

**Mission.** To ensure that the DoD is provided mission effective survivable air platforms now and in the future. WSL is the Navy's field activity for weapon system non-nuclear survivability, weapons lethality, and live fire test and evaluation (LFT&E) that conducts survivability testing for all three major services.

## Unique Features

- WSL is the largest LFT&E facility in the world, encompassing five major test sites capable of supporting full-scale test articles. It also includes an underground test site for smaller scale test articles.
- It is the only facility with three High-Velocity Airflow Systems (HIVASs) generating flight representative air flow to operating aircraft: SHIVAS-9-engine (550 knots), HIVAS-4 engine (500 knots), and Huff-n-Puff 1-engine (600 knots / portable). LFT&E has paid enormous dividends in the design of more survivable aircraft.
- The Missile Engagement Threat Simulator (METS) is a high-pressure gas gun capable of precisely delivering "live" MANPADS and other projectiles at velocities up to and above 18 pounds at 3,000 feet per second.
- Remote Test Site (RTS) collects Hostile Fire Indication (HFI) data on a remotely operated H-60 platform elevated 30 feet with threats launched from a range of up to 3 kilometers (km).



**Combat Support.** One prime example involves the MANPADS.

The threat of one person toting an inexpensive IR-guided, shoulder-launched missile and successfully destroying a military aircraft is real! For example, during Desert Storm, several F/A-18 and A-10 aircraft returned safely to base after having suffered major structural damage from surface-to-air missiles. And during Operation Enduring Freedom, when Afghan forces attacked al Qaeda and Taliban holdouts in one of the biggest battles of the Afghan war, seven Apache helicopters were attacked. However, they were redesigned based on WSL LFT&E; and although they were hit, all seven managed to limp back to base.

**Cost / Time Savings.** Live flight testing is the best; however, it is expensive (particularly for air-launched weapons), is short on controlled repeatability, and usually ends with the loss of a valuable test asset. Computer simulations are extremely useful; but even the most sophisticated simulation cannot capture the millions of variables that influence a weapon's in-flight performance. Wind tunnel testing comes closer to reality, but it is usually done with models and does not include the missile control systems. HIVAS testing is a highly effective, cost-saving alternative.

**RDT&E / LFT&E. Survivability** testing is conducted at six test sites under rigidly controlled, highly realistic conditions.

**Susceptibility** is reduced via enhanced countermeasures, tactics, and threat suppression; by improving airframe agility and threat warning; as well as by signature reduction. **Vulnerability reduction** is achieved via improving battle damage repair methods and aircrew protection. **Types of Testing.** MANPADS launch; IR measurement; simulated in-flight; pool and carrier deck fires; ground cookoff tests; static and simulated in-flight crew ejections; communications link payout; bomb ejections; propulsion systems; hydraulic ram effects on fuel systems; fuel ingestion; engines under simulated full-operating conditions; warhead detonations; thermal and structural test; and ballistics testing including gun fired fragments.

**Size / Description / Location.** WSL encompasses 30 square miles of outdoor laboratory test space, and the test site is capable of handling explosives of up to 100 pounds of Class 1.1 or equivalent.

## Main Facilities

- **WSL.** Provides the DoD with the only test facility capable of conducting survivability and vulnerability gunfire tests on remotely controlled, fully operational aircraft under simulated high velocity air flow. Tests are performed against: components; subassemblies; subsystems; systems; full-scale aircraft; simulators; munitions effectiveness tests up to 105-mm; IR measurement tests using remotely controlled aircraft installed on a 360-degree rotatable gun mount; and in-flight, aircraft carrier, and ground fire cookoff tests up to and including full-scale specimens.
- **MANPADS.** With the unsuccessful but dramatic missile attack on an Israeli airliner in Kenya in 2002, officials in Washington became very interested in this counter-terrorism device. Shoulder-launched, IR-guided MANPADS are a significant threat to the safety of commercial aircraft. China Lake began conducting survivability testing using a C-130 aircraft, and lessons learned were critical to advancing this technology. LFT&E using live Stinger missiles against F-14s and F-16 were also conducted. To counter this threat, China Lake engineers developed a computer-based information system known as the

Portable Resource for the Investigation of Suspected MANPADS (PRISM), which can identify locations where MANPADS could be launched against aircraft. The FBI funded an update to the prototype to include threat launch envelopes for determining airport security zones for 80 airports. These zones are plotted by a flight-path threat-analysis simulation provided by the Missiles and Space Intelligence Center in Huntsville, Alabama. Additionally, engineers have developed the METS that uses a high-pressure gas gun to deliver live MANPADS at full-scale operating test articles simulating MANPADS engagements under realistic conditions.



