Gulfstream Aerospace Corporation (GAC) Document No.: GIV-GER-9978, Flight Test Report - GIV Gust Lock System, follows this page and is included after appropriate authorization from GAC per a redacted Proprietary Notice Restriction contained on the cover page of the report.

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Flight Test Report - GIV Gust Lock System

[redacted]

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REVISION HISTORY

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-	-	Initial Release, No Change (NC)

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1.0 SUMMARY

The Gulfstream IV gust lock testing was completed in accordance with the test plan GIV-GER-9977 (dated June 19, 2014). Any deviations from the original test plan are noted in the flight test report. The following results were noted:

NOTE: Engagement or disengagement of the gust lock system was verified via standard flight controls checks for freedom of movement

- The gust lock system could be disengaged manually with the hydraulic systems pressurized or depressurized if the gust lock system hooks were not preloaded.
- Aileron system inputs could not be used to preload the gust lock system to a level preventing disengagement.
- The aileron gust lock hook may disengage prior to, and independently of, elevator and rudder gust lock hooks disengagement.
- The elevator and rudder gust lock hooks may not disengage if one or more hydraulic systems are pressurized and the rudder gust lock system is sufficiently preloaded via the rudder trim system input.
- The elevator and rudder gust lock hooks may not disengage if one or more hydraulic systems are pressurized and the elevator gust lock system is sufficiently preloaded via inputs to the control columns by pulling back and holding force.
- With combined hydraulic system pressurized, the rudder gust lock hook preloaded via rudder trim input, and the gust lock handle unlatched but not fully stowed, the gust lock system disengaged when the FPSOV was pulled.

  NOTE: Aerodynamic or pilot-input preloading were not part of this test point.
- An active yaw damper can cause a RUDDER LIMIT CAS message to illuminate while taxiing during turns if the gust lock system is engaged.
- During taxi, with the yaw damper active, a noted reduction in rudder surface deflection was recorded with the gust lock system engaged.
- The RUDDER LIMIT CAS message may illuminate if rudder trim is input with the gust lock system engaged and one or more hydraulic systems are pressurized.
- The RUDDER LIMIT CAS message may illuminate if rudder pedals are moved with the gust lock system engaged and one or more hydraulic systems are pressurized.
- Throttle advancement was impeded prior to reaching takeoff power with the gust lock handle latched ON. Approximately 1.15 EPR was the highest thrust setting recorded.
- Throttle advancement to takeoff power was possible with the gust lock handle unlatched, but not fully stowed, with the rudder gust lock hook preloaded using rudder trim input.

- When FPSOV was pulled in flight with flaps at 20 degrees, the spoilers and ailerons showed a change in recorded position.
- When FPSOV was pulled in flight with flaps at 20 degrees, the yaw damper did not disengage until a slight aileron command was input by the Pilot.

2.0 ACRONYMS

FCS	Flight Control System
GL	Gust Lock
YD	Yaw Damper
FDR	Flight Data Recorder
FDAU	Flight Data Acquisition Unit
EPR	Engine Pressure Ratio
FPSOV	Flight Power Shut-off Valve
TC	Type Certificated
CVR	Cockpit Voice Recorder
CAS	Crew Alerting System / Calibrated Air Speed
PLA	Power Lever Angle
ENG1PLA	Engine 1 Power Lever Angle
ENG1EPR	Engine 1 Engine Pressure Ratio
ATENGAG	Auto Throttle Engaged
FP	Flight Power (Shutoff Valve)
HYD	Hydraulics
SFCALRNLH	Left Hand Aileron Surface Position
SFCELEVA	Elevator Surface Position
SFCRUDDER	Rudder Surface Position
COMB HYD	Combined Hydraulic System
BRKPRESLH	Left Hand Brake Pressure

3.0 INTRODUCTION

This document presents results of testing for the Gulfstream IV elevator, rudder, and aileron flight control systems gust lock operations.

The purpose of testing is to support NTSB Accident Investigation ERA14MA271 and to demonstrate how the gust lock system interacts with GIV flight control systems and throttle movement in different configurations. The tests also focused on gust lock handle behaviour, throttle movement, thrust (EPR) attainment and aircraft annunciations. Testing used static and dynamic conditions to simulate different configurations that may affect gust lock system functionality.

Company testing was conducted on a Gulfstream model GIV aircraft, serial number [redacted].

3.1 Test Objective

Testing was performed to characterize the following:

- Gust Lock Freedom of Release
- FPSOV Activation
- Gust Lock/Throttle Interlock
- Control Surface Deflections
- Yaw Damper Characterization

3.2 Configuration

Testing was performed on Gulfstream GIV aircraft serial number [redacted]. The aircraft had all standard systems (with part numbers listed below) installed and is like aircraft serial number 1399.

Flight Data Recorder Part Number
FDR – P/N S800-2000-00 S/N [redacted] (Per CMP)

Flight Data Acquisition Unit Part Number:
FDAU - P/N 2231230-14-A-1 S/N [redacted] (Per CMP)

Cockpit Voice Recorder Part Number
CVR – P/N 2100-1020-00 S/N [redacted] (Per CMP)

3.3 Test Scope

The scope of the tests was limited to investigating the test objectives listed above and as specified in the flight test plan (GIV-GER-9977). Testing was performed on 2 different days, with a majority of the testing being complete on 06/19/14. The remainder of the hangar tests was complete on 06/21/14.

TABLE 1 - SUMMARY FLIGHT TEST INFORMATION

A/C No.	Date	Test Cases	Personnel
[redacted]	190614	G1-G10, T1-T3, F1	[redacted]
[redacted]	210614	G11-G13	[redacted]

3.4 System Description

3.4.1 Gust Lock System

The gust lock system is a ground safety system that protects the ailerons, elevators, and rudder from wind gusts via mechanical latches which hold the surface in a stationary position. The system is completely mechanical, consisting of pushrods, cables, cranks, and pulleys. The system is engaged and disengaged via the gust lock handle located in the cockpit center pedestal.

The gust lock handle is a two-position lever located on the right hand side of the control center pedestal. Moving the handle forward to the OFF position releases the gust locks and unlocks the control surfaces. Moving the handle aft to the ON position locks the ailerons and the rudder in the neutral position and the elevators in the 13 degrees trailing edge down position. The gust lock handle locks in the forward and aft positions. A spring latch at the lever knob must be unlocked before the gust lock handle can be moved in either direction.

