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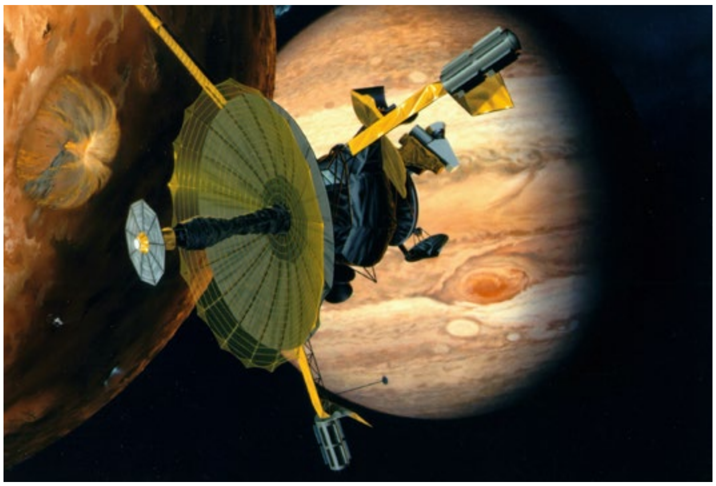
America 250 YEARS

Sandia gets Galileo to Jupiter



YO, IO! — Artist rendering of NASA's Galileo spacecraft flying past Jupiter's moon, Io. Galileo would make several close approaches to the volcanically active moon during its orbit around Jupiter. **Photo courtesy of NASA**

Labs' expertise keeps spacecraft alive in intensely radioactive Jovian atmosphere

By **Magdalena Krajewski**

NASA's Galileo mission to Jupiter was one of the most successful planetary explorations in history, and Sandia helped make it possible.

Launched in 1989, Galileo was the first spacecraft to orbit one of the outer planets. It traveled 2.8 billion miles before it disintegrated into the atmosphere of Earth's gigantic neighbor in 2003.

"We learned mind-boggling things," Galileo project manager Claudia Alexander said in a 2003 Lab News article. "This mission was worth its weight in gold."

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A letter from the Labs Director

On July 4, 2026, the United States marks 250 years since the signing of the Declaration of Independence. It's a time to reflect on our nation's history and on the generations of Americans who have served this country and advanced the ideals upon which it was founded.

For 78 of those 250 years, Sandia has answered President Harry Truman's call to "render exceptional service in the national interest." We have helped shape U.S. history through scientific and technological achievements. We have stepped forward when our nation needed us most, solving hard problems, responding to emerging threats and making the impossible possible.

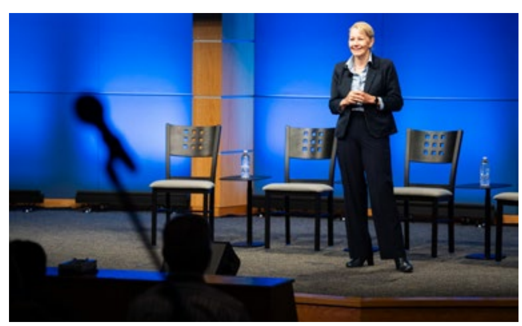
The stories in this special edition remind us that Sandia's impact extends far beyond our campuses. Repeatedly, the nation has turned to us for expertise and a willingness to take on challenges that few others can.

We can take pride in the role Sandia has played in our nation's story. New challenges lie ahead but our purpose remains unchanged. We will continue to serve the nation with the same sense of mission and commitment that has defined Sandia from the beginning.

Everything we accomplish starts with our people. You will see yourselves and your work reflected in the impressive collection on these pages. As our nation marks 250 years of history, these stories remind us that each generation is called to contribute something of its own.

The Sandians who came before us did exactly that, and now it's our turn to carry this mission forward and add to the American story. It is still being written and, in so many ways, Sandians continue to help write it.

Laura McGill
Laboratories Director
Sandia National Laboratories



LOOKING AHEAD — Labs Director Laura McGill speaks to a group at an Employee Experience event in April. **Photo by Craig Fritz**

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EDITOR'S NOTE: Please send your comments and suggestions for stories or for improving the paper. If you have a column (500-800 words) or an idea to submit, contact the Lab News editor at labnews@sandia.gov.

Aires Tide debuts on National Mall to celebrate America250

AIRES TIDE — Sandian Ricardo Sena looks at an 11-foot-tall, 3D-printed model of Aires Tide, a new concept for fast-tracked flight tests, during an event at Steve Schiff Auditorium on Jan. 21. A similar metal version is on display at the Great American State Fair in celebration of America's 250th birthday. Learn more about Sandia's contributions to Aires Tide and its successful drop test in May. **Photo by Craig Fritz**

Galileo to Jupiter

CONTINUED FROM PAGE 1

READY FOR LIFTOFF — A 1989 photo shows the launch of Space Shuttle Atlantis, carrying Galileo into Earth's orbit. **Photo courtesy of NASA**

Who wants to go to Jupiter?

Talk of exploring the largest planet in the solar system and its many moons dates back to as early as 1959, but serious planning did not begin until more than a decade later. And once it did, it became clear that Jupiter's intense radiation belts would make the mission exceptionally challenging, if not impossible.

That's when NASA called in Sandia and its expertise in radiation-hardened microelectronics. Core to its mission, the Labs had spent decades ensuring that electronics for nuclear weapons could withstand intense radiation environments. And now it would take those lessons "to infinity and beyond," to quote "Toy Story's" Buzz Lightyear.

"At the time, Sandia was the only organization capable of designing, fabricating and qualifying the critical parts needed for the spacecraft," Paul Dressendorfer, one of the Sandia engineers who led the effort, said in 2003.

In 1980, Sandia announced it had been selected to supply radiation-hardened memory and processor chips for Galileo to NASA's Jet Propulsion Laboratory. The following year, the Labs began supplying electronic components capable of withstanding a radiation dose of up to 50,000 rads.

A late upset

In 1982, Galileo project officials identified another problem that required a pivot late in the game. Four spacecrafts that had flown past Jupiter in the 1970s had encountered problems later attributed to Single Event Upsets — errors in memory cells caused by highly charged particles.

The challenge now was to build chips that were not only radiation resistant but also immune to SEU events. Sandia scientists and engineers did just that, and in 1985 delivered more than 10,000 radiation-hardened, SEU-immune chips to JPL.

"Sandia's work in this area was absolutely crucial for the success of the mission," Project Galileo Director John Casani said in 1985. "SEU was not a well understood phenomenon early in the project. Sandia's quick solution to the problem avoided the necessity to develop a new computer for the spacecraft at a very late date."