- **Flight Representative Air Flow.** Available by any of three systems. SHIVAS uses nine TF-33 engines and simulates flight representative external air flow of 550 knots over an area of 40 SF. HIVAS uses four TF-33 engines and simulates flight representative external air flow of 500 knots over 18 SF. Portable air flow can also be achieved at any of the five test sites using a single TF-30 engine capable of 600 knots over 2 SF. Air flow is delivered to aircraft surfaces or engine inlets for live-fire testing, ordnance testing of flares and rocket motors, and stores ejection tests. Other test articles include radar antennas, parachutes, aircraft canopies, and ejection seats. Each air flow system has the capability to cover larger areas with lower air flow velocities.
- **Hostile Fire Indication.** Data collection is conducted using a remotely operated H-60 aircraft positioned atop a 30-foot rotating tower. The various threats can be launched from a range of up to 3 km.

## Equipment

- **METS.** This 6-inch diameter, 40-foot long high-pressure gas gun is capable of launching actual and simulated MANPADS missiles.
- **Test Pads.** Range in size from a 65- x 105-foot heat-resistant concrete pad up to a 75- x 235-foot dirt pad. All can be equipped with instrumentation support (up to 400 recordable data channels), high-speed video coverage, 200-channel specimen control via dedicated remote control systems, ballistic impact testing, warhead testing, and firefighting capabilities including AFFF and CO<sub>2</sub>. An environmentally safe oil-and-water separator system is used to contain and process test pad runoff.



- **Equipment.** Includes jet engine stands, overhead stands for mounting drones, free-fall weapons, sting mount stand for aerodynamic tests, full-scale aircraft, Drott rolling crane (65,000-pound capacity), gun tower, spin fixture (capable of spinning engine disks and components at 3,000 to 17,000 rpm), and fire lighting systems that includes a 6-inch bore gun capable of firing 18-pound objects at 3,000 feet per second.
- **Fabrication Capabilities.** Include computer numerically controlled (CNC) lathes, CNC mills, CNC waterjet, welders, drill press, cut-off saw, press brake, shear and sheet metal roller (to construct and modify large steel structures), test stands, engine stands, aircraft replicas, machined components, composite panels, and repairs.

**Instrumentation and Data Collection.** WSL has 384 channels with wideband data-carrying capacity at each of the five major test sites. Data includes temperature, pressure, strain, liquid flow, air flow, mechanical load, mechanical displacement, vibration, flash / flame detection, projectile velocity, IRIG-B time code, and custom specimen control using analog-to-digital (A/D) and digital-to-analog (D/A) interfaces to existing computers. Typical measurements recorded include temperature, pressure, strain, thrust, optical flash, and standard propulsion. WSL also has the ability to record and control numerous military and commercial bus systems, including MIL-1553, ARINC-429, and CAN. High-definition video, specialized video systems, and high-speed photography are available. An automatic events control system with 100-microsecond resolution controls critically timed events. Instrumentation is tailored to handle slow-response phenomena and wideband (2-MHz data measurements).

**Interesting Facts.** The WSL has performed a wide range of unique testing outside of traditional LFT&E. Examples include Louisville Slugger bats, cell phone towers, freeway collision barriers, Mars Rover and Pathfinder systems, ejections seat testing, and extensive work for the FAA.

**Recognition / Awards.** WSL engineers participated in the Trans World Airlines (TWA) Flight 800 investigation, and feature articles have appeared in *Air and Space Magazine* and other publications.