A disengaged gust lock system neither affects the flight performance of the aircraft, nor receives any flight loads. An engaged gust lock system locks the control surfaces capable of withstanding wind gust of 60 knots.

Each gust lock consists of a mechanical latch, springs, and a bungee rod. The aileron gust lock mechanism is located at Fuselage Station 283 below the cabin flooring. The elevator and rudder gust lock mechanisms are located at Fuselage Station 775 in the tail compartment. Moving the gust lock handle to the aft position transmits motion to the gust locks through a 3/32-inch diameter 7 x 7 cable. Final input to the locks is made through a spring bungee. The aileron and rudder gust locks engage the flight control system linkage when they are in the neutral position. If a surface is not in the neutral position when the gust lock handle is engaged, a cammed lead-in at the gust lock will guide the control linkage into the lock as the control reaches neutral position. (This action occurs when the controls in the cockpit initially attempt to pass through neutral with the gust lock handle in the ON position.) As the

surface reaches neutral, the control linkage progresses along the cam, deflecting the spring bungee to engage the gust lock. The elevator lock detent is at the upper end of the mechanical latch and engages when the control columns are moved forward, deflecting a spring bungee. With the gust lock handle in the OFF position, the bungee acts as a fixed rod to minimize any possibility of the locks being engaged or jammed. An additional safety feature is a set of two springs at each gust lock which will unlock the surfaces in the event of a failure in the system.

3.4.2 Flight Power Shutoff Valve (FPSOV)

The flight power shutoff system provides a means to manually shut off hydraulic pressure to the flight control system actuators. This is accomplished by the flight power shutoff T-handle, located on the aft portion of the center pedestal. When the T-handle is pulled up, it operates a shutoff valve which shuts off hydraulic pressure to the following actuators: ailerons, flight spoilers, ground spoilers, elevators, and rudder.

The flight power shutoff valve is located at Fuselage Station 498.0, at approximately the centerline of the aircraft. Access to the valve is readily available through the right main landing gear wheel well. The valve is a two-section, two-position (open or closed), manually operated rotary valve. The two sections of the valve are mounted in a single body. The sections of the valve are mechanically connected, but hydraulically separate. The valve is rotated by means of a crank splined to the valve shaft and is connected by a controlex push-pull cable, which is routed under the floorboards to the flight power shutoff T-handle. One section of the valve controls the application of hydraulic pressure from the combined hydraulic system to the flight control system actuators. The other section of the valve controls the application of hydraulic pressure from the flight hydraulic system to the flight control system actuators. The push-pull cable run is sealed at Fuselage Station 321.5 where it exits from the pressurized area.

Pulling the flight power shutoff T-handle to the up (vertical) position causes motion to be transmitted by the push-pull cable to the flight power shutoff valve, moving it to the closed position. With the shutoff valve in the closed position, hydraulic pressure is removed from the flight control system actuators by porting cylinder pressure to return. With hydraulic pressure removed, the flight controls revert to manual operation and the flight spoilers and ground spoilers become inoperative. Returning the flight power shutoff T-handle to its normal position (horizontal) will return the flight power shutoff valve to the open position, restoring hydraulic system pressure to the respective flight control actuators.

A mechanical stop is provided for the flight power shutoff valve to prevent its travel beyond the point that it cannot be returned to the open position by returning the T-handle to the normal (horizontal) position.

3.4.3 Gust Lock/Throttle Interlock

The Gust Lock contains a safety mechanism that restricts the movement of the throttle levers with the gust lock system engaged / locked. The function of the mechanism is to restrict throttle movement with locked flight controls. The gust lock sector assembly inside the pedestal housing mounted to the cockpit

floor contains a stop which interfaces with corresponding stops on the left and right power lever sectors. These stops are positioned on the sectors to allow full throttle movement with the gust lock handle stowed, and 6 degrees of rotation above idle at the throttle sectors with gust lock handle in the up and latched position.

3.4.4 Yaw Damper System

A series mode yaw damper is incorporated into the rudder actuator. Controlled by the autopilot, the yaw damper provides stability augmentation by automatically counteracting any dutch roll tendency of the aircraft. The system is referred to as a series mode system in that no feedback is provided through the rudder pedals.

The yaw damper system consists of a solenoid-operated shutoff valve, transfer valve, servo ram and summing lever / transducer. Electrical power is supplied to the system through the Right Main and Essential 28 VDC buses. Hydraulic power is supplied to the system by the Flight hydraulic system only. Located on the pilot's flight panel, the YAW DAMP ENG / DISENG switch engages or disengages the yaw damper. With the yaw damper engaged (amber DISEN switch legend extinguished), 28 VDC power energizes the solenoid-operated shutoff valve to the open position. Flight hydraulic system pressure then flows to the transfer valve. Hydraulic pressure flow and volume through the transfer valve is controlled by the torque motor using a jet pipe / receiver pipe arrangement.

Depending on commands provided by the autopilot, the torque motor positions a jet pipe to direct hydraulic pressure to two receiver pipes inside the transfer valve. If equal commands are sent by the autopilot, the jet pipe remains in a centered, or null, position. When unequal commands are sent, the torque motor deflects the jet pipe in the necessary direction to supply more pressure to one receiver pipe than the other. This shifts the transfer valve spool and hydraulic pressure flows from the transfer valve to the servo ram.

Under hydraulic pressure, the servo ram then moves in the desired direction to reposition the rudder actuator servo control valve which, in turn, results in rudder movement. As the system moves the rudder, a summing lever / transducer assembly provides position information to the yaw servo amplifier. The servo amplifier, in turn, nulls the signal to the transfer valve.

3.5 Instrumentation

The following instrumentation and fixturing were required for testing as specified by the test plan. See Section 4.2 for a list of deviations.

- Video and audio recording devices to record pilot inputs and handle/lever positions
- The standard TC configuration flight data recorder
- Tape marks affixed to the cockpit pedestal to measure gust lock handle positions

4.0 TEST RESULTS AND DISCUSSION

The test point sequence is reordered in this document from the original test plan to separate the Hangar, Ground, Taxi, and Flight test segments.