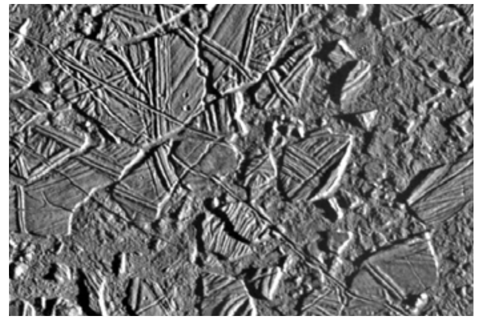
'Mind-boggling' discoveries

Galileo launched aboard Space Shuttle Atlantis on Oct. 18, 1989. Six years later it arrived at its destination, where it would spend the next eight years in orbit, circling Jupiter 35 times before being intentionally guided into the Jovian atmosphere, where it disintegrated on Sept. 21, 2003.

The Jet Propulsion Laboratory noted at the time that the "hardy spacecraft endured more than four times the cumulative dose of harmful radiation it was designed to withstand."

Over its 14-year odyssey, Galileo returned 30 gigabytes of data and 14,000 pictures.

Among those "mind-boggling" discoveries was the subsurface ocean of Europa, one of Jupiter's four largest moons, first spotted in 1610 by the spacecraft's namesake, Italian astronomer Galileo Galilei. Beneath Europa's icy crust lay a vast liquid water ocean, twice the size of all the oceans on Earth, though intensely salty and packed with radionuclides. The ocean is kept liquid by heat generated by Jupiter's gravitational pull, making Europa one of the most promising places in the solar system to search for life beyond Earth.



SPLASHY DISCOVERY — One of the mission's most significant findings was that a vast liquid ocean existed below Europa's icy crust, pictured here. **Photo courtesy of NASA**

Galileo also found that Io was the most volcanically active body in the solar system, that Ganymede possessed its own magnetic field, and that both Ganymede and Callisto also might harbor subsurface oceans. An atmospheric probe dropped into Jupiter's clouds in 1995 sent back direct measurements before being crushed by pressure — data that could not have been gathered any other way. Taken together, these discoveries have fundamentally changed how scientists think about where life might exist in our solar system.

Not just any Labs

In the decades since, Sandia has continued to play a role in space exploration, but Galileo is remembered as the Labs' most direct and celebrated contribution. Perhaps Dave Myers, former deputy director of what is now known as Microsystems, Engineering, Science and Applications said it best in a 2001 Lab News article: "It's not like just any microchips would work in the Jovian radiation field."

He was right. Sometimes when the nation needs something extraordinary, the only place to turn to is Sandia.

Behind the scenes of Deepwater Horizon

Science, collaboration and innovation

By **Krystal Romero-Martinez**

WHEN DISASTER STRIKES — In a May 2010 photo, oil surfaces above the Deepwater Horizon wellhead. Oceanographer Ed Levine said, "With all of the skimmers in the world out there, you might as well be using thimbles. **Photo courtesy of National Science Foundation**

On April 20, 2010, the BP Macondo well experienced a blowout, causing oil and gas to rise up to the Deepwater Horizon production platform. When the oil spill erupted, most people saw the tragic images: flames against the night sky, the collapsing oil rig, crude oil spreading across the Gulf of Mexico and the devastating loss of 11 lives. Behind the scenes, scientists and engineers from multiple DOE national laboratories, including Sandia, were called upon for their expertise in understanding what happens when things go wrong in extreme, high-risk environments.

Call for expertise

Many of these scientists and engineers study pressure, explosions, system failures and worst-case scenarios — thinking that was essential in response to the Deepwater Horizon accident. Oil was spouting from deep beneath the ocean floor under intense pressure, which made it incredibly difficult to measure, predict and stop.

Sandians offered a multidisciplinary approach that combined computational modeling, sensor technology and materials science to the response effort. By modeling how oil and gas were flowing, the team helped analyze what was happening far below the surface. The team estimated the amount escaping and evaluated potential future developments.

Every estimate shaped real-world decisions: how to contain the spill, how to protect coastlines and how to reduce further damage.

One of Sandia's first critical tasks was to assess the state and strain of the riser pipe — specifically investigating a kinked section to determine how many pipes were inside based on its external shape. This analysis was crucial for planning intervention methods and preventing further damage.

Understanding pressure and structural integrity

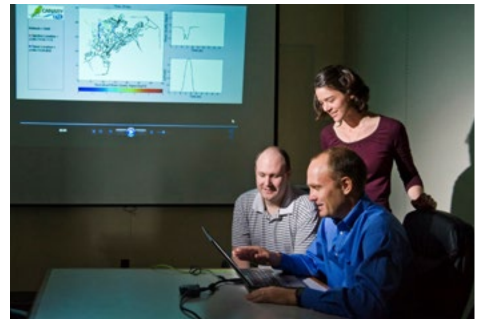
Sandia researchers used advanced computer simulations to better comprehend what went wrong during the spill. By creating detailed virtual models of the well, the blowout preventer and the internal structure of the pipe, they were able to see how oil and gas flowed under extreme pressure and how the equipment responded.

The simulations revealed that the pipe had suffered significant damage and deformation, which weakened the well's integrity and prevented the safety device from sealing the well properly. These insights showed why the blowout preventer failed and helped identify weak points, not only in the equipment design, but also in the pipe and well construction. Once the damaged structure was retrieved, Sandia's analysis was confirmed.

Overall, this deeper understanding helps engineers improve safety measures and prevent similar disasters in the future.

CANARY and real-time monitoring

Sandia's CANARY software, developed in partnership with the U.S. Environmental Protection Agency's National Homeland Security Research Center, was originally created to provide real-time anomaly detection for critical infrastructure systems, such as water distribution networks and other complex engineered systems. Its purpose was, and is, to detect subtle changes in water-quality sensor data that could indicate emerging problems before they become serious failures. When it came to the spill response, CANARY played a vital role in detecting oil concentrations and monitoring the effectiveness of dispersants.



REAL-TIME DATA MEETS RAPID RESPONSE — Sandia researchers work on the CANARY Event Detection Software. **Photo by Randy Montoya**

After the BP oil spill and similar industrial incidents, CANARY's capabilities gained increased attention for potential application in monitoring offshore oil and gas operations and improving safety in that sector.

