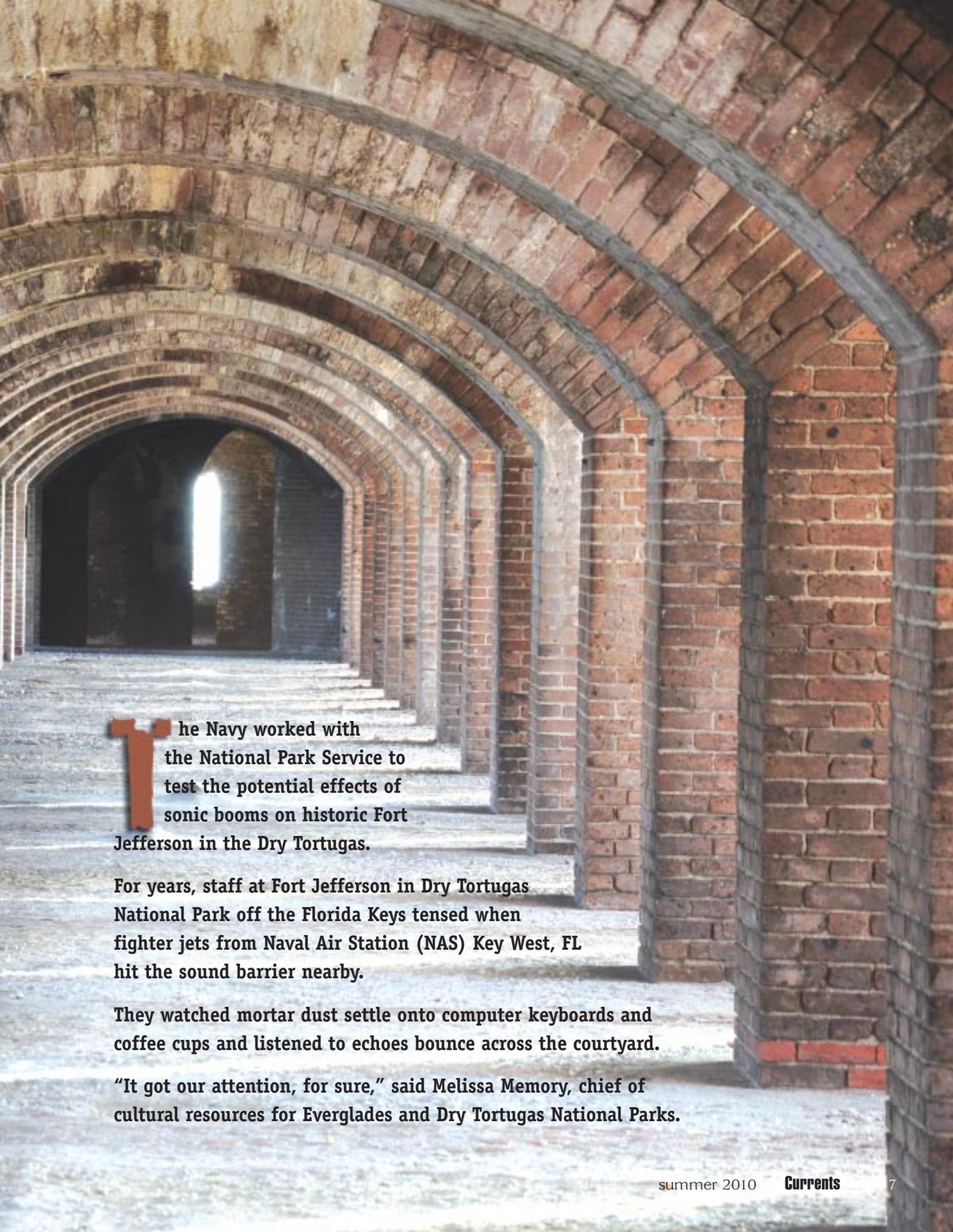


Navy & Park Service Test

SONIC BOOM

Effects on **Fort Jefferson**

Study Finds Limited Danger from Key West
& Recommends Expanding Buffer Zone

The image shows a perspective view down a long, arched brick tunnel. The arches are made of red brick and are supported by brick pillars. The floor is made of concrete steps that lead down towards the end of the tunnel. At the far end, there is a bright light source, possibly an opening to the outdoors, creating a strong contrast with the dark interior of the tunnel.

