C. Dryden Flight Research Center (DFRC)

DFRC, located at Edwards Air Force Base, California, is NASA's primary installation for flight research and flight testing. DFRC supports operations and development of future access-to-space vehicles, conducts airborne science missions and flight operations, and develops piloted and UAS test beds for research and science missions. Projects at Dryden over the past 66 years have led to major advancements in the design and capabilities of many civilian and military aircraft. In the past, DFRC has also conducted tests in support of the Agency's space programs.

Range Safety at Dryden was established by the Dryden Center Director under an alliance agreement with the Air Force Test Center (AFTC) to provide independent review and oversight of Range Safety issues. Range Safety supports the Center by providing trained FTS engineers, Range Safety risk analysts, and Range Safety Officers to provide mission and project support primarily for UAS Projects.

1. Enhanced Flight Termination System (EFTS)

The DFRC/AFTC Range Safety Alliance has an operational EFTS transmitter site. The EFTS transmitter site has successfully been used to support four UAS Projects. Modifications are being planned to address the needs of upcoming flight Projects. Dryden also continues to support flight Projects with Inter-Range Instrumentation (IRIG) FTS.

Dryden has supported other Ranges by assisting in the verification process for their respective fixed EFTS transmitter sites.

2. DRFC/AFTC Range Safety Alliance

Dryden Range Safety continues to provide FTS support to AFTC Projects such as X-47B. Dryden is also providing assistance to the AFTC Range Safety Office as it undergoes a major re-organization.

Dryden Range Safety continues to support the testing of UASs. The UASs that were flown with Dryden assistance include:

a. Small UASs (sUAS)

sUAS are in the model-type classification of flight vehicles. Dryden has established an area that offers sUAS projects a unique opportunity to conduct flights within the restricted airspace. Dryden has also established a streamlined flight approval process for sUASs that makes the airworthiness and safety review quicker and easier than those performed for larger UASs. Dryden has supported many hours of operations on multiple platforms from different manufacturers.
Dryden currently operates two Radio Controlled (RC) model aircraft named Dryden Remotely Operated Integrated Drone (DROID) (Figure 17). One of the vehicles is used for low-cost

FIGURE 17: DRYDEN REMOTELY OPERATED INTEGRATED DRONES (DROID)

flight research. The second DROID aircraft is used as a UAS trainer for Dryden's UAS Pilots. In May, the DROID team successfully completed flight testing of Dryden's Auto Ground Collision Avoidance System.

b. Blended Wing Body (BWB) Low Speed Vehicle (LSV)

The BWB LSV UAS, also known as X-48 LSV (Figure 18), is a dynamically scaled version of the original concept vehicle. The X-48 LSV Project is a partnership between NASA, Boeing, USAF Research Laboratory, and Cranfield Aerospace. The primary goals of the test and research project are to study the flight and handling characteristics of the BWB design, match the vehicle's performance with engineering predictions based on computer and wind tunnel studies, develop and evaluate digital flight control algorithms, and assess the integration of the propulsion system to the airframe. The BWB testing will address several key goals of NASA's Environmentally Responsible Aviation Project, namely noise reduction, emissions reduction, and improvement in fuel economy. Industry studies suggest that because of its efficient configuration, the BWB would consume 20 percent less fuel than jetliners of today, while cruising at high subsonic speeds on flights of up to 7,000 nautical miles.

FIGURE 18: BLENDED WING BODY LOW SPEED VEHICLE

In early 2012, the X-48 was modified by reducing the number of engines from three to two more efficient model engines, the installation of noise-shielding vertical fins, and the removal of the winglets. These modifications were made to make the vehicle quieter and more fuel efficient. The designation for this new configuration is X-48C.

To date, the Project has conducted 92 successful flights in the X-48B configuration and 12 successful flights in the X-48C configuration, all with LSV #2. LSV #2 achieved the 100th flight milestone in October 2012.

c. NASA Global Hawk

Dryden has acquired two former United States Air Force Advanced Concept Technology Demonstration Global Hawk UASs (Figure 19). These pre-production Global Hawks were built by Northrop Grumman for the purpose of carrying reconnaissance payloads. The vehicles will begin a new life as a supplement to NASA's Science Mission Directorate by providing a high altitude, long endurance airborne science platform. The vehicle has an 11,000 nm range and 30+ hour endurance at altitudes above 60,000 feet MSL. To date, NASA Global Hawks have flown 15 successful flights with NASA 871 and 62 successful flights with NASA 872. NASA 872 supported one successful earth science campaign this year, Hurricane and Severe Storm Sentinel (HS3 2012), based out of WFF. NASA Global Hawks also supported DARPA's KQ-X program which tested autonomous aerial refueling capabilities between two unmanned vehicles (Figure 20).

FIGURE 19: NASA GLOBAL HAWK

Dryden Range Safety has supported flight planning and risk analysis tasks in support of FAA certificate of authorization applications as well as real-time operations support during KQ-X.

FIGURE 20: GLOBAL HAWKS AERIAL REFUELING

d. Ikhana

NASA's Ikhana UAS is a General Atomics Predator-B modified to support the conduct of Earth science missions for the Science Mission Directorate (Figure 21). Ikhana was registered with the FAA and given the tail number N870NA. The vehicle is undergoing upgrades in order to standardize the vehicle with the rest of the Predator-B fleet.

The Range Safety Office has supported flight planning and risk analysis tasks in support of FAA certificate of authorization applications.

FIGURE 21: NASA'S IKHANA UAS

e. Boeing Phantom Eye

Phantom Eye is an autonomous, hydrogen-powered, high-altitude, long endurance vehicle built by Boeing to develop future UAS technology opportunities (Figure 22). The vehicle completed its first flight in June 2012 and a video capturing this milestone can be viewed here: http://www.youtube.com/watch?v=To5fcvaC1eg

Several more flights are scheduled with the next one starting in early 2013.

FIGURE 22: BOEING PHANTOM EYE

f. Sierra Nevada Corporation (SNC) Dream Chaser Engineering Test Article (ETA)

SNC Dream Chaser ETA is an unpowered, autonomous test bed that has the same outer mold line as manned Dream Chaser vehicle. Dream Chaser is one of the vehicles competing in NASA's Commercial Crew Development Program. The vehicle is based on the NASA HL-20 lifting body design. The first drop flight is scheduled for early Spring 2013. A video of the captive carry flight can be viewed here: http://www.space.com/15954-dream-chaser-space-plane-flight-test.html

FIGURE 23: DREAM CHASER

g. Lockheed Martin X-56A

The X-56A is a low speed, subscale vehicle designed to test lightweight flexible wing/fuselage technologies. The first flight is scheduled for early 2013 and an informational video can be viewed here: http://www.engineeringtv.com/video/Lockheed-Martins-X-56A-UAV-Test

FIGURE 24: LOCKHEED MARTIN X-56A