Beyond Hollywood

For many readers, the first exposure to the Deepwater Horizon accident came not from an investigative report, but from Hollywood — "Deepwater Horizon," starring Mark Wahlberg — raising the question of what the film captured and what it inevitably left out. The 2016 film might have brought widespread attention to the tragic 2010 oil rig accident, capturing the human drama and immediate chaos, but it only scratched the surface of the complex scientific and engineering efforts that followed. Behind the scenes, many DOE labs like Sandia played a crucial role in understanding what went wrong and how to stop the spill.

The film succeeded in raising public awareness and empathy, but the real story of recovery and prevention continues long after the credits roll — driven by the work of scientists, engineers and responders dedicated to protecting the environment and improving offshore drilling safety.

Partnerships are key

In May 2010, at the request from then-Secretary of Energy Steven Chu, Sandia, along with Lawrence Livermore and Los Alamos national laboratories, deployed experts to BP's crisis center in Houston. By combining Sandia's expertise in modeling, simulation and materials analysis with expertise from the other labs, teams quickly diagnosed the causes of the blowout and identified ways to improve safety. This collaboration ensured that cutting-edge research directly informed practical solutions to contain the spill and prevent future incidents.

Equally important was the close coordination between government agencies — including the DOE, Environmental Protection Agency, Coast Guard and Department of the Interior — and industry partners. This unified effort streamlined response activities, accelerated cleanup operations and supported the development of stronger regulatory standards. Together, these partnerships not only enhanced the immediate crisis response but also laid the groundwork for improved offshore drilling safety, demonstrating how collaboration across government, industry and national laboratories can drive innovation and protect the environment.

Legacy and ongoing impact

The Deepwater Horizon disaster highlighted the critical role of national laboratories like Sandia in response to complex environmental emergencies. Through advanced modeling, sensor development and collaborative problem-solving, it forced significant advancements in oil spill science and preparedness. Beyond the immediate crisis, Sandia's contributions to these advancements continue to influence current research and operational practices — advancing scientific understanding, improving preparedness and enhancing the nation's ability to respond to future offshore drilling accidents.

Hitting a bullet with a bullet

By **Magdalena Krajewski**

In 2008, the nation called on Sandia to help the Navy figure out how to shoot down a defective 5,000-pound satellite that was dangerously close to reentering Earth's atmosphere.

The U.S. military reconnaissance satellite, known as USA-193, had failed shortly after its launch two years earlier. By January 2008, it was in a deteriorating orbit and expected to crash within weeks, but where it would land was anyone's guess.

Officials were concerned that the frozen hydrazine fuel on board could cause debris to spread over several hundred miles, posing a serious safety risk. Additionally, there was a potential security threat if the satellite landed on an adversary's territory.

The clock was ticking.

"We were contacted on Jan. 11, 2008, by the Missile Defense Agency and asked to deliver the required 'hit point' for a high probability of success within nine days," said Daniel Kelly, then manager of the Lethality and Threat Department, in a 2008 edition of Lab News.

Kelly led a team of six who worked tirelessly to perform hundreds of impact simulations using Sandia's now-retired Red Storm supercomputer, which was just two years old at the time.

Red Storm contained 26,569 processors and every single one was used to help researchers determine a slew of outcomes and possibilities, ultimately identifying the best option for shooting down the errant satellite. The complex simulations helped identify the optimal altitude to hit the satellite, how it should be struck to minimize the spread of debris — including its hazardous fuel — and the best way to shoot down and destroy the satellite with a single shot.

After more than a month of simulations and analysis, Sandia briefed then-President George W. Bush on his options and on Feb. 12, 2008, he gave the final go-ahead for Operation Burnt Frost, ordering the Navy to bring the satellite down. Eight days later, the Navy fired an SM-3 missile that intercepted the truck-sized satellite 153 miles above the Earth at 17,000 miles per hour, destroying it with a single missile shot. The successful mission was described as "hitting a bullet with a bullet."

Red Storm originally was built to run detailed simulations and models to help researchers understand and ensure the safety and reliability of nuclear weapons without conducting underground tests. When it fired up in 2006, it was the world's second-fastest supercomputer, but in scalability, it was the best of the best. By the time Red Storm was retired in 2012, it was considered one of the most influential machines of its era, Operation Burnt Frost was hailed as the machine's most notable public impact.

MISSION ACCOMPLISHED — The USS Lake Erie (CG 70) launches a Standard Missile-3 at a non functioning National Reconnaissance Office satellite as it travels in space at more than 17,000 mph over the Pacific Ocean on Feb. 20, 2008. The objective was to rupture the satellite's fuel tank to dissipate the approximately 1,000 pounds (453 kg) of hazardous hydrazine fuel, before it entered Earth's atmosphere.

Photo courtesy of the U.S. Navy

Following the success of the operation, then-NNSA Administrator Thomas D'Agostino said in Lab News, "This is a great example of the ways that the nation's investment in nuclear deterrence can be more broadly employed for national security."

Out of tragedy, a safer space

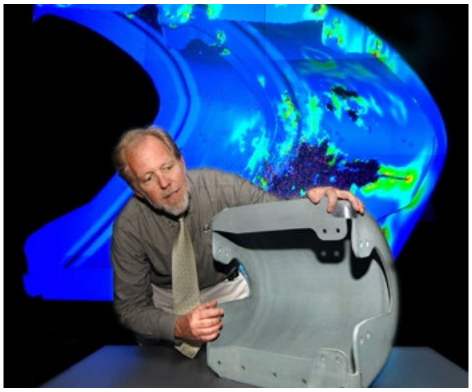
By **Johann "Yo" Snyder**

Space. A dangerous frontier. That reality was tragically painted across the sky in 2003 when the space shuttle Columbia disintegrated over Texas and Louisiana during reentry, just 16 minutes before it was scheduled to land at Kennedy Space Center in Florida. In the aftermath, as has often happened in times of dire national need, Sandia was called upon to help find what happened and what could be done to prevent such a tragedy from occurring again.

Two days after the Columbia disaster, Sandia was contacted to see how it could assist with an investigation. A team of Sandians including Tom Bickel, Carl Peterson and Basil Hassan were sent to Johnson Space Center to determine how the Labs could help.

"Sandia's expertise in material and engineering science was a perfect fit in the investigation," said Engineering Sciences Director Tom Bickel, programmatic lead for Sandia's efforts at that time, in a **2003 edition of Lab News**.

Not long after that visit, NASA initiated a comprehensive investigation with several agencies, and Sandia was a key part of it. Researchers from both New Mexico and California used the Labs' computational and experimental engineering and material sciences resources, long before AI assistance, to help determine if an impact from foam insulation breaking off from the external tank during the launch could have led to Columbia's fate. "Sandia played an important role in determining the cause of the disaster," Bickel said. "Sandia helped guide the investigation and served as an expert adviser to NASA."