4.1 Methodology

The following procedures outline the test methodology.

- The gust lock handle was considered unlatched when the spring-loaded handle is rotated towards the aft position such that the entire handle is capable of being moved slightly forward, out of its detent position.
- The gust lock system was considered OFF and unlocked when the aileron, rudder and elevator systems are able to move freely.
- The gust lock system was considered ON and locked when the handle is in the full aft position (in the detent, with handle latched) and the flight control systems are locked in place.
- The rudder trim was initially set to zero units before starting any test.
- FDR recorded data for all tests.

4.2 Deviations

The actual tests deviated from the Instrumentation list in Section 3.5 as follows:

– Cockpit video and audio recording devices were only used on test cases G4, G8, G10, & T3.

– Pedestal protractors and tape marks were not installed

– Inclinometers and throw boards were used to measure surface deflections for G9-G11

Additional test cases that deviated from the original test plan were performed and recorded in the following test results section.

5.0 HANGAR TESTS

5.1 Hangar Test-Baseline GL On, Surface Deflections (G11)

1. Initial A/C configuration:
   -Rudder trim ZERO
   -Hydraulic power OFF
   -Gust lock handle OFF
   -*Tail stand required
2. Move GL to ON position.
3. Apply 20 lbs of force, in both directions, to:
   -One Aileron Surface

-One Elevator Surface
-Rudder Surface

4. Record surface deflection using protractor/inclinometer.

RESULTS:

Manual Control Surface Deflection in Hangar with Gust Locks Engaged, Readings from surface inclinometer	Control Surface Deflection (deg)			
	Test G11			
	TRAILING EDGE UP/LEFT	TRAILING EDGE DOWN/RIGHT	MAX Δ (inclinometer)	MAX Δ (RVDT)
Elevator - Inclinometer	1.01	0.19	1.2	1.67
Rudder - Inclinometer	1.75	0	1.75	1.23
Aileron - Inclinometer	1.86	2.48	4.34	3.69

FIGURE 1 - G11 SURFACE DEFLECTION RESULTS

5.2 Hangar Test-Hydraulics On, Surface Deflections (G12)

1. Initial A/C configuration:
-Rudder trim ZERO
-Hydraulic power OFF
-Gust lock handle ON
-*Tail stand required

2. Start Combined hydraulic power source (cart).

3. Apply 20 lbs of force, in both directions, to:
-One Aileron Surface
-One Elevator Surface
-Rudder Surface

4. Record surface deflection using protractor/inclinometer.

RESULTS:

Manual Control Surface Deflection in Hangar with Gust Locks Engaged, Readings from surface inclinometer	Control Surface Deflection (deg)			
	Test G12			
	TRAILING EDGE UP/LEFT	TRAILING EDGE DOWN/RIGHT	MAX Δ (inclinometer)	MAX Δ (RVDT)
Elevator - Inclinometer	0.7	0.09	0.79	0.37
Rudder - Inclinometer	0.75	-0.2	0.95	0.35
Aileron - Inclinometer	0.82	0.73	1.55	1.09

FIGURE 2 - G12 SURFACE DEFLECTION RESULTS

5.3 Hangar Test-Hydraulic Preload, Surface Deflections(G13)

1. Initial A/C configuration:
   -Rudder trim ZERO
   -Combined system hydraulic power ON
   -Gust lock handle ON
   -*Tail stand required

2. Input 3-5 degrees of rudder trim.

   RESULTS: 2.5 units of right rudder trim activated the rudder limit CAS message

3. Apply 20 lbs of force, in both directions, to:
   -One Aileron Surface
   -One Elevator Surface
   -Rudder Surface

4. Record surface deflection using protractor/inclinometer.

   RESULTS:

Manual Control Surface Deflection in Hangar with Gust Locks Engaged, Readings from surface inclinometer	Control Surface Deflection (deg)			
	Test G13			
	TRAILING EDGE UP/LEFT	TRAILING EDGE DOWN/RIGHT	MAX Δ (inclinometer)	MAX Δ (RVDT)
Elevator - Inclinometer	0.4	0.09	0.49	0.33
Rudder - Inclinometer	-0.5	-0.8	0.3	0.17
Aileron - Inclinometer	0.69	0.51	1.2	0.95

FIGURE 3 - G13 SURFACE DEFLECTION RESULTS

5. Remove hydraulic power.
6. Return rudder trim to zero
7. Reset GL to OFF position, end ground stationary hangar testing.

RESULTS:

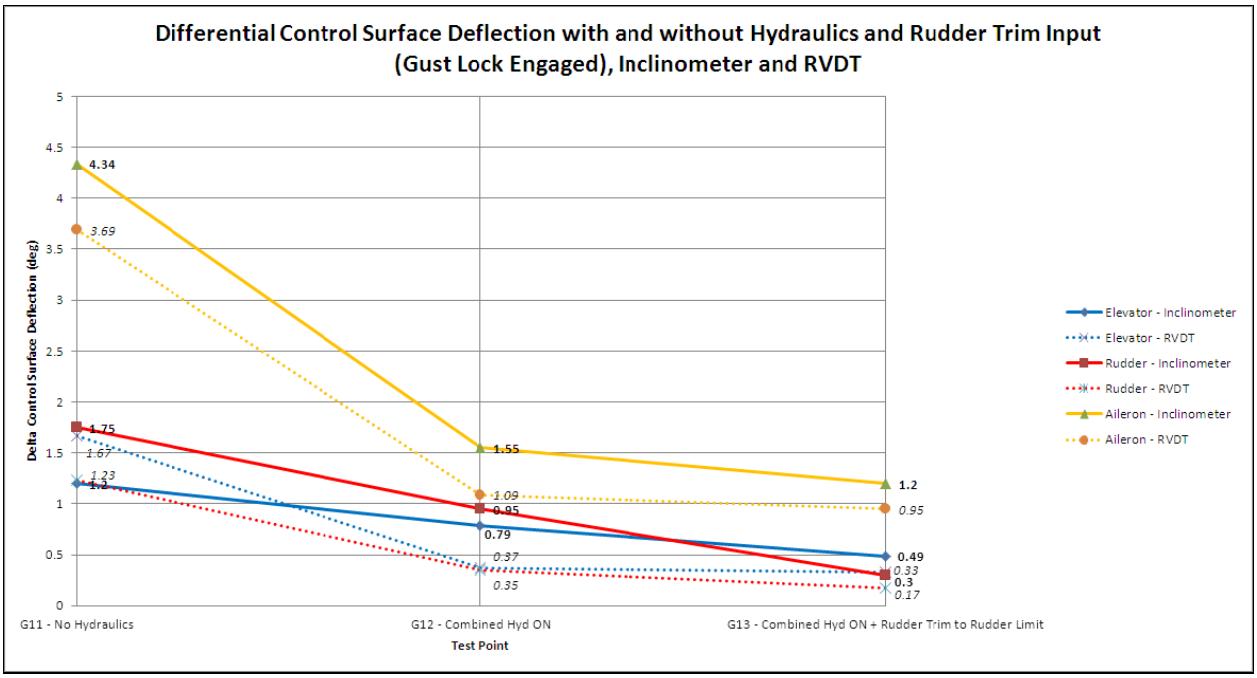

FIGURE 4 - G11, G12, G13 SUMMARY RESULTS

RESULTS: FDR surface position data was also recorded. The circled areas of the FDR plots in Figure 5 correlate to the same data collection time as the surface deflection measurements in Figure 4.

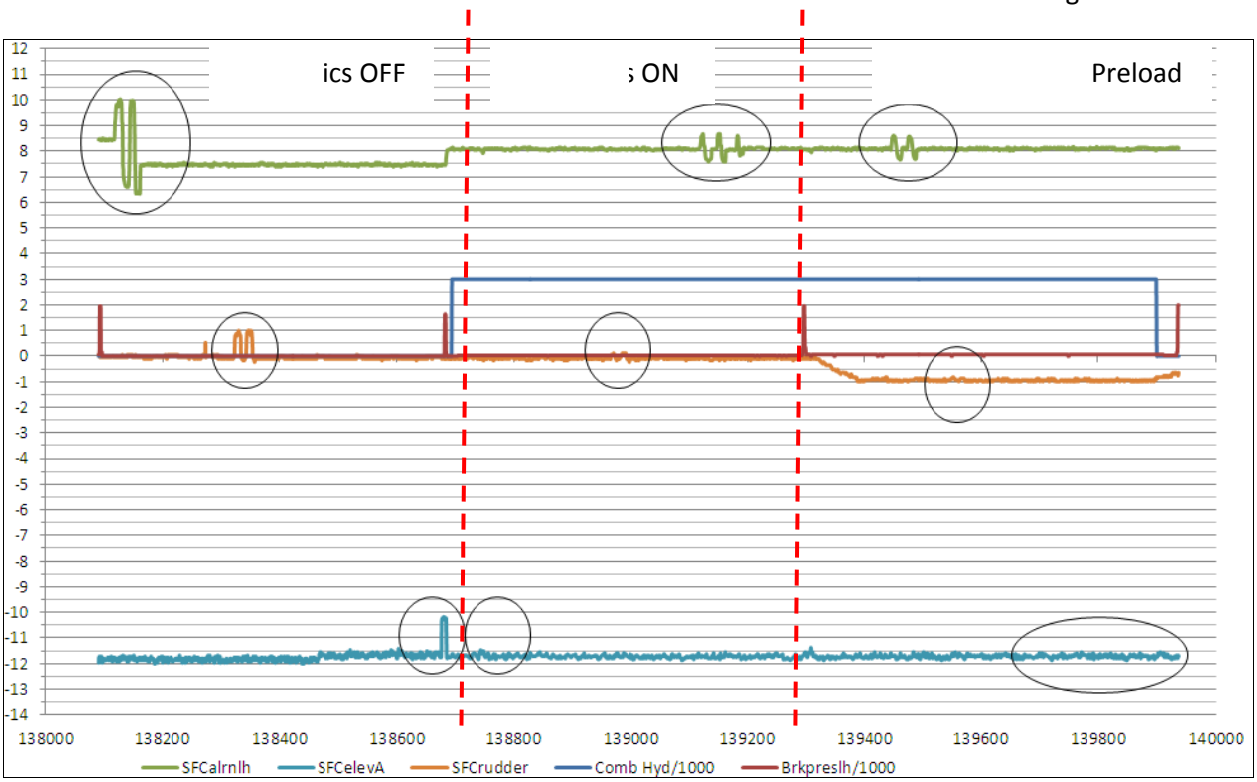

FIGURE 5 - G11, G12, G13 FDR RVDT POSITION RESULTS

6.0 GROUND STATIONARY TESTS

6.1 Aircraft Preparation

1. Inspect the aircraft to ensure all standard TC components are installed and functioning correctly:

   -Gust Lock System
   -Flight Data Recorder
   -Cockpit Voice Recorder
   -FPSOV System

2. Install cockpit video/audio recorder

   DEVIATION: Audio/video recorder not installed for all tests.

3. Install pedestal protractor

   DEVIATION: Protractor not installed

6.2 Ground Stationary Test-Baseline GL On, No Hyd (G1)

1. Initial A/C Configuration:
   -Rudder trim ZERO

-Hydraulic power OFF
-Gust lock ON

2. Check all FCS controls for freedom of motion, record results.

   RESULTS: All surfaces locked

3. Proceed to next test.

6.3 Ground Stationary Test-Baseline GL On, Hyd On (G2)

1. Initial A/C configuration:
   -Rudder trim ZERO
   -Hydraulic power OFF
   -Gust lock ON

2. Provide Combined system hydraulic power to A/C (engines or cart).

   RESULTS: Left engine (only) running and remains ON for tests G2-G10.

3. Check all FCS controls for freedom of motion, record results.

   RESULTS: All surfaces locked

4. Proceed with next test.

6.4 Ground Stationary Test-Baseline GL Unlatched, Hyd On (G3)

1. Initial A/C configuration:
   -Rudder trim ZERO
   -Combined system hydraulic power ON
   -Gust lock ON

2. Unlatch GL handle, move slightly forward out of detent.

3. Check FCS controls for freedom of motion, record results.

   RESULTS: GL returns to forward/down position and all surfaces are free. The GL release felt the same as with hydraulics off.

