

Proposed Changes to the SWIFT Flight Test Plan

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FRL Team - Pilots

- *Roy Martin: Chief Test Pilot, Northrop-Grumman*
 - 9600 hrs – 60 aircraft types
 - F-5 pilot for QSP-SSBD
- *Dr. Donald Ward: Professor Emeritus, Texas A&M*
 - 5500 hrs PIC, former Commandant of USAF TPS
 - Author: Flight Testing Engineering text
- *Celine Kluzek: PhD Student*
 - 1200 hrs PIC, MEI, IFR, glider, CFI
 - Ferry, maintenance, and currency flights
 - Weight and balance, performance, weather
 - Flight test procedures, schedule

FRL TEAM continued

- *Cecil Rhodes: Aircraft Mechanic*
 - FAA A&P, A&I Mechanic
 - FAA Inspector's Authorization
- *Andrew Carpenter: PhD Student*
 - 220 hrs PIC, 10 hrs glider, 130 hrs complex
 - Maintenance chief, final inspection, instrumentation
 - Hotfilm anemometry, IR thermography, variable roughness
- *Lauren Hunt: PhD Student*
 - IR Thermography, documentation, weather
 - Flight test procedures

FRL Team – Continued

- *Jerrod Hofferth: PhD Student*
 - IR Thermography, documentation, weather
 - Flight test procedures
- *Shane Schouten: MS Student*
 - Pre-flight inspection, Model fab, stress analysis
 - Store installation, instrumentation
- *Dr. Helen Reed: Head, Aerospace Eng*
 - Boundary-layer stability, CFD of O-2
- *Dr. William Saric, Professor*
 - overall technical supervisor
 - scheduling and flight test planning
 - go/no-go decisions



AFRL-TRB & SRB 3 Aug 07

Background Material

available at <http://flight.tamu.edu/pubs/reports.html>

- *Saric WS, Carpenter AL, Hunt LE, Kluzek CD 2007a. "SWIFT - Flight Test Plan for Swept-Wing Experiments." TAMUS-AE-TR-06-001-revA, Technical Report, July 2007*
- *Saric WS, Carpenter AL, Hunt LE, McKnight CW, Schouten SM 2007b. "SWIFT – Safety Analysis for Swept-Wing Experiments." TAMUS-AE-TR-06-002-revA, Technical Report, July 2007*
- *Saric WS, Carpenter AL, Hunt LE, Kluzek CD 2006. "Cessna O-2 General Flight Test Procedures: Operations for the Flight Research Laboratory." TAMUS-AE-TR-06-003, Technical Report, January 2006*
- *Saric WS, 2006. "Final Report: Swept Wing in Flight Testing." TAMUS-AE-TR-06-004, Technical Report, June 2006*

History

- *AFRL SRB determined test to be “low” risk*
- *Since SWIFT flight approval in fall 2005, we have had 60 flight operations and approximately 120 hours of flight time with the model on the aircraft*
 - does not count maintenance and ferry flights
- *Principal operations out of College Station with successful cold-weather deployments of 1 week each to Coffeerville, Kansas (March 2006) and Lincoln, Nebraska (October 2006)*

Flight Test Plan

- *The aircraft is dedicated to this program and has continuous availability*
- *The flight schedule is to fly out of College Station everyday between 2 Aug 07 and 31 Oct 07 depending on:*
 - 1. Test pilot availability
 - 2. Weather
 - 3. Aircraft maintenance
 - 4. Instrumentation maintenance
 - 5. Flight and ground crew availability

List of Proposed Changes

- 1) *Use the aft engine electrical system for instrumentation power instead of batteries and an inverter*
- 2) *Reduce the required fuel reserve time from 1 hour to 30 minutes*
- 3) *Set a new aft CG limit at 141 inches*
- 4) *Change wording on some of the wind limitations*

Reasons for Changes

- *Next campaign of flight measurements will include more instrumentation*
 - 30 lb air tank and vacuum pump to run the pressurized DRE control system
 - 46 lb of anemometers to run 10 channels of hotfilms for shear stress measurements
 - 10 lb universal power supply to provide electrical power during engine start-up for pressure transducers and anemometer
 - All new instrumentation will be installed aft of the pilot and co-pilot shifting the CG aft beyond current limits
 - More instrumentation means less fuel which reduces 2 dives per flight to 1 per flight
- *Current winds aloft limitations are too restricting and not necessary*