A CLOSER LOOK — Former Sandia Engineering Sciences Director Tom Bickel checks out the leading edge of a space shuttle wing in a Lab News photo from 1993.
Photo by Randy Montoya

LAUNCH — The Space Shuttle Columbia, with a crew of seven and a science module aboard, lifts off from Launch Complex 39 at Kennedy Space Center on Oct. 18, 1993. **Photo courtesy of NASA**

Sandia's work focused on two major areas: aerothermodynamics and impact analysis. In aerothermodynamics, Sandia used its expertise in computational fluid mechanics, rarefied gas dynamics and material thermal response to conduct computational fluid dynamics analyses for the orbiter at various altitudes, heat transfer predictions and calculations of plumes simulating hot gas entering the wing.

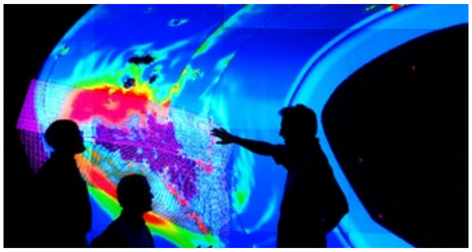
Meanwhile, engineers in Sandia's structural mechanics groups performed simulations of foam impacting the orbiter. They developed and refined material response models for the shuttle's reinforced carbon composite, thermal protection system tile and foam materials using NASA-provided data and Sandia-measured properties.

The simulation and material testing work performed by Sandia staff, along with corroborating work by NASA engineers and contractors, led to large-scale testing done at the Southwest Research Institute in San Antonio, Texas. Testing there was performed on full-scale mock-ups that used parts of the wing and flight hardware from the remaining orbiter inventory and museum displays. The tests assessed potential damage from foam impacts on different locations of the orbiter wing's leading-edge and the thermal protection system tiles on the wing's underside.

The team discovered that firing foam projectiles at various locations on the leading-edge reinforced-carbon composite panels could have produced damage ranging from localized cracking to actually breaking the panels. One of the most dramatic tests at the Southwest Research Institute produced a 16-inch-diameter hole in the lower half of a leading-edge panel on the orbiter. Damage of that kind would allow high-temperature gases to enter the wing and melt the aluminum structure during reentry, a scenario that would end in catastrophe.

Ultimately, the investigation determined this is precisely, and sadly, what happened: foam insulation from the external tank did indeed break away and damage the left wing and its thermal protection system, leaving the wing as a vulnerable weak spot during the shuttle's reentry through the volatile atmosphere.

However, Sandia's contributions didn't end with the investigation to determine what caused the accident. Solutions were also needed. As NASA prepared for a Return to Flight mission, which was scheduled for launch in early May 2005, Sandia's engineers were developing the Impact Penetration Sensing System. This system was designed to monitor the shuttle's wing's



EXPLAINING THE PROCESS — In a 1993 photo, Kenneth Gwinn, right, points to an image of a Sandia computer model and analysis of foam impacting the leading edge of the space shuttle to David Crawford, left, and Kurt Metzinger. **Photo by Randy Montoya**

leading edges for damage during launch.

The sensing system allowed for real-time monitoring of the shuttle's structural integrity, sending signals back to mission control if significant damage occurred as the shuttle lifted off. This innovative technology was crucial for ensuring the safety of astronauts and the success of the future shuttle missions.

Space shuttle flights continued for another eight years after Columbia, due in part to Sandia's ability to help determine what went wrong and how to prevent it in future launches. The shuttle program ended in 2011 with the final flight of space shuttle Atlantis. The subsequent flights after Columbia allowed NASA to continue work on the International Space Station and do repairs on the Hubble Space Telescope, missions that wouldn't have been possible without the contributions of Sandia's research and engineering expertise.

While space may always be a dangerous frontier, in 2003, Sandia helped make it just a little safer so the nation could continue to explore the boundless wonders it holds.

Bombs disabled, not destroyed

PAN Disrupter neutralizes shoe bombs, Unabomber device and more

By **Katherine Beherec**

On Dec. 22, 2001, Massachusetts State Police officers aimed a small device at Richard Reid's shoe bombs and rendered them useless without blowing them up. Sandia developed the device, as well as the training the officers needed to use it.

Bomb disablement expert Chris Cherry and a team of researchers developed the Percussion-Actuated Nonelectric Disrupter in the early 1990s to keep bomb technicians safe and disable bombs without exploding them. The PAN works by punching holes in the bomb, ruining the circuitry and disabling active bomb components.

Since 1992, Sandia has developed and licensed a family of bomb disablers for different situations. The PAN Disrupter has become the primary tool used by bomb squads nationwide to disable conventional, handmade bombs remotely.

"This is another example of our national labs' technological wizardry being put to good use to support America's security," former Energy Secretary Spencer Abraham said in a 2002 Lab News article.

Unlike the devices that preceded it, the PAN was created not only to disable a bomb but do so nonexplosively. A bomb that has been destroyed lacks valuable information, whereas prosecutors can use intact bombs as evidence.

BOMB BUSTERS — Sandia bomb disablement experts Chris Cherry, right, and Rod Owenby demonstrate use of two Percussion-Actuated Non-electric Disrupters on a mock bomb in a photo from 2002. **Photo by Randy Montoya**

PAN on tour

Before the shoe bomber, the PAN Disrupter disabled the Unabomber's device number 17. In April 1996, at the FBI's request, Cherry and his team traveled to a cabin in a remote area of Montana to disarm a bomb following the arrest of Theodore Kaczynski. The intact bomb was evidence that helped lead to Kaczynski's guilty plea and sentencing.

"The cabin was a wealth of information," Cherry said in 1998. "We were there with white gloves going through the evidence to try to ascertain what some of the chemicals were and some of the parts he may have used to construct the bombs.

"Our objective was not just to defuse the bomb but to surgically defuse it so that we would have all the evidence captured. We couldn't just blow apart the bomb. We had to go into it to ensure that all the evidence was preserved and we understood the working functions of it."

Later, the PAN was instrumental in safely disabling several suspect bombs in Atlanta during the 1996 Summer Olympic Games. It was also deployed by bomb squads in Salt Lake City during the 2002 Winter Olympic Games.