4. Ensure GL to OFF position, proceed to next test.

6.5 Ground Stationary Test-Baseline GL Unlatched Rudder Preload (G4)

This test case's results include audio/video recordings. Refer to the following video file:

- "G4-GL_Unlatch_by_Removing_Rudder_Trim.mov"

1. Initial A/C configuration:
   -Rudder trim ZERO

-Combined system hydraulic power ON
-Gust lock OFF

2. Move GL to ON position.
3. Check FCS controls for freedom of motion, record results.

   RESULTS: All surfaces Locked

4. Input 3-5 degrees of rudder trim.

   RESULTS: 2.5 units of right rudder trim activated the rudder limit CAS message for the remainder of the test.

5. Unlatch GL handle, move slightly forward out of detent.
6. Check FCS controls for freedom of motion, record results.

   RESULTS: Ailerons are free and rudder and elevator are locked.

7. Remove rudder trim preload.

   RESULTS: GL releases when rudder trim reaches 0 units of trim and GL handle quickly goes down.

8. Ensure GL to OFF position, proceed to next test.

6.6 Ground Stationary Test-Baseline GL Unlatched Elevator Preload (G5)

1. Initial A/C configuration:
   -Rudder trim ZERO
   -Combined system hydraulic power ON
   -Gust lock OFF
2. Move GL to ON position.
3. Input control column force in aft direction to preload the GL system. Hold.
4. Check FCS controls for freedom of motion, record results.

   RESULTS: All surfaces Locked

5. Unlatch GL handle, move slightly forward out of detent.
6. Check FCS controls for freedom of motion, record results.

   RESULTS: With approximately 15 Lbs of aft column force, GL would release. With approximately 30 Lbs of aft column force, GL would not release.

7. Release column.

   RESULTS: When column is released, GL would release

8. Ensure GL to OFF position, proceed to next test.

6.7 Ground Stationary Test-Baseline GL Unlatched Aileron Preload (G6)

1. Initial A/C configuration:
   -Rudder trim ZERO
   -Combined system hydraulic power ON
   -Gust lock OFF
2. Move GL to ON position.
3. Input control wheel (yoke) force to preload the GL system. Hold.
4. Check FCS controls for freedom of motion, record results.

   RESULTS: All surfaces Locked
5. Unlatch GL handle, move slightly forward out of detent.
6. Check FCS controls for freedom of motion, record results.

   RESULTS: Aileron wheel force could not keep the GL from releasing. GL always released.
7. Release wheel preload
8. Ensure GL to OFF position, proceed to next test.

6.8 Ground Stationary Test-Baseline FPSOV Affect (G7)

1. Initial A/C configuration:
   -Rudder trim ZERO
   -Combined system hydraulic power ON
   -Gust lock OFF
2. Move GL to ON position.
3. Check FCS controls for freedom of motion, record results.

   RESULTS: All surfaces locked.
4. Pull the FPSOV handle.
5. Check FCS controls for freedom of motion, record results.

   RESULTS: All surfaces locked.
6. Reset GL to OFF position, proceed to next test.

   RESULTS: GL releases, all surfaces free.

6.9 Ground Stationary Test-FPSOV GL Unlatched Rudder Preload (G8)

This test case's results include audio/video recordings. Refer to the following video file:

- "G8-GL_Unlatch_with_Flight_Power_Shutoff_Selected.mov"

1. Initial A/C configuration:
   -Rudder trim ZERO
   -Combined system hydraulic power ON
   -Gust lock OFF
2. Move GL to ON position.
3. Input 3-5 degrees of rudder trim.

   RESULTS: 2.5 units of right rudder trim activated the rudder limit CAS message
4. Check FCS controls for freedom of motion, record results.

   RESULTS: All surfaces Locked
5. Unlatch GL handle, move slightly forward out of detent.
6. Pull FPSOV handle.
7. Check FCS controls for freedom of motion, record results.

   RESULTS: GL immediately releases and all surfaces are free.
8. Ensure GL to OFF position, proceed to next test.

6.10 Ground Stationary Test-Baseline GL/Throttle Interlock (G9)

1. Initial A/C configuration:
   -Rudder trim ZERO
   -Combined system hydraulic power ON
   -Gust lock OFF
2. Move GL to ON position.
3. Check FCS controls for freedom of motion, record results.

   RESULTS: All surfaces Locked
4. Move thrust levers forward until GL interlock system prevents motion.
5. Record PLA position.

   RESULTS: The FDR recorded the following values.

   - Left PLA/EPR = 14.2/1.15.
   - Right PLA/EPR = 15.1/1.00 (Right engine not running)
6. Return thrust levers to idle position.
7. Reset GL to OFF position, proceed to next test.

6.11 Ground Stationary Test-GL/Throttle Interlock Release (G10)

This test case's results include audio/video recordings. Refer to the following video files:

- "G10-R_PLA_to_EPR_160_Manual_GL_ON.mov"
- "G10-R_PLA_Movement_Showing_GL_Movement_and_Spring_Action.mov"

1. Initial A/C configuration:
   -Rudder trim ZERO
   -Combined system hydraulic power ON
   -Gust lock OFF
2. Move GL to ON position.
3. Check FCS controls for freedom of motion, record results.

   RESULTS: All surfaces Locked
4. Input 3-5 degrees of rudder trim.

   RESULTS: 2.5 units of right rudder trim activated the rudder limit CAS message
5. Unlatch GL handle, move forward slightly out of detent.
6. Check FCS controls for freedom of motion, record results.

   RESULTS: Rudder and Elevator Locked, Aileron free
7. Move thrust levers forward until GL interlock system prevents motion OR GL handle begins moving.
8. Record PLA position.

   RESULTS: As reviewed on the FDR plot, the PLA was approximately 28 when the GL started to move (Reference Figure 6).
9. Record GL handle position.

   RESULTS: GL handle remained in the unlatched, slightly forward position.
10. Continue moving thrust levers forward until GL system disengages.
11. Record GL handle position when system disengages.

    RESULTS: GL handle released to full forward and stowed position. Also noted a large amount of spring back in the GL handle as the throttle was moved forward.
12. Record PLA position.