The Navy worked with the National Park Service to test the potential effects of sonic booms on historic Fort Jefferson in the Dry Tortugas.

For years, staff at Fort Jefferson in Dry Tortugas National Park off the Florida Keys tensed when fighter jets from Naval Air Station (NAS) Key West, FL hit the sound barrier nearby.

They watched mortar dust settle onto computer keyboards and coffee cups and listened to echoes bounce across the courtyard.

“It got our attention, for sure,” said Melissa Memory, chief of cultural resources for Everglades and Dry Tortugas National Parks.

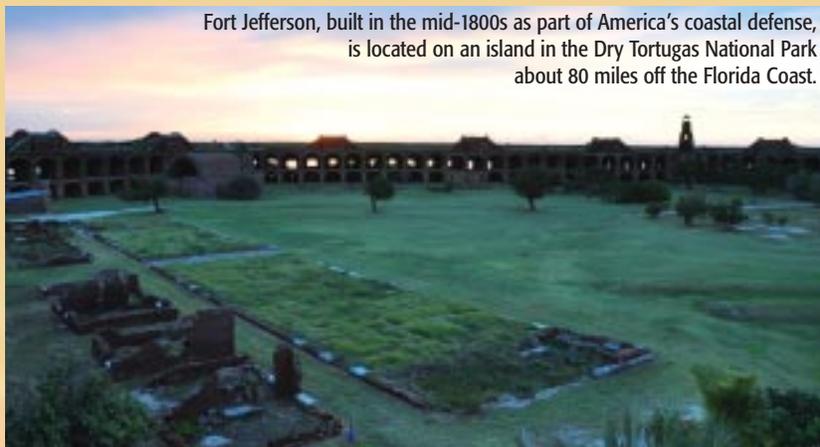
Concerns about the potential effects of sonic booms prompted a collaborative effort between the Park Service and the Navy to find out if sound waves were damaging

the historic structure. So in 2009, the Navy's U.S. Fleet Forces Command, eager to head off any potential issues or training impact, conducted a sonic boom study at Fort Jefferson.

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It's always better to identify up front any issues or problem areas. Any impact on natural resources may lead to training restrictions and that's what we try to avoid."

Mudd, convicted in 1865 of conspiring with John Wilkes Booth in the assassination of President Abraham Lincoln. More than a century of weather and use have deteriorated the fort despite ongoing restoration efforts. (For more about the history of Fort Jefferson, read our sidebar entitled "The Basics About Fort Jefferson.")



Fort Jefferson, built in the mid-1800s as part of America's coastal defense, is located on an island in the Dry Tortugas National Park about 80 miles off the Florida Coast.

"The Park Service had been concerned about sonic booms near the fort for years," Memory said. The Navy used the study's findings as part of an Environmental Assessment for Atlantic Fleet training in the Key West Range Complex.

"Our overall objective is to continue training," said Sean Heath, a biologist with Naval Facilities Engineering Command Southeast. "We don't want anything to impact training.

The U.S. government built Fort Jefferson in the mid-1800s as part of America's coastal defenses, and later housed Civil War prisoners there. The most famous prisoner was Samuel

"The concerns reached us fairly late in the environmental assessment process, about two years in," said Heath, project manager for the assessment. "Luckily we had a contractor with a whole lot of experience with sonic booms."

Robert Kull fit the bill perfectly.

Kull is a former Air Force officer and currently senior project manager at Parsons, one of the companies the Navy hired to conduct the study. In his former job as head of the Environmental Effects Branch at the Air Force Research Laboratory at Wright-Patterson Air Force Base, he studied and monitored the effects of sonic booms on the environment.