Operation America

Cherry's team built both the tool and the training program to deploy it. In 1994, Sandia trained bomb squads from across the nation to use the technology in Operation

FORCE MULTIPLIER — Bomb-disablement expert Chris Cherry demonstrates use of the Percussion-Actuated Non-electric Disrupter to bomb technicians who participated in the Operation America workshop near San Diego in 2002. **Photo from Sanida archives**

Albuquerque. In 1997, Sandia offered the same training at Operation Riverside, and later, Operation America, in partnership with the National Institute of Justice.

Participants included specialists from bomb squads of major U.S. cities, including New York, Houston and Los Angeles; state police departments; and federal agencies such as the FBI, Secret Service and the Bureau of Alcohol, Tobacco and Firearms.

"This is the honors program for bomb techs," Cherry said in 2002. "We are proud to work with some of the country's best bomb squads to discuss and practice the art and science of disabling the increasingly complex terrorist bombs of today while protecting the lives of the public and our first responders."

Through the training sessions, officers who disabled Richard Reid's shoe bombs and dozens of others were equipped with the PAN device and given experience to use it in their departments. Since Operation America, the FBI has trained thousands of officers to use the PAN Disrupter through its Hazardous Devices School and other programs.

Beyond the PAN

Over the last 30 years, Cherry's instinct to neutralize bombs without destroying evidence has informed bomb disablement technology as the threat landscape has evolved. In 2010, a Sandia-developed device that shoots a blade of water capable of penetrating steel aided U.S. troops in Afghanistan in disabling deadly improvised explosive devices, or IEDs. Like the PAN Disrupter, it was designed to defeat the device while retaining it for evidence.

Expertise in bomb disablement, demonstrated by building these tools and training programs, later positioned Sandia to lead the High Explosives Home Team for the Nuclear Emergency Support Team, a DOE program that responds to nuclear or radiological incidents worldwide.

JUST SO — Airman 1st Class Patrick Connolly of Dayton, Ohio, demonstrates the placement of a water disruptor developed at Sandia near its target in a simulated village used to train soldiers heading overseas. **Photo by Randy Montoya**

Little envelopes, big threat

How the anthrax investigation reshaped Sandia's future

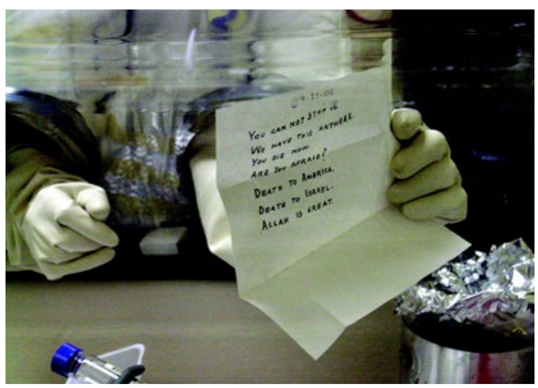
By **Magdalena Krajewski**

A week after the Sept. 11, 2001, attacks, a new threat was on the horizon. Letters containing vague threats and what was described as a sand like substance were showing up in the mailrooms of major media outlets in New York City and Boca Raton, Florida.

That substance, the nation would soon learn, was anthrax.

Robert Stevens, who worked as a photojournalist for supermarket tabloid The Sun, published by American Media, would be the first known victim and fatality of the 2001 anthrax attacks.

Not long after Stevens's death, more anthrax-laced letters would be mailed to U.S. senators Tom Daschle of South Dakota and Patrick Leahy of Vermont.



LETTERS — A laboratory technician at the U.S. Army's Fort Detrick bio-medical research laboratory holds an anthrax-laced letter addressed to Sen. Leahy in December 2001. **Photo courtesy of the FBI**

Five people, including Stevens, would die from anthrax inhalation, while 17 others would become ill after exposure.

At that time, Sandia's work in bioscience was relatively new, but all of the sudden, bioterrorism was "no longer a theoretical event, it was not a hypothetical, it was not something that would only happen elsewhere," Duane Linder, senior manager of Sandia's Chem-Bio National Security program, said in a 2011 Lab News article. "We had individuals dying from exposure to anthrax. Just the stark reality of this was very much driven home. And it highly motivated everyone involved."

Within weeks, Sandia was mobilized on multiple fronts in the biological sphere, drawing on its trusted strengths in physical security and technology development.

Decon foam

In 1999, Sandia researchers announced the development of a decontaminating foam referred to as "The Answer to Anthrax" in a news release photo caption that year.

Made from ordinary substances found in common household products, the foam was found to neutralize chemical agents the same way detergent lifts an oil stain from a stained shirt. In those early lab tests, the foam destroyed simulants of the most concerning chemical agents and a simulant of anthrax.

More than two years later, decon foam would be used in its first real-world application to successfully clean mailrooms and congressional buildings that had been contaminated by anthrax-laced letters.

Sandians Larry Bustard and Mark Tucker were flown out to Washington, D.C., to serve as technical advisers in the cleanup efforts there. The foam would also be used to successfully decontaminate portions of ABC News facilities in New York.

Weaponization concerns loom

By mid-to-late October, the letters had stopped, but the residual effects would continue for several more weeks.

In addition to the criminal investigation led by the FBI, there was a technical investigation needed to explore the scientific and environmental impacts of the anthrax contamination. That's where Sandia came in again.

In February 2002, the first anthrax spore materials from the letters sent out months earlier arrived at Sandia. The team tapped to investigate the spores had to sign nondisclosure agreements and work in secret for nearly seven years.

ANSWER TO ANTHRAX — In a photo from 1999, researcher Mark Tucker examines two petri dishes, one with a simulant of anthrax, left, and the other treated with the newly developed decon foam. **Photo by Randy Montoya**

Using advanced microanalysis tools developed for nuclear weapons work, manager Ray Goehner and his team in the materials characterization department analyzed hundreds of samples and found that the anthrax in the letters was not weaponized with added chemical dispersants that would enhance inhalation. While highly refined and deadly, the spores were not treated with additives meant to create an aerosolized cloud for widespread infection, which was of grave concern to investigators. Sandia's findings were crucial in ruling out state-sponsored terrorism.

In the summer 2008, Joseph Michael, who had served as the principal investigator for the project, was released from his nondisclosure agreement and flown to Washington, D.C., to participate in an FBI press conference along with scientists from around the country who had been tasked with investigating other aspects of the case.

New class of threat

The anthrax attacks helped accelerate Sandia's move into biotech and biosecurity, which, as Len Napolitano, then director of Exploratory Systems and Development in California, said in a 2011 Lab News article, was "the first area of fundamental science that did not have a tie back directly to our nuclear mission, but Sandia was transitioning from a nuclear lab to a national security lab."