    RESULTS: With hydraulics ON, the right engine OFF and the GL handle unlatched, the right throttle lever (only) was pushed forward until the GL/throttle interlock restricted movement. Further movement of the throttle was possible and correlated with additional forward movement of the GL handle. An increased friction force could be felt on the throttle lever as it "pulled" the GL handle with it. As soon as pilot input force was removed from the lever, both the lever and GL handle moved aft ("springs back"). Moving the throttle lever even further forward caused the GL handle to quickly release into the fully stowed position. See video "G10-R_PLA_Movement_Showing_GL_Movement_and_Spring_Action.mov".

Depending on the amount of pressure, the PLA was approximately 40 just before the GL released. This was measured on the FDR and reviewed after the test was completed. By increasing the pressure, the GL did release(Reference Figure 6).

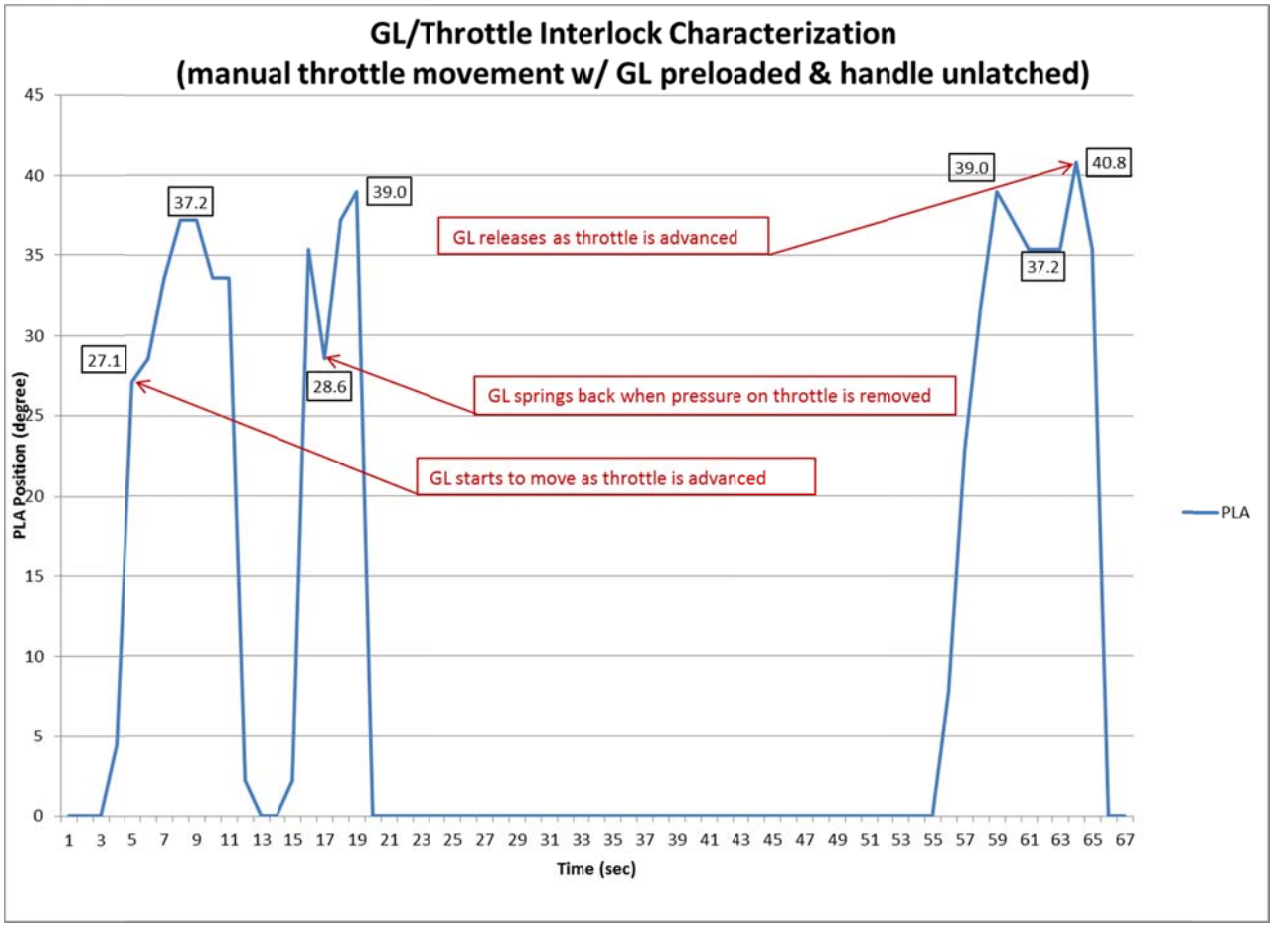

FIGURE 6 - G10 FDR RESULTS

ADDITIONAL RESULTS: As part of this test case, EPR was also recorded. With hydraulics ON, the GL handle unlatched (with rudder trim preload) the throttle levers were manually pushed forward until the GL/throttle interlock restricted motion. The throttles were able to be manually advanced to reach an EPR of 1.60. See video "G10-R_PLA_to_EPR_160_Manual_GL_ON.mov".

13. Return thrust levers to idle.
14. Remove rudder preload.
15. Ensure GL to OFF position, proceed to next test.

7.0 DYNAMIC TESTS

7.1 Dynamic Taxi Test-Yaw Damper Baseline (T1)

1. Initial A/C configuration:
   -Rudder trim ZERO
   -Left & right engines on, ready for normal taxi operations
   -Gust lock OFF
   -Yaw damper ON
2. Perform normal taxi operations.
3. C/W 2 left and right 90 degree turns at approximately 20 Knots. Ensure ground speed does not exceed 30kts including turns.

   RESULTS: See graph (Figure 7). The rudder would move from -2 degrees to +3 degrees when turning left and right.