“A sonic boom,” he explained, “is caused by colliding waves of pressure created as an object moves through the air.” He compared the pressure to a wave in the water created by a boat—it spreads away from the object then either dissipates or hits something. In the case of a sonic boom the sound is created when the pressure wave moving at the speed of sound hits the ground, like a wave breaking on the shore.

“You can feel it and hear it, that vibration,” Kull said. “A sonic boom can be powerful enough to crack windows or knock things off shelves.”

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Equipment used during the sonic boom study at Fort Jefferson included accelerometers to measure shock and vibration on the walls and yachting cannons, normally used to signal the start of boat races, to produce sound waves.



In the early 1990s, Kull worked with a team that came up with a way to perform non-destructive tests of the effects of sonic booms on “unconventional” buildings, including old or weakened structures.

Kull is familiar with environmental issues around Fort Jefferson as well. He headed the conduct of laboratory research in the late 1980s that he said debunked an earlier study suggesting that sonic booms had a negative effect on bird hatching in the Dry Tortugas.

“We were unable to show any link between sonic booms and the birds’ eggs,” he said.

For an expert on loud things Kull is rather soft-spoken. But he knows his noise.



The Basics About Fort Jefferson

Fort Jefferson is situated in the Dry Tortugas, a group of seven islands (known as keys) and coral reefs about 70 miles from Key West. Poised on the edge of the main shipping channel between the Gulf of Mexico, the western Caribbean, and the Atlantic Ocean, the area has been heavily traversed for hundreds of years—first by Spanish explorers, then by merchant ships.

Soon after the United States acquired Florida in 1822, they began planning construction of a fort in this important strategic location. The fear was that should enemy forces gain control of the Tortugas, they could stop the flow of goods that passed between the Gulf Coast (including New Orleans, Mobile and Pensacola) and the eastern seaboard of the United States. Enemy forces would also be well-positioned to launch an attack on either the eastern seaboard or the Gulf Coast.

In 1847, the U.S. government began construction of Fort Jefferson on Garden Key. Construction was hampered by the remote location of the fort, harsh weather conditions, and a scarcity of workers, particularly during the Civil War. The fort was operational throughout the war, however—the Union army used the harbor during their campaign to block the supply line to the confederacy; and the fort became a prison for deserters (as well as for Dr. Samuel Mudd). After the war, the invention of the rifled cannon made the fort obsolete, as its thick walls could now be penetrated. The Army abandoned Fort Jefferson in 1874.

Although the fort was never completely finished, it stood as one of the largest fortresses ever built—a key link in the chain of coastal forts that stretched from Maine to California. Perhaps because of its impressive size and scope, Fort Jefferson was never attacked, but its harbors offered passing ships the chance to resupply, refit, or seek refuge from storms. In the late 1800s, it also served as a quarantine hospital.

At its peak, Fort Jefferson's military population was 1,729. In addition, a number of officers and enlisted personnel brought their wives and families. There were also lighthouse keepers and their families, cooks, a civilian doctor and his family, civilian

machinists, carpenters, blacksmiths, masons, general laborers, the resident prisoner population, and slaves to help construct the fort. In all, there were close to 2,000 people at Fort Jefferson during its peak years.

The three-tiered, six-sided fort is composed of 16 million bricks, covering 11 of Garden Key's 16 acres. It contained living quarters for soldiers and officers, gunpowder magazines, storehouses, and other buildings. The fort featured some of the largest and most advanced weapons of its age, including 15-inch Rodman smoothbores, which weighed 25 tons apiece.



With a crew of seven men, they could fire a 432-pound projectile a distance of three miles. These heavy guns were mounted inside the walls in a string of open casemates, or gunrooms, facing outward toward the sea through large openings called embrasures. Technologically advanced iron shutters were used to protect the cannon openings. These hinged, wrought-iron shutters, known as Totten shutters, were placed between the mortar core of the fort and the brick façade. During use, the shutters were unlocked from the bronze strike plate below. As the fuse was lit, gases escaping from the muzzle seconds before the cannonball launched would