He goes on, saying, "This was a new class of threat. We were looking for bigger tanks or faster planes, and they were mailing little envelopes."

How Sandia stepped up in the face of tragedy

By **Magdalena Krajewski**

CAMERA-EQUIPPED — Search dog and its human teammate explore rubble of the World Trade Center in New York shortly after the September 11 attacks. The K-9 cameras developed by Sandian Richard Sparks were used around the clock in the search and recovery mission at Ground Zero. **Photo from Sandia archives**

Sept. 11, 2001, is a day still etched in the memories of most Americans, nearly 25 years later.

Former Sandia historian Rebecca Ullrich remembered driving to work when a radio announcer broke the news of a plane crashing into the World Trade Center. Before she could fully process the information, the announcer broke in with news that a second plane had hit the south tower.

"When I got to the Labs, people were huddled around the televisions in the break room," Rebecca said at a Labswide event before her retirement. "No one knew what was happening, and then the towers collapsed. We were in shock."

Ullrich and her colleagues, like much of the nation, were stunned, glued to the television as the unthinkable unfolded.

But not all was quiet on the Labs front.

Within an hour of the attacks, then-Labs Director Paul Robinson was on the phone with NNSA Administrator Gen. John Gordon.

Sandia was well-known for its counterterrorism work, particularly in "modeling the collision of fully fueled large jet aircraft into structures," Robinson said in a 2011 Lab News article.

"Gordon asked if we could immediately model the crashes at the World Trade Center and the Pentagon, an idea our computer modeling team had already started working on following the first crash," Robinson said.

"'You guys are the ones who have been working on counterterrorism the hardest,'" Robinson recalled Gordon saying. "'Get some people back here to help me handle all the requests we're getting and the communications with all the other labs and sites.'"

DAY OF UNITY AND MOURNING — Flags across the nation were lowered to half-staff the morning after the Sept 11 attacks. Pictured here is Sandia Security Police Officer Buster Dial lowering the flag in front of Bldg. 800.
Photo by Randy Montoya

On Sept. 12, 2001, while all other civilian air traffic was grounded, a small Learjet carrying a group of Sandians departed Albuquerque, headed to Andrews Air Force Base near the nation's capital. Former Sandia Vice President Roger Hagengruber had been tapped to lead one of the teams on board and remembers the pilot calling him to the cockpit during the flight.

"He said, 'You'd better take a look at this. I've never seen anything like this before; there isn't a thing in the air. It's empty,'" Hagengruber said.

In the days that followed, Sandia experts assessed the security of critical infrastructure and government buildings. They worked 12-hour days through the weekend to produce a report categorizing risks as high, medium or low, along with recommendations for improving security. This report later became known as the 72-hour Report.

After five days, the team provided a classified briefing to Gordon on their findings.

"There were several important actions taken as a result of that report," Hagengruber said. "The ability of this laboratory to contribute was a reflection of 30 years of capabilities and our understanding of how security and technology intersect."

Following the briefing, he and his team returned home. Meanwhile, several Sandians were on the ground in New York City and at the Pentagon, assisting with recovery efforts.

Months earlier, Sandia had begun researching how K-9 collar camera kits could provide police officers and emergency responders with K-9 vision from safer positions. Just days after the attacks, those kits and project leader Richard Sparks were on their way to Ground Zero in New York City. Sparks spent 22 days at the site, helping Urban Search and Rescue teams equip their search dogs with the kits to sift through the rubble for survivors.

A group of Sandians from the Labs' emergency management team was dispatched to the Pentagon to aid in rescue and recovery efforts as part of New Mexico's Urban Search and Rescue team. They removed debris, helped stabilize the structure, recovered parts from the plane, identified victims' remains and gathered personal items.

"You can't help but feel anger or hate that this act was committed," Bruce Berry, a Sandia emergency planner at the time, said. "Of course, you can't dwell on that because you are there to do a job. But when you come across remains, you wonder, whose mother was this? Whose son?"

On Sept. 21, 2001, Robinson penned an article in the first edition of Lab News to be published since the attacks and wrote, "This week the trumpet has sounded the call for 'exceptional service' louder than at any time in our lives. Let us answer the call."

Fire over the Atlantic and the case of TWA 800

By **Troy Rummler**

TWA 800 — A photograph from the National Transportation Safety Board's final report shows wreckage from the crash reconstructed in a hangar in New York. **Photo courtesy of NTSB**

As the nation turned 220, optimism from the collapse of the Soviet Union and the end of the Cold War gave way to growing fears about terrorism. The Oklahoma City bombing in 1995, unrest in Saudi Arabia and heightened security for the Summer Olympics in Atlanta formed a tense backdrop to a tragedy that triggered the most extensive government investigation up to that time.

During the evening of July 17, 1996, TWA Flight 800 burst into flames after takeoff from John F. Kennedy International Airport in New York City and spiraled into the Atlantic Ocean. All 230 people on board died. A singular question rang throughout the nation: Why?

Sandians helped discover the facts of what happened, leading to policy reforms and new technologies that would carry air travelers to a safer future.

Clues emerge from massive investigation

The National Transportation Safety Board led the investigation as the FBI worked to determine whether a bomb caused the crash. CIA analysts spent thousands of hours

AIRCRAFT SAFETY — Sandian Kevin Howard inspects electrical wiring in the wheel well of a retired Boeing 727 in this 2006 photograph. **Photo by Randy Montoya**

assessing whether the plane could have been hit by a missile.

The Coast Guard was among the first on scene and mobilized a recovery operation that eventually included dozens of ships and hundreds of personnel working at the surface to retrieve bodies and wreckage. The Navy ran salvage operations more than a hundred feet below.

From the recovered wreckage, clues emerged that the disaster had originated inside the center wing fuel tank, a reserve tank with a capacity of more than 12,000 gallons positioned between the wings under an airplane. Sandia explosives expert Paul Cooper was called to assess the damage from the reconstructed pieces.

"When I got there, the plane's pieces were being reassembled, and I could walk through the fuel tank. I looked around and could see where it started and where it detonated," he recalled in 2012.

This came as a surprise. Fuel tanks on commercial planes were largely considered explosion-proof. Engineers understood that inside the tank, fuel vapors and oxygen would mix in the space above the fuel, even in an otherwise empty reserve tank with small puddles that never completely drain out. This mixture was potentially combustible; all it would need was a spark. So, aircraft were designed to eliminate any possible source of ignition from the fuel tanks.

If there had been a spark, where did it come from?

Sandia researchers combined computational simulations with experiments to model how a vapor explosion would have spread through and breached the tank. Their data helped investigators form a theory of how the accident occurred.

