LANL support of DoD operations goes beyond stockpile stewardship. For example, LANL personnel train frontline forces on how to safely identify and then disarm improvised explosive devices.

Why are LANL weapons-related programs so critical to the national security? One word: deterrence. There are pundits who believe that nuclear weapons are anachronistic relics of the Cold War. The Obama administration thinks differently. The president vowed to maintain our nuclear deterrence by making significant investments in both the infrastructure and personnel of the weapons complex. These investments are critical for the continued testing and evaluation of the nation's stockpile, as well as for attracting the best and brightest personnel into the weapons complex.

For all the engineering, science, and art that take place at LANL to ensure our national security, I thank you. My year of study went by too quickly. It is an honor to have served with you. Be assured that I am grateful for the knowledge that I gleaned and for the lasting friendships I made.

New Video Chronicles **Two Decades** of **Successful** Stockpile Stewardship

Miles O'Brien

"Hello, I'm Miles O'Brien. Welcome to Los Alamos. As you know, this is the birthplace of the atomic bomb. Over the years, the weapons devised here have literally changed the course of human history. And in fact, now, it is no longer pie-in-the-sky thinking to imagine a world without nuclear weapons. So what does that mean in a place like Los Alamos? It's not what you think."

So begins "Heritage of Science," a 15-minute video produced by Los Alamos National Laboratory. The video chronicles two decades of Laboratory work in national security science and stockpile stewardship. It shows, in greater detail that ever before, the work performed at Los Alamos for the Stockpile Stewardship Program, including the science behind how weapons work, the changes that occur in weapons systems as they age, the manufacturing of replacement components, and the initiatives that keep an experienced workforce intact. The video also discusses the Laboratory's role in nuclear nonproliferation—minimizing the spread of nuclear weapons, fissile material (materials capable of sustaining a nuclear chain reaction), and weapons-applicable nuclear technology and science.

"Stockpile Stewardship is one of the nation's premier scientific and engineering programs," notes Bret Knapp, the acting principal associate director of the Weapons Program Directorate. "Los Alamos plays a key role in this program. The Laboratory is the design agency for the W76, W78, and W88 warheads, as well as for the B61 gravity bomb. Los Alamos is also the production agency for the W88 pit [the fissile core of a nuclear weapon's physics package]. Combined, these systems constitute the majority of the nation's nuclear deterrent."

Los Alamos does not stockpile nuclear weapons, nor does the Laboratory manufacture them. Since 1992, the United States has not conducted any full-scale nuclear tests. To ensure that, without such testing, the nuclear weapons in the stockpile will perform as designed, Los Alamos scientists rely on advanced computer simulations, hydrodynamic tests, and subcritical experiments.

Using conventional explosives, Los Alamos scientists perform subcritical experiments to test the basic properties of plutonium driven to high pressures. Subcritical experiments do not generate sustained nuclear chain reactions and thus do not produce nuclear explosions.

As explained in the video, Los Alamos computer scientists have developed three-dimensional, full-motion computer models that can predict the behavior of weapons materials and components—and ultimately, the overall performance of a nuclear weapon. These simulations combine data gleaned from past nuclear tests and from hundreds of individual experiments on everything from the most basic materials (such as metals, plastics, and foams) to the most complex weapons components, such as plutonium and high explosives.

Los Alamos scientists also perform hydrodynamic tests, using high explosives and powerful electrical currents to create some of the unique conditions inside a nuclear weapon during the nuclear explosion, including the liquefying of plutonium (hence the term, hydrodynamic). They then take x-ray snapshots to capture these processes, which take place in a millionth of a second. The x-rays enable researchers to study the shapes, densities, and distribution of materials during detonation.

"I believe that this video will help viewers gain a deeper understanding of the complexity behind Stockpile Stewardship, the elements that make it up, and its technical challenges," says John Bass of the Laboratory's Information Resource Management Division. Bass served as the production's line producer and director. "They will also be shown the part nuclear weapons play in the world today and the trends toward managing the stockpile for the future—all this on high-definition video."

"The taxpayers deserve to understand how Los Alamos uses the significant financial resources provided by the government to help ensure the security of the United States," adds Jon Ventura of the Laboratory's Principal Associate Directorate, Weapons Programs. "We hope viewers gain a better understanding of the increasingly complex technical challenges confronting the nation's security and subsequently Los Alamos as it seeks to sustain the nuclear deterrent. The film highlights some of the unique technology (experimental and computational) and technical excellence resident only at Los Alamos. We also hope that viewers will get a sense of the commitment of Los Alamos staff and management to meeting the nation's security challenges."