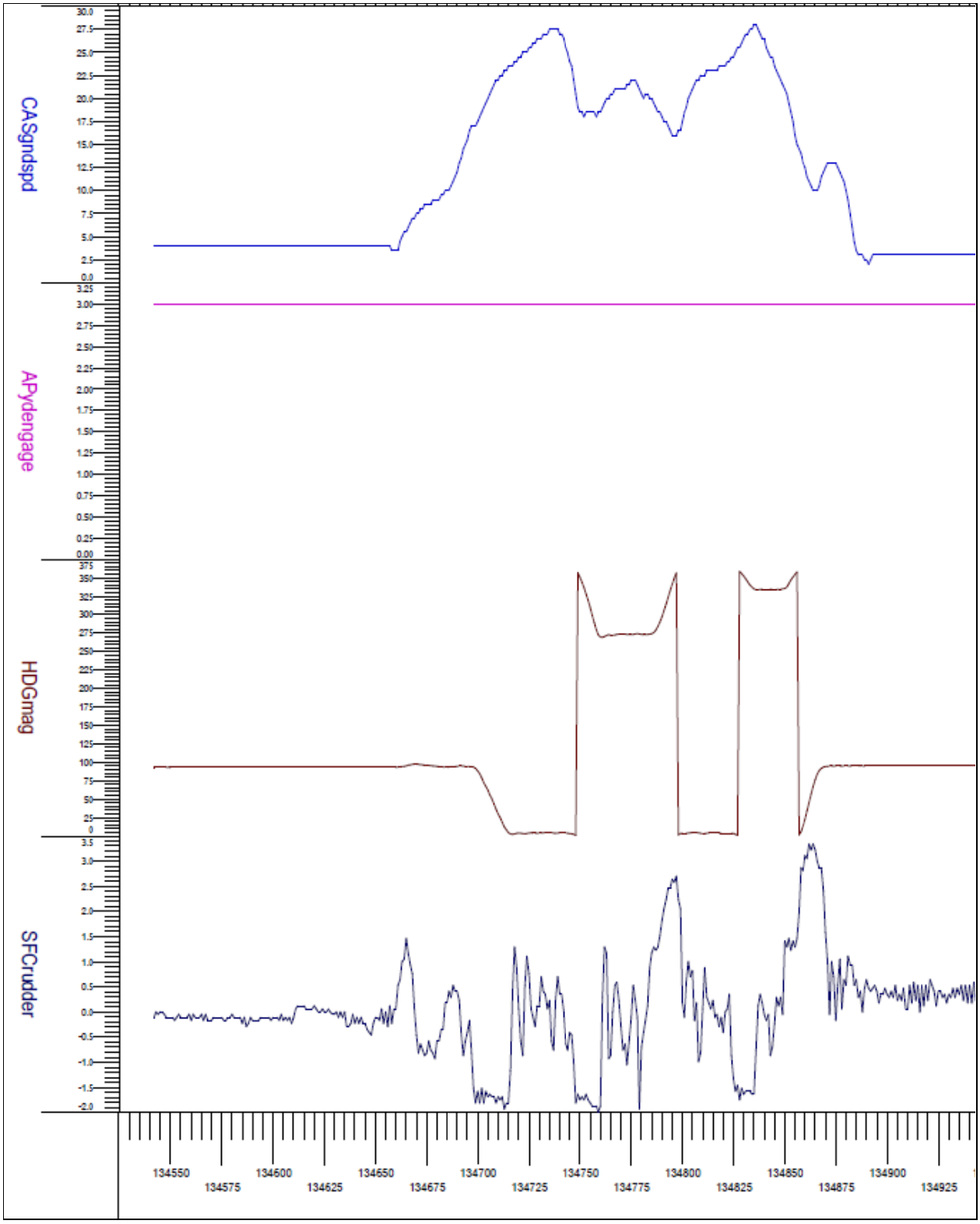

FIGURE 7 - T1 FDR RESULTS

4. Stop aircraft. Proceed with next test

7.2 Dynamic Taxi Test-Yaw Damper Characterization (T2)

1. Initial A/C configuration:
   -Rudder trim ZERO
   -Left engine ON, ready for normal taxi operations
   -Gust lock OFF
   -Yaw damper ON
   -Ensure winds are calm
2. Ensure only one engine is running.

   DEVIATION: The right hand engine had to be on for this test in order to operate the yaw damper system while taxiing. This test was done with the elevator not in the forward/locked position.
3. Move GL to ON position
4. Perform normal taxi operations.

   DEVIATION: This test was done with the elevator not in the forward/locked position. The column was held aft to prevent elevator gust lock engagement. Ailerons and rudder remained locked.
5. C/W 2 left and right 90 degree turns at approximately 20 Knots. Ensure ground speed does not exceed 30kts including turns.

   RESULTS: Some of the turns were aggressive and the rudder limit CAS message did illuminate when turning hard in either direction. The rudder limit CAS message was intermittent and was dependent on the rate of turn. The rudder would move from -1.25 degrees to +1.25 degrees when turning left and right. See FDR plots (Figure 8).