Inside the tank are sensors that measure the amount of fuel. These are powered by low-voltage wires that never carry enough electricity to ignite the vapors. However, this plane was 35 years old, and aging, potentially unsafe wiring had been found in the wreckage, including near the tank. A short could have transferred a powerful surge of energy from nearby higher voltage wires to the low-voltage sensor wires and into the tank. On top of that, nearby air conditioning equipment would have already heated the tank and its contents to combustible temperatures.

After four years of investigation, the National Transportation Safety Board finally concluded an electrical short was the most probable cause.

It wasn't terrorism.

As a result of Sandia's work, policymakers and aircraft manufacturers were forced to recognize that commercial jet fuel tanks were not explosion-proof, as they had once believed. Reforms were passed requiring aircraft to be equipped with military-inspired systems that now pump nitrogen into empty spaces, rendering vapors inert. Aircraft maintenance routines were reevaluated, too.

Sandia carries on with excellence in aircraft safety

The investigation also inspired new technologies as Sandia researchers continued to study aircraft safety in the following years.

Larry Schneider led a team that invented a technology called Pulse Arrested Spark Discharge to non-destructively inspect, identify and locate damaged wiring. Previous, similar diagnostics could only locate exposed wires if they were touching a metal structure, like a strut. The new technology was licensed and commercialized as ArcSafe, earning an Federal Laboratory Consortium award for technology transfer in 2007.

"Rather than reacting to a problem, these systems can find a fault before it manifests into a catastrophic event," Schneider told the Lab News in 2006.

Others at Sandia went on to advocate for better safety investigations and education. In a conference paper submitted to a 2004 International Society of Air Safety Investigators seminar, Sandians Paul Werner and Richard Perry, reflecting on numerous tragedies wrote, "One obvious lesson from the short history of aviation is that most accidents are not the result of unknown scientific principles (but from) the failure to apply well known engineering practices."

WIRING DIAGNOSTIC — Sandians Larry Schneider, left, and Mike Dinallo prepare to employ the Pulse Arrested Spark Discharge diagnostic in 2006 on a wiring bundle in the cockpit of a retired Boeing 737. **Photo by Randy Montoya**

When the TWA 800 crash happened, Chuck Rhykerd, now a manager, was a post doc. He did not participate in the investigation, but today he recalls the mood of the nation and the impact it had on the Labs.

"For better or worse, the climate of fear back then resulted in the DHS, TSA and the security we have in airports today. Sandia pivoted in that era, growing to meet the national security challenges of the day."

How Sandia helped clear fallen sailor's name

By **Magdalena Krajewski**

DEADLY EXPLOSION — Iowa's number two turret is cooled with sea water shortly after exploding. The explosion killed 47 sailors aboard the battleship.
Photo courtesy of U.S. Navy

In April 1989, 47 sailors were killed after a gun turret exploded during a fleet exercise aboard the U.S. Navy battleship USS Iowa.

The initial investigation concluded that Clayton Hartwig, one of the crewmembers killed in the blast, had deliberately caused the deadly explosion. These findings were heavily scrutinized by the victims' families, independent experts and members of Congress.

Critics argued the evidence was weak and demanded an independent, scientific review. The Government Accountability Office started asking around and, "They kept hearing the name, Sandia National Laboratories," said Director of Components Dick Schwoebel in a 1990 Lab News article.

In November 1989, New Mexico Sen. Jeff Bingaman penned a letter, along with two other members of the Armed Services Committee, to then-Sandia president Al Narath asking for help. Sandia was well regarded as an expert in weapons testing and explosives analysis, so the request focused on exploring the physical evidence. Narath agreed, and dozens of Sandia experts, including Schwoebel, got to work.

Testing the sabotage theory

As the project's technical lead, Schwoebel kicked things off by reviewing the Navy's initial technical report, making notes and adding questions in the margins. In mid-December, he and three other team members visited the Iowa, where they toured the gun turrets from top to bottom, witnessed the devastating effects of the explosion, took samples for materials analysis and interviewed some of the sailors.

From there, the team ran various controlled experiments to see if the Navy's sabotage theory made sense, examining whether a small detonator or device could ignite the powder bags. They quickly discovered that it would have been extremely unlikely for a small device to have caused the blast the way the Navy described.

Next, the group tested accidental ignition scenarios, looking into mechanical causes — specifically the loading process of the 16-inch gun and a possible overram.

Overram theory

Dave Anderson was leading the explosives studies team at the time and, in a 1990 Lab News article, said, "Maybe halfway through the study, we began acknowledging to ourselves that the only real, hard evidence we collectively had — we and the Navy — that was not in dispute was the overramming. And we kept coming back to that."

WRONGLY ACCUSED — United States Navy Capt. Fred Moosally, left, presents Gunner's Mate 2nd Class Clayton Hartwig with a duty award in Norfolk, Virginia, in 1988. Hartwig was wrongly accused for deliberately causing the USS Iowa explosion.
Photo courtesy of U.S. Navy

Iowa's guns used powder bags that were pushed into the barrel using a hydraulic rammer. The question posed was whether the gunpowder bags could accidentally ignite if the loading ram pushed them too hard and too far into the barrel, causing them to compress enough to ignite.

Sandia conducted hundreds of impact tests simulating conditions just like these, albeit on a smaller scale, at the Coyote Canyon Test Complex in the Sandia foothills. As expected, many of the tests resulted in explosions.

On May 25, 1990, Schwoebel, Paul Cooper, Karl Schuler and Jim Borders were set to testify before the Senate Armed Services Committee on their findings. But the day before, the Navy announced that a full-scale test had been carried out that day at the Naval Surface Warfare Center in Dahlgren, Virginia, to check Sandia's findings related to the overramming. The test had resulted in the powder bags unexpectedly igniting.

The Navy secretary immediately reopened the Iowa investigation and suspended all further firing of 16-inch guns on its battleships.

Sandia's testimony

When Schwoebel first heard the news, he was stunned.

"It was almost like fiction, it was dramatic and could not have come at a more crucial time — just before our testimony," he said

TESTIMONY — Dick Schwoebel testifies before the Senate Armed Services Committee on May 25, 1989.
Photo from Sandia archives

in the same 1990 Lab News article.

The testimony continued, demonstrating that an accidental explosion was possible, challenging the Navy's earlier theory that suggested intentional sabotage.

Upon the hearing's conclusion, Armed Services Chairman Sam Nunn turned to the Sandia team and said, "Sen. Bingaman's been bragging on your laboratory out there for a long time, and we know now that he's been telling us a great deal of truth. We appreciate your being here."