1. Electrical Power – Current Configuration

- *Two 24 volt batteries are mounted underneath the pilot and co-pilot's seats*
 - All SWIFT instrumentation are independent of aircraft instruments
 - Batteries are mounted underneath the seats to shift the CG forward
 - Mission time is limited to 2 hours
 - 2 hour turnaround time to recharge batteries in between flights
 - 52 lbs of batteries (26 lbs each), equivalent to 9 gallons of fuel which is 45 minutes of flight is lost due to battery weight

1. Electrical Power – Proposed Configuration

- *Utilize the aircraft's two engine-driven alternators*
 - 120 amp total capacity with both alternators
 - 10 amp estimated continuous load of aircraft instruments
 - 21 amp worst case electrical load for SWIFT instrumentation
 - SWIFT instrumentation limited with circuit protection
 - *40 amp circuit breaker for all 115 VAC instruments*
 - *1 amp fuse for 24 VDC α/β sensor and pilot real-time display*
 - *1 amp fuse for inverter “kill switch”*
 - *1 amp circuit breaker for 24 VDC electronic vacuum regulator*
- *All instruments will be grounded to the airframe*
- *A universal power supply will provide power to the pressure transducers and anemometer during engine start-up*
- *Configuration has already been tested with two other flight programs and over 50 hours of flight time in the O-2*

2. Reduced Fuel Reserve to 30 Minutes

- *FAR-Part 91.151 calls for a 30-minute fuel reserve for Day VFR flight*
 - Instrumentation batteries weigh 52 lbs. New instrumentation weighs 86 lbs. The 34 lb difference would be made up with 6 gallons of less fuel
 - 6 gallons will reduce the runtime by 30 minutes
 - 2 dives per flight now become 1 per flight
 - Plan is to reduce fuel reserve to increase mission time by 30 minutes and continue to perform 2 dives per flight
- *Plan is to be in the traffic pattern at Easterwood Airport with 30 minutes of fuel in the port wing*
- *Starboard wing will always have more fuel preventing simultaneous fuel starvation of both engines*
- *Fuel will be monitored with fuel gauge, fuel flow meter, and clock observed by the co-pilot*
- *6 emergency airports within 20 minutes of both Test Area I and II*
- *Test pilot will always have the call for an early abort and RTB*

3. New Aft CG Limit

- *Current AFT CG Limit is 140.5 inches from the datum*
 - Aircraft POH sets a CG limits between 137.5 – 143 inches
- *New instrumentation requires a new aft limit of 141 inches*
- *Past SWIFT flights have shown no indication of aft CG problems*
- *Pilot will fly the aircraft with a simulated instrumentation flight at 141 prior to flying with passengers and the SWIFT model*
 - Ballast will be added to the instrument rack to reach 141
 - Pilot will focus on low-speed directional control

4. Wind Limitations

- *The principal reason for the crosswinds aloft limitation is the possibility of exceeding $\beta = 7^\circ$ at 170 KIAS.*
 - loads on model then exceed worst-case scenario
- *The pilot's best diagnostic tool is the β display which shall never exceed 7 degrees on the model.*
 - Pilot can easily identify areas of turbulence or wind shear at low speeds during the climb to 10,500 ft and then make a decision to RTB or continue with the mission.
- *Previous limit was 27 kts aloft. The change is now 20 kts aloft AND a 90° shift over 3,000 ft. The absolute limit is 50 kts.*
 - pre-flight weather forecast and measurements during climb determine go/no-go

4. New Wind Limitations

Problem	Decision	Reason
Ground winds greater than 15 knots	No Go	Wind speed exceeds FRL limitations
Crosswind component exceeds 6 knots	No Go	Crosswind component exceeds aircraft operating manual for an asymmetrical wing loading
Winds aloft exceed 20 knots AND a wind shift greater than 90° occurs within a 3000' band	No Go	Crosswind component may exceed design limitation set on airfoil support structure
Greater than 15 knots wind-speed inversion within a 6000' band	No Go	Turbulence may result in a crosswind component exceeding design limitations set on the airfoil support structure
Winds at any test altitude exceed 50 knots	No Go	Environment too unstable for testing
Sideslip angle on aircraft exceeds 7 degrees based on the pilot's β display	Slow down and RTB	Crosswind component is exceeding design limitation set on airfoil support structure

Benefits from Changes

- *2 dives can continue to be performed*
- *Turnaround time will be reduced to 1 hour*
- *Mission time is not limited by the 2 hour battery capacity*
- *Air tank and anemometer can be installed without violating aft CG limits*
- *Fewer canceled flights due to weather*