The video also shows how the role of nuclear weapons in the national security of the United States continues to evolve. As the video notes, it takes a weapons laboratory to understand a weapons laboratory. As other nations may decide to develop nuclear weapons, it takes the expertise and the facilities of a weapons laboratory like Los Alamos to understand what those nations are doing.

"The broadly embraced goal of moving toward a world free of nuclear weapons will require the talents and ingenuity of Los Alamos," says Joe Martz of the Seaborg Institute. "The work of Los Alamos not only is consistent with this new landscape, but also is essential in moving toward this goal."

"It's my hope that visitors to the Bradbury Science Museum learn that the people of Los Alamos National Laboratory are our greatest strength," says Kevin Roark, the media relations specialist for the Principal Associate Directorate, Weapons Programs, who worked on the script and served as one of the project's producers. "I would like everyone who sees the new video to maybe realize that although the specific work we do has changed significantly over the years, our role today is essentially the same as it's always been: to apply the best science and technology available to solving the toughest national security problems that are out there."

Hosting the video is Miles O'Brien, a former CNN broadcast news journalist best known for this coverage of the U.S. space program. O'Brien has his own production company and creates stories for the PBS New Hour, the Discovery Science Channel. and the National Space Foundation. Interviewed on the video are United States Secretary of Defense William Perry, Laboratory Director Charles McMillan, and Los Alamos scientists, including David Funk, Tim Goorley, Deniece Korzekwa, Frank Merrill, Nathaniel Morgan, and Kim Scott.

"Heritage of Science" will be screened at the Bradbury Science Museum's Weapons Theater every day that the museum is open. The video will be shown every 20 minutes. More than 80,000 people visit the museum each year. The Laboratory is also studying the possibility of making the video available on the Web.

The museum is located at 1350 Central Avenue in downtown Los Alamos. It is open Tuesday through Saturday from 10 a.m. to 5 p.m. and Sundays and Mondays from 1 p.m. to 5 p.m., every day except Thanksgiving, Christmas, and New Year's Day. Admission is free. For more information, visit www.lanl.gov/museum/.

–Octavio Ramos Jr.

Proposed National Park Will Honor MANHATTAN PROJECT

In July the Obama administration announced that it will ask Congress to establish a new three-unit national historical park to preserve remaining U.S. resources used in the Manhattan Project, the secret World War II effort to develop atomic bombs. The Manhattan Project National Historical Park would include wartime facilities and sites in Los Alamos, New Mexico (design and assembly of the wartime bombs); Oak Ridge, Tennessee (uranium enrichment); and Hanford, Washington (plutonium production).

"The Manhattan Project was one of the most important events in our nation's history. I believe it is important for us to acknowledge its legacy, and a National Historical Park is the best way to achieve that goal," says Jeff Bingaman, U.S. senator from New Mexico. The proposed park has received strong support from New Mexico's federal Congressional delegation, including Senators Bingaman and Tom Udall, retired senator Pete Domenici, and Congressman Ben R. Lujan. Work toward the goal began in earnest in 2004, when Senator Bingaman and Representative Doc Hastings of Washington co-sponsored legislation authorizing a National Park Service feasibility study.

During the study the Park Service reported strong public approval for conserving the Manhattan Project sites.

Says Senator Udall, "Telling the story of the Manhattan Project will serve as a useful educational tool, especially for those generations who didn't live through World War II or the Cold War. . . . I am pleased that we are now taking the next important step toward preserving this history for future generations."

In Los Alamos, if the park becomes reality, parts of the project's story will be told through sites still on Laboratory land, specifically those associated with work leading to the 1940s plutonium implosion bomb (Fat Man) and the gun-type uranium bomb (Little Boy). In town, park sites will include the former residence of

J. Robert Oppenheimer, scientific head of the project, and Fuller Lodge, the social center for Manhattan Project scientists during the war.

"DOE will be a major player in the development of the park management plan," says Ellen D. McGehee, the Laboratory's historic buildings manager. In announcing the proposal this summer, Interior Secretary Ken Salazar explained that DOE would continue managing and operating the Laboratory facilities associated with the Manhattan Project, while the National Park Service would provide interpretation and education in connection with those resources.

–Ashley Martinez

Revival Meetings: Return of the Weapons Working Group

A worker checks a laser diagnostic used on the Barolo subcritical experiment, recently conducted at the U1a underground test complex in Nevada. Barolo is one of the myriad experiments discussed at Weapons Working Group meetings.

Weapons Working Group (WWG) meetings at LANL have served as a classified forum for discussing nuclear weapons issues for more than 50 years. In April 2011, after an 18-month hiatus, monthly WWG meetings were resumed with an expanded scope and new format that will keep the scientists and engineers in the Los Alamos weapons community up to speed with the broad range of experiments that feed into the Nuclear Weapons Program.