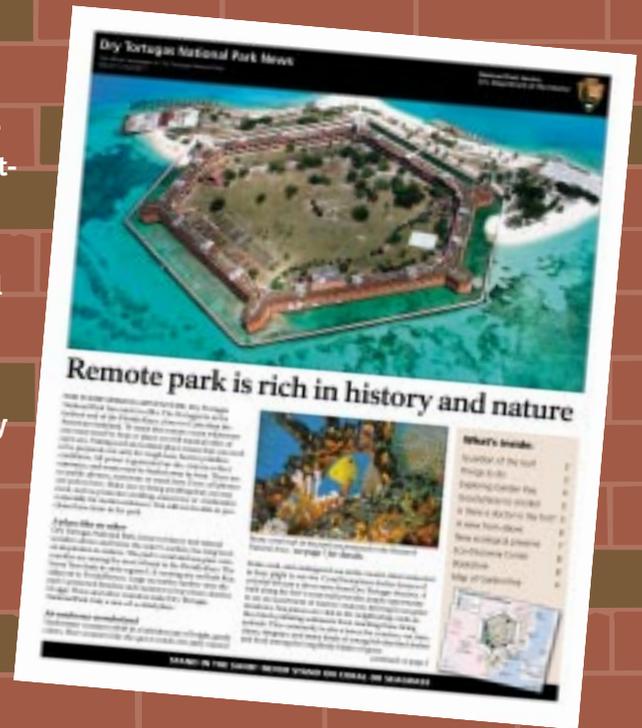
momentarily throw the shutters open. The shutters were carefully balanced so that they would swing freely and ‘rebound’ into the closed position.

Unfortunately, the very metal that provided valuable protection to soldiers under fire proved devastating to the fort itself. In a saltwater environment, the wrought iron quickly began to rust and expand. As the iron rusted, it pushed the brick apart, causing serious structural damage to Fort Jefferson’s walls. A multi-stage preservation project is underway to remove all original iron elements from the shutters and stabilize the exterior walls by replacing all of the crumbling bricks. Concrete made of local sand and coral—just as was used in the original construction—and historic bricks salvaged during demolition are being used to preserve the historic appearance of the walls. Finally, replicas of the original Totten shutters will be installed.

The Dry Tortugas were first discovered by Ponce De Leon in 1513. First named Las Tortugas (The Turtles) due to the abundance of sea turtles, the word “Dry” was soon added to mariners’ charts to warn of the lack of fresh water. The islands were designated as a bird refuge in 1908. In 1935, President Roosevelt designated Fort Jefferson as a national monument, and the entire area received National Park status in 1992.

The natural geography of the area and the presence of tropical storms have combined to produce hundreds of shipwrecks in the area over the years. Remnants of many of these wrecks still lie submerged just offshore.

For more information about the Dry Tortugas and Fort Jefferson including a variety of fact sheets available for downloading, visit the National Park Service’s web site at www.nps.gov/drto/index.htm then select “Brochures” from the “Plan Your Visit” menu.



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When he heard about the Fort Jefferson study, Kull called on his former colleagues who came up with the technique for testing unconventional structures. They jumped at the chance to go to Key West and revisit their theory.

“Spending a week in the Dry Tortugas was definitely part of the interest,” Kull said.

THE TESTS predicted how the walls would respond to 90 different supersonic operations by three types of aircraft.

During the study, he and his crew stayed at Fort Jefferson, located about 80 miles off the Florida coast and reachable only by plane or boat. The scientists placed sound and motion

sensors at six points around the structure, on restored and original walls.

Then they generated a loud, focused sound wave to test how the vibration affected the walls. The tests predicted



how the walls would respond to 90 different supersonic operations by three types of aircraft.

“We used accelerometers to test the movement of the walls and extrapolate what a sonic boom would do,” he said.

shift, but again there is no structural damage.”

Only a “focused” sonic boom, as opposed to a more diffused “carpet” boom, generated at altitudes below 20,000 feet with the aircraft accelerating supersonically toward the fort from four to 12 miles out have any potential to do damage, and then only to the most susceptible parts of the fort, according to the study.

“That set of circumstances is unlikely to occur,” Kull said, “given the small size of the island versus the vast scope of the Key West Range Complex.” The Key West operating area covers over 8,000 nautical miles.



