

2011

**NASA Range Safety
Annual Report**

B. Dryden Flight Research Center

The Dryden Flight Research Center (DFRC), located at Edwards Air Force Base, California, is NASA's primary installation for flight research and flight testing. The Center 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 DFRC over the past 65 years have led to major advancements in the design and capabilities of many civilian and military aircraft. DFRC has also conducted tests in support of the Agency's space programs.

Range Safety operations at Dryden are managed by the Range Safety Office (RS Office). The RS Office was established by the DFRC Director to provide independent review and oversight of Range Safety issues under an alliance agreement with the Air Force Flight Test Center (AFFTC). The RS Office supports the Center by providing trained Flight Terminations System (FTS) engineers, Range Safety risk analysts, and Range Safety Officers to provide mission and project support primarily for UAS Projects. The DFRC/AFFTC Range Safety Alliance allows each RS Office to work on the other's projects, providing experience that may not have been available otherwise.

1. Enhanced Flight Termination System

The DFRC/AFFTC Range Safety Alliance has an operational Enhanced Flight Termination System (EFTS) transmitter site. The EFTS transmitter site has successfully been used to support three 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.

2. DFRC/AFFTC Range Safety Alliance

The Dryden Range Safety Office continues to provide FTS support to AFFTC projects such as X-47B and has provided FTS support on the Global Observer Project.

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

a. Small UASs

Small UASs (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 Drones (DROID) (Figure 11). The first of these vehicles is used for low cost flight research. Currently, the DROID team is integrating Dryden's Auto Ground Collision Avoidance System software with the goal of eventually incorporating the software into larger UAS platforms such as Dryden's Ikhana. The second DROID aircraft is used as a UAS trainer for Dryden's UAS Pilots.



FIGURE 11: DRYDEN REMOTELY OPERATED INTEGRATED DRONES (DROID)

b. Blended Wing Body Low Speed Vehicle

The Blended Wing Body (BWB) Low Speed Vehicle (LSV) UAS, also known as X-48B LSV (Figure 12), is a dynamically scaled version of the original concept vehicle. The X-48B 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 (ERA) 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. To date, the project has conducted 86 successful flights, all with LSV #2.

LSV #2 is currently undergoing modifications to make the vehicle quieter and more fuel efficient. These modifications include 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. The designation for this new configuration is X-48C. The first X-48C flight is expected to occur in early 2012.



FIGURE 12: BLENDED WING BODY LOW SPEED VEHICLE

c. NASA Global Hawk

Dryden has acquired two former United States Air Force (USAF) Advanced Concept Technology Demonstration (ACTD) Global Hawk UASs (Figure 13). 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 nautical mile range and 30+ hour endurance at altitudes above 60,000 feet MSL. To date, NASA Global Hawks have flown 9 successful flights with NASA 871 and 43 successful flights with NASA 872. NASA Global Hawks supported three successful earth science campaigns this year: Winter Storms and Pacific Atmospheric Rivers (WISPAR 2011), Hurricane and Severe Storm Sentinel (HS3 2011), and Airborne Tropical Tropopause Experiment (ATTREX 2011).

The Range Safety Office has supported flight planning and risk analysis tasks in support of FAA Certificate of Authorization (COA) applications as well as real-time operations support.



FIGURE 13: NASA GLOBAL HAWK

d. Ikhana

NASA's Ikhana UAS (Figure 14) is a General Atomics Predator-B modified to support the conduct of Earth science missions for the Science Mission Directorate. The aircraft is designed to be disassembled and transported in a large shipping container aboard standard military transports.

Ikhana has been registered with the FAA and given the tail number N870NA.

The Range Safety Office has supported flight planning and risk analysis tasks in support of FAA Certificate of Authorization (COA) applications as well as real-time operations support. The vehicle has flown 19 flights this year.



FIGURE 14: NASA'S IKHANA UAS

e. Boeing Phantom Ray

Phantom Ray (Figure 15) is a fighter-sized flying test bed to develop future UAS technology opportunities. The vehicle successfully completed all flights.