"We are attempting to draw in the enormous wealth of scientific and engineering expertise that exists throughout the Laboratory," says WWG coordinator Mark Potocki of X Theoretical Design (XTD) Division, Primary Physics Group (XTD-3). "I encourage everyone in the weapons community to participate in the meetings."

WWG meetings are an interdisciplinary forum for disseminating the scientific and technical information that is crucial to the modern Nuclear Weapons Program.

The meetings provide an interactive setting at which experimental plans and results can be shared with a diverse and knowledgeable audience. The goal is not only to inform the weapons community but also to capture timely feedback from people with different technical backgrounds and viewpoints. Their input can aid the experimenters and analysts and often serves as a "reality check" about what experiments do, or do not, reveal.

The Nuclear Weapons Program conducts a wide range of experiments that generate vital data for the Stockpile Stewardship Program and the Laboratory's global-security efforts. Weapons-relevant experiments are now conducted at dozens of facilities across the nuclear weapons complex. These experiments range from small-scale tests designed to isolate a physics effect or measure a fundamental property of a particular material to full-scale experiments used to study the complex physics of implosions in realistic weapons configurations.

"It's difficult to keep up with all the experiments being done today," says Michael Bernardin, leader of XTD Division. Bernardin played a leading role in reviving the WWG. "The new WWG meetings are meant to provide a 'one-stop shopping' experience, a place to learn about upcoming experiments and hear fresh results."

Each WWG meeting begins with 10-minute briefings from three Laboratory leaders who have their fingers on the pulse of the experimental programs: Dave Funk, Weapons Experiments Division leader; Rick Martineau, program manager for Science Campaign 2, Dynamic Materials Properties; and Doug Fulton, Physics Division leader.

Funk gives updates on hydrodynamic tests (tests of nuclear weapons without their fissile materials) at both Los Alamos and Lawrence Livermore national laboratories. Martineau covers plutonium experiments conducted at multiple sites across the nuclear weapons complex, and Fulton presents material-dynamics experiments conducted at the Los Alamos Proton Radiography facility and elsewhere. Fulton also covers high-energy-density experiments executed on the University of Rochester's Omega laser, Livermore's National Ignition Facility, and Sandia National Laboratories' pulsed-power machine, called Z.

The briefings are followed by a 40-minute feature presentation delving into topical issues in detail. For example, WWG audiences have recently heard from Laboratory Fellow Gary Wall, XTD-3, about experiments being conducted for the Scaling and Surrogacy project, and from Laboratory Fellow John Pedicini, XTD-3, about the designs being considered for extending the life of an Air Force weapon.

WWG meetings have long been an important communications channel for the Nuclear Weapons Program. Harold Agnew, who would later become the Laboratory's third director, founded the WWG in 1960 as the major decision-making committee for warhead development. WWG meetings were held through the end of the Cold War to keep the weapons workers informed about the planning, execution, and results of underground nuclear tests. When nuclear testing was halted in 1992, the focus of the meetings shifted to hydrodynamic and subcritical tests (tests of nuclear weapons with their fissile materials sufficiently reduced to avoid a nuclear explosion). Other topics, including specific materials science issues and the evaluation of missile flight tests, were also covered.

Agnew also established the process for documenting the meetings in written form, a practice that continues to this day. More than 540 WWG meetings have been held, leaving behind an extensive historical archive of valuable nuclear weapons information.

WWG meetings are held on the first Thursday of each month in the Strategic Computing Complex auditorium. The meetings are classified, so attendance is restricted to Q-cleared Los Alamos employees with Sigmas 1–11. Anyone interested in receiving email announcements of upcoming WWG meetings is encouraged to contact Mark Potocki (potocki@lanl.gov, 667-4634).

–Craig Carmer

Students Intern at **National Security Science** Magazine

Ashley Martinez
Undergraduate Student,
University of New Mexico

Students wanting to work at Los Alamos National Laboratory are in luck. The Laboratory is a major employer of students—about 1200 in 2011. The starting pay for students is over $13 an hour and is dependent on their level of education.

"The Lab provides great opportunities for experiencing real-world problems in a variety of different scenarios," Richard Rivera told me. Rivera is a student at New Mexico Institute of Mining and Technology in Soccoro. Rivera worked this summer as an intern in the Network Infrastructure Group (NIE-1), which designs and installs the Laboratory's local area networks and provides access to Laboratory computing resources. As a student in electrical engineering, Rivera found his NIE-1 assignments perfectly relevant to his studies.