"People at the Labs worked extremely hard," Schwoebel said at the time, emphasizing that Sandia did not prove what happened on the Iowa, only demonstrated a plausible scenario which "touched on some important issues."

Hartwig exonerated

While the Navy never officially determined what caused the Iowa explosion, in October 1991, they did formally exonerate Hartwig and issue an apology to the sailor's family.

Adm. Frank B. Kelso II, the chief of naval operations, said that after reopening the investigation and reviewing the evidence connected to the explosion, the Navy had concluded that there is "no clear and connecting evidence" to support its initial claim against the 24-year-old sailor. He went on to say that while the cause of the accident may never be known, he was regretful for the Navy's initial investigation and apologized for the "burden it has caused the family to bear."

Cleanrooms here, there, everywhere

Sandia technology plays vital role in everyday life

By **Magdalena Krajewski**

When Sandia physicist Willis Whitfield invented the modern cleanroom, he aimed to solve a very specific problem: preventing tiny dust particles from contaminating the small, delicate components used in nuclear weapons assembly.

Little did he — or anyone — know that his innovation would become a critical part of everyday life. From computer chips to vaccine and pharmaceutical manufacturing, aerospace and defense, hospital operating rooms, and even food processing and packaging, cleanroom technology invented at Sandia protects many of the sensitive products and processes the world relies on.

Let the air be the janitor

In 1959, Whitfield was part of a team trying to figure out how to keep microscopic dust particles out of complex manufacturing environments. At the time, cleanrooms of a sort existed, but the term "clean" was open to interpretation. Tests showed that one of the best cleanrooms from that era still averaged more than one million particles per cubic foot of air. For context, that's roughly the same number of tiny, invisible specks floating around a typical college classroom or busy office today, according to Indoor Air Quality data from the Environmental Protection Agency.

The revolutionary technology now known as laminar flow was born from a simple sketch Whitfield made on an airplane in 1960. Laminar flow — or as Whitfield once described it, "letting the air be the janitor" — involves continuously sweeping a room with highly filtered air. This process pushes particles to the floor, filters them out, and circulates clean air back into the room with a steady, slow movement.

Data collected in 1961 using Whitfield's prototype showed air quality that was 1,000 times cleaner than the best cleanrooms of the time, so clean that some doubted the results. In a 2024 Lab News article, former Labs historian Rebecca Ullrich recalled, "People at meetings questioned his claims. There were people there who had to vouch for Whitfield's credibility."

The cleanest air in the world

In 1962, a Lab News article called the new cleanrooms a "significant breakthrough." D.W. Ballard, then supervisor of the Advanced Manufacturing Division, said the technology was "far beyond our most optimistic expectations." Another supervisor, J. Gordon King, told the paper, "The cleanest air in the world is what we have."

MR. CLEAN — In a 1962 photo, Willis Whitfield stands inside the laminar flow clean room he invented.
Photo from Sandia archives

That same year, Whitfield presented his "ultra-cleanroom" at the Institute of Environmental Sciences meeting in Chicago.

HOSPITAL CLEANROOMS — In this 1964 photo taken at Charles S. Wilson Memorial Hospital cleanroom technology is used in the operating room. This technology continues to be used in hospitals to prevent infection in operating and recovery rooms. **Photo from Sandia archives**

Following the publicity, Ullrich noted, “Industry jumped all over it.” Early adopters included leaders in electronics and communications technology, automotive manufacturing, telecommunications and medical research.

Cleanroom technology today

Today, 64 years later, cleanroom technology remains essential to cutting-edge industries such as manufacturing of the microchips that power smartphones and computers; biotechnology and pharmaceutical firms developing vaccines and life-saving medicines; aerospace and defense organizations build satellites and advanced avionics; automotive manufacturers of electric vehicles and sophisticated sensors; and medical device companies creating implants and surgical instruments.

True to its original purpose, cleanrooms continue to play a vital role in Sandia’s nuclear deterrence mission by preventing tiny dust particles from contaminating controlled environments. The cleanroom

CLEANROOMS TODAY — Computer scientist Anh Luong works in a cleanroom at Sandia’s Center for Integrated Nanotechnologies. **Photo by Craig Fritz**

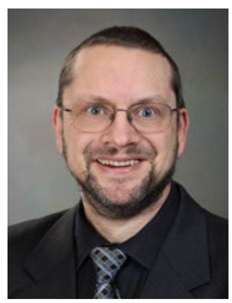
supports stockpile stewardship, enhances safety and advances technologies critical to national security.

Mileposts

Brad Boyd 25

Russ DePriest 25

Chris DiAntonio 25



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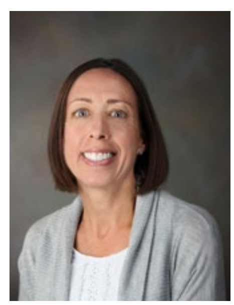

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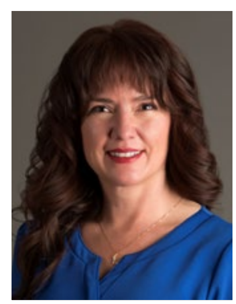

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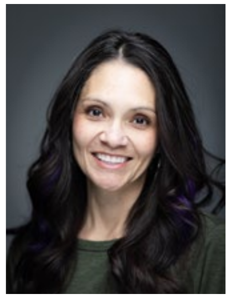
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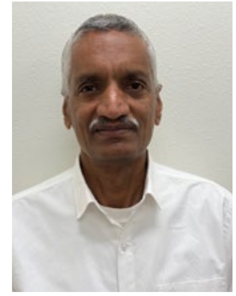
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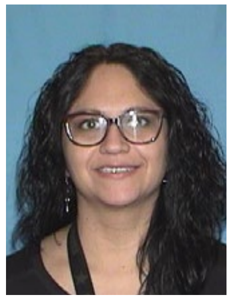
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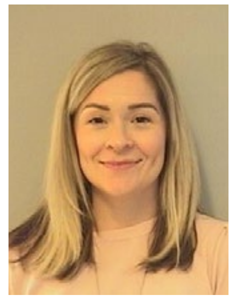
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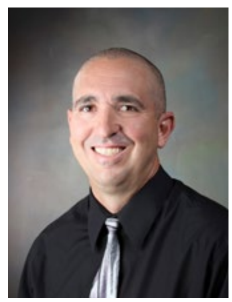
David Robertson 15


Walter Schuler 15


Brian Troelsen 15


Camille Valdez 15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