FIGURE 15: BOEING PHANTOM RAY

Dryden Flight Research Center Missions 2011				
Date	Project Name	Mission	Location	Mission Result
01/13/2011-01/14/2011	Ikhana	Flight # 119; TRACER Flight 11	Yuma, AZ	Success
01/19/11	NASA Global Hawk (872)	Flight # 22; Dropsonde Test @ 15k ft MSL	Edwards AFB	Success
01/19/2011-01/20/2011	Ikhana	Flight # 120; TRACER Flight 12	Yuma, AZ	Success
01/21/11	NASA Global Hawk (872)	Flight # 23; Wake Survey with Proteus	Edwards AFB	Success
01/25/2011-01/26/2011	Ikhana	Flight # 121; TRACER Flight 13	Edwards AFB	Early RTB
01/26/2011-01/27/2011	NASA Global Hawk (872)	Flight # 24; Dropsonde Test @ 30k ft MSL	Edwards AFB	Success
02/03/2011-02/04/2011	Ikhana	Flight # 122; TRACER Flight 13	Yuma, AZ	Success
02/04/11	NASA Global Hawk (872)	Flight # 25; High Altitude Dropsonde Test	Pacific Ocean	Success
02/10/2011-02/11/2011	Ikhana	Flight # 123; TRACER Flight 14	Yuma, AZ	Success
02/11/2011-02/12/2011	NASA Global Hawk (872)	Flight # 26; WISPAR Science Flight 1	Pacific Ocean	Early RTB
03/02/11	NASA Global Hawk (872)	Flight # 27; Functional Check Flight	Edwards AFB	Success
03/03/2011-03/04/2011	NASA Global Hawk (872)	Flight # 28; WISPAR Science Flight 2	Pacific Ocean	Success
03/09/2011-03/10/2011	NASA Global Hawk (872)	Flight # 29; WISPAR Science Flight 3	Alaska; 80 deg North Latitude	Success

Dryden Flight Research Center Missions 2011

Date	Project Name	Mission	Location	Mission Result
03/29/11	NASA Global Hawk (872)	Flight # 30; Pilot Proficiency Flight	Edwards AFB	Success
03/29/11	NASA Global Hawk (872)	Flight # 31; Pilot Proficiency Flight	Edwards AFB	Success
04/14/11	Ikhana	Flight # 124; Pilot Proficiency Flight	Edwards AFB	Success
04/27/11	Ikhana	Flight # 125; Pilot Proficiency Flight	Edwards AFB	Success
04/27/11	Phantom Ray	First Flight	Edwards AFB	Success
05/04/11	Ikhana	Flight # 126; Pilot Proficiency Flight	Edwards AFB	Success
05/05/11	Phantom Ray	Flight 2	Edwards AFB	Success
05/10/11	NASA Global Hawk (872)	Flight # 32; Functional Check Flight	Edwards AFB	Success
05/12/11	NASA Global Hawk (872)	Flight # 33; Pilot Proficiency Flight	Edwards AFB	Success
05/12/11	NASA Global Hawk (872)	Flight # 34; Pilot Proficiency Flight	Edwards AFB	Success
05/19/11	Ikhana	Flight # 127; Pilot Proficiency Flight	Edwards AFB	Success
05/21/11	Ikhana	Flight # 128; Pilot Proficiency Flight/Dry Run for USAF Test Pilot School Student Flight	Edwards AFB	Success
05/21/11	Ikhana	Flight # 129; TPS Student Flight	Edwards AFB	Success
05/25/11	Ikhana	Flight # 130; TPS StudentFlight	Edwards AFB	Success
06/01/11	Ikhana	Flight # 131; TPS StudentFlight	Edwards AFB	Success
06/04/11	Ikhana	Flight # 132; TPS StudentFlight	Edwards AFB	Success
06/09/11	Ikhana	Flight # 133; TPS StudentFlight	Edwards AFB	Success
06/15/11	Ikhana	Flight # 134; TPS StudentFlight	Edwards AFB	Success
06/16/11	Ikhana	Flight # 135; TPS StudentFlight	Edwards AFB	Success
06/21/11	Ikhana	Flight # 136; TPS StudentFlight	Edwards AFB	Success

Dryden Flight Research Center Missions 2011				
Date	Project Name	Mission	Location	Mission Result
06/28/11	Ikhana	Flight # 137; TPS StudentFlight	Edwards AFB	Success
09/01/11	NASA Global Hawk (872)	Flight # 35; Dropsonde Test	Edwards AFB	Success
09/08/2011-09/09/2011	NASA Global Hawk (872)	Flight # 36; HS3 Science Flight 1	Pacific Ocean	Success
09/13/2011-09/14/2011	NASA Global Hawk (872)	Flight # 37; HS3 Science Flight 2	Gulf Of Mexico	Success
10/20/11	NASA Global Hawk (872)	Flight # 38; Functional Check Flight	Edwards AFB	Success
10/24/11	NASA Global Hawk (872)	Flight # 39; ATTREX Science Flight 1	Pacific Ocean	Early RTB
10/28/2011-10/29/2011	NASA Global Hawk (872)	Flight # 40; ATTREX Science Flight 1	Pacific Ocean	Success
11/05/2011-11/06/2011	NASA Global Hawk (872)	Flight # 41; ATTREX Science Flight 2	Pacific Ocean	Success
11/09/2011-11/10/2011	NASA Global Hawk (872)	Flight # 42; ATTREX Science Flight 3	Pacific Ocean	Success
11/21/11	NASA Global Hawk (872)	Flight # 43; GHMOF Checkout Flight	Edwards AFB	Success

FIGURE 16: 2011 DRYDEN MISSIONS