I have had four internships, beginning in 2008 at the end of high school. I worked for NIE-1 for three summers and did independent mapping of servers using a program called Spectrum. Mapping out servers gives NIE-1 a picture of what is in server closets—useful information for when people respond to trouble calls. After a few semesters at the University of New Mexico in Albuquerque, I decided to study professional writing and found a new student position in the Information Resource Management Division, Communication Arts and Services (CAS) group. CAS offered me work experience relevant to my degree.

I was given the opportunity to work with *National Security Science* (*NSS*) magazine. Working with *NSS* has given me experience in professional writing and editing. I now have five pieces of writing published at the Laboratory. I have also learned how much work it takes to publish a professional magazine.

I learned a great deal from my mentors at CAS, but the best part of my LANL experience was getting to see my own writing in print. It is an amazing feeling to see your own work go into print for the world to read.

–Ashley Martinez

This summer *NSS* had the opportunity to work with two students. Ashley Martinez and Marisa Sandoval made significant contributions to the magazine.

Marisa Sandoval
Graduate Student,
University of Arizona

WASTE DISPOSAL at LOS ALAMOS THEN AND NOW

In 1943, Allied victory remained far from certain, and the specter of an Axis nuclear weapon loomed. The race to develop the first atomic bombs at Los Alamos involved the manufacture and handling of many hazardous materials. The exigencies of war and paucity of federal regulations, however, rendered the disposition of hazardous materials a lower priority. The original war-era Chemistry and Metallurgy building, for instance, did not have a filtration system, so small quantities of hazardous materials, including plutonium, were released directly into the atmosphere. Untreated radioactive liquids were released directly into nearby canyons, and solid waste was simply buried in the surrounding uninhabited area. Under wartime circumstances, these practices were considered both necessary and acceptable.

After the war, improvements could be made in waste management practices. The facilities constructed toward the end of the war at "DP Site" as a replacement for the original Chemistry and Metallurgy building included simple filtration systems that significantly restricted the release of airborne radionuclides. Radioactive waste treatment facilities were built, and hazardous materials previously dumped into pits were retrieved and buried in much safer containers. As the science of waste management improved, the Laboratory made steady progress in managing hazardous waste materials throughout the early years of the Cold War.

The 1970s witnessed the rise of environmental science and regulation and brought an enhanced Laboratory commitment to new methods for protecting the environment in and around Los Alamos. For example, in addition to building more-sophisticated treatment facilities, the Laboratory could more closely monitor the creation and disposition of harmful materials, identify and correct environmental deficiencies, and provide more-accurate data to the public and decision makers.

Today, the Laboratory remains committed to minimizing its impact on the environment. In addition to constantly improving environmental monitoring and hazardous waste disposition practices, the Laboratory has meticulously restored several waste sites by removing more than 80,000 cubic yards of contaminated materials. The complete remediation of all LANL sites is currently scheduled for completion in 2015.

Handling hazardous waste materials is a top priority, and they are disposed of in the safest and most effective ways available. Indeed, the Laboratory's protocols for handling hazardous waste materials often exceed the requirements of national, state, and local regulations. For example, the new Chemistry and Metallurgy Research Replacement (CMRR) facility, where the Laboratory's analytical chemistry, materials characterization, and metallurgy research and development will be conducted, will meet or exceed all current safety and environmental protection standards. As better science and technology are applied to mitigating the hazardous waste legacy of World War II and the Cold War, the environmental damage of the past is diminished and a more sustainable environment is secured for the future.

–Alan Carr

National Security Science
Mail Stop A142
Los Alamos National Laboratory
Los Alamos, NM 87545
Email: NSSPub@lanl.gov
Tel: 505-667-7814
www.lanl.gov/orgs/padwp/

Presorted Standard
U.S. Postage Paid
Albuquerque, NM
Permit No. 532

With deep appreciation, the men and women of Los Alamos National Laboratory dedicate this issue of *National Security Science* to all those who, directly and indirectly, valiantly defended the Laboratory and town site from the Las Conchas wildfire, the largest wildfire in the history of New Mexico. Your bravery, vigilance, and tireless efforts kept us secure, making it possible for us to rapidly return to the business of helping keep the nation secure.

Raspberries are already returning to Los Alamos out of the ashes of the Las Conchas wildfire.

Issue 3 October 2011 • LALP-11-015

National Security Science highlights work in the weapon and security programs at Los Alamos National Laboratory. Current and archived issues of *NSS* are available at http://www.lanl.gov/orgs/padwp/. *NSS* is unclassified and funded by the Weapons Program Directorate.