A scientist fires off a yachting cannon to test the effects of sonic boom on the walls of historic Fort Jefferson.

The Park Service did not want them to use jets to create an actual sonic boom, so they came up with an interesting solution—yachting cannons.

The small cannons are used to signal the start of boat races and reenact pirate battles. In a video taken during the study, Kull tapped on the back of the cannon with a hammer, setting off the blank shotgun shell with a loud “boom” and a puff of smoke.

Results indicated that only in a rare set of circumstances could the fort’s walls be affected by sonic booms. In most instances, the booms did not have any potential negative effects.

“I can understand why they were concerned, but the booms were not causing structural damage,” Kull said. “The walls are thick but they are not in good condition. Over time, with weather and other factors, the mortar has degraded and a sonic boom might cause loose mortar to



The Basics About NAS Key West

Located at the southernmost point of the continental U.S., Key West has long been recognized as a strategic location. The first military base was established at Key West in 1823. In the early years, naval vessels out of Key West fought pirates in the Caribbean and intercepted illegal slave traders. During the Civil War, a blockade was organized at the base to prevent the Confederates from receiving supplies from overseas.

In 1898, the battleship Maine sailed from Key West to Havana, Cuba, where it was sunk, contributing to the United States' declaration of war on Spain. Subsequently, the entire U.S. Atlantic Fleet moved to Key West for the duration.

During World War I, Key West was chosen as an ideal site for the nation's fledgling aviation force to train, and in 1917, NAS Key West was commissioned. More than 500 aviation officers were trained at NAS Key West during World War I. After the war, the station lay dormant until 1940, when the growing threat of German submarine warfare led to its reopening. After World War II, NAS Key West was retained as a training facility.



Offering perfect year-round flying weather, NAS Key West is the U.S. Navy's premier training station for tactical aviation squadrons. Local aerial ranges enable aviators to engage in training maneuvers within minutes of takeoff. This saves fuel, time and tax dollars. The station is equipped with a sophisticated tactical combat training system, similar to the one depicted in the popular movie "Top Gun," which tracks and records combat aerial maneuvers. As a host station, NAS Key West provides and maintains facilities and services for tenants such as the Joint Inter-agency Task Force South, the U.S. Coast Guard and others. The station is located within a national marine sanctuary, and NAS Key West's mission is carefully integrated with the environment and in concert with the community.

For more information about the base, visit www.cnic.navy.mil/keywest/index.htm.



An F/A-18 C "Hornet" strike fighter flies over the Fort Jefferson National Monument.
Lieutenant Commander Creighton Holt

Still, the findings of the resulting Environmental Assessment recommends stipulating the expansion of an existing buffer zone around the Dry Tortugas by 2,000 feet, from 18,000 to 20,000 feet, to ensure natural and historic resources would not be impacted.

“From the Navy perspective, it’s good to keep this standoff distance at the forefront,” said Sean Heath. “We’re just reminding everyone that there is a historic fort in a national park right in the middle of the Navy’s operating area.”

Memory said the Park Service will continue to monitor the overall sound situation at the fort and evaluate the sonic boom study as part of a look at how sounds affect the structure and the visitor experience. She praised the Navy’s efforts and said a continuing relationship with the Navy is important.

RESULTS indicated that only in a rare set of circumstances could the fort’s walls be affected by sonic booms.

“Part of our mission is to preserve the historic structure for future generations, and the Navy is a part of that,” she said. “The history of the Army and the Navy is a big part of the history of Fort Jefferson. This was a great collaboration and we want to keep the lines of communication open.”

For his part, Kull said he was happy to have participated in the study.

“There are very few studies of this sort, so it provided a valuable set of data and procedures for testing sonic booms on unconventional structures,” he said.

“For the Navy the impact on training was minimal,” Heath said. And the upshot of the study was positive.

“The Navy benefitted because the training impact was minor, and we maintained a good neighbor relationship with the Park Service,” he continued. “We worked together on this.” ⚓

Fort Jefferson photos courtesy of Parsons

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