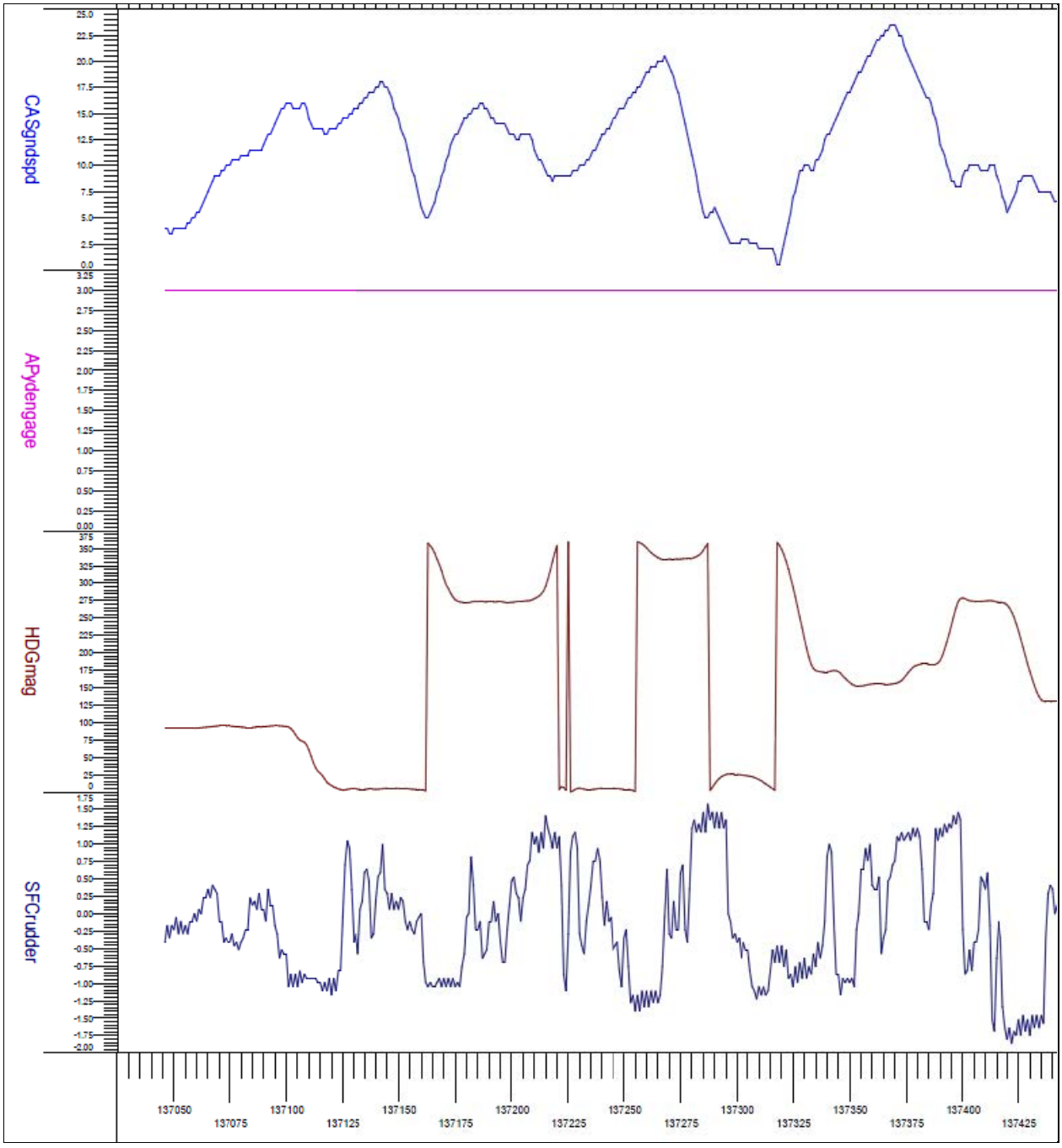

FIGURE 8 - T2 FDR RESULTS

6. Stop aircraft. Proceed with next test

7.3 Dynamic Taxi Test-Auto Throttle Engaged Test (T3)

This test case's results include audio/video recordings. Refer to the following video files:

- "T3-EPR135_AT_and_GL_Engage.mov"

- "T3-EPR140_AT_and_GL_Engage.mov"
- "T3-EPR150_AT_and_GL_Engage.mov"

1. Initial A/C configuration:
   -Left & right engines ON, ready for run-pad operations
   -Rudder trim ZERO
   -Gust lock OFF
   -Yaw damper ON
   -Brakes ON

   Condition: Aircraft heading was 94 degrees at the start of this test

2. Correlate EPR/PLA

   RESULTS: Plotted the PLA vs EPR for this day using FDR data recorded during this test.

   - With PLAs at 24.3/24.3, EPR was 1.34/1.34
   - With PLAs at 25.7/25.7, EPR was 1.40/1.40
   - With PLAs at 30.0/28.6, EPR was 1.49/1.49

   Outside temperature was 31.2 C and pressure altitude was -92 feet.

3. Move GL handle to ON position.
4. Input 3-5 degrees of rudder trim.

   RESULTS: 2.5 units of right rudder trim gave us the rudder limit CAS message

5. Unlatch GL handle, move slightly forward out of detent.
6. Verify that GL handle has not returned to OFF position.
7. Manually set target EPR

   RESULTS: 1.35 was used.

8. Engage Auto Throttle (AT).
9. Observe interaction of AT and GL/throttle interlock.

   RESULTS: As the Autothrottle system moved the throttles moved forward, the GL would also move forward. See video "T3-EPR135_AT_and_GL_Engage.mov".

10. Record EPR value.

    RESULTS: After AT's were engaged, the EPR over shot to 1.40 and returned to 1.35 (See Figures 9 & 10).

ENG1pla	ENG2pla	ENG1epr	ENG2epr	ATengag
17.50	17.50	1.156	1.168	0
17.50	17.50	1.172	1.176	0
18.75	18.75	1.187	1.180	1
22.86	22.86	1.203	1.223	1
24.29	24.29	1.269	1.351	1
24.29	22.86	1.348	1.402	1
24.29	21.43	1.379	1.383	1
22.86	21.43	1.379	1.355	1
22.86	21.43	1.363	1.340	1
22.86	21.43	1.344	1.328	1
22.86	21.43	1.332	1.324	1
22.86	22.86	1.324	1.324	1
24.29	22.86	1.332	1.328	1
24.29	22.86	1.332	1.336	1
24.29	22.86	1.340	1.340	0
15.00	15.00	1.316	1.289	0
0.00	0.00	1.207	1.160	0

FIGURE 9 - T3 AT/PLA/EPR FDR RESULTS 1

ENG1pla	ENG2pla	ENG1epr	ENG2epr	ATengag
17.50	20.00	1.160	1.168	0
17.50	18.75	1.172	1.191	1
17.50	20.00	1.184	1.203	1
20.00	21.43	1.195	1.219	1
22.86	24.29	1.219	1.309	1
24.29	24.29	1.301	1.391	1
24.29	22.86	1.363	1.383	1
24.29	21.43	1.383	1.363	1
24.29	21.43	1.375	1.348	1
22.86	21.43	1.348	1.336	1
24.29	21.43	1.340	1.340	1
22.86	22.86	1.336	1.336	1
24.29	22.86	1.332	1.332	1
22.86	22.86	1.332	1.332	1
24.29	22.86	1.332	1.336	1
24.29	24.29	1.336	1.340	1
24.29	22.86	1.340	1.344	1

FIGURE 10 - T3 AT/PLA/EPR FDR RESULTS 2

11. Record PLA position.
    RESULTS: See Figures 9 & 10.

12. Repeat test using a manual EPR of 1.40
    RESULTS: (See Figure 11).

ENG1pla	ENG2pla	ENG1epr	ENG2epr	ATengag
18.75	18.75	1.168	1.195	0
18.75	20.00	1.203	1.215	1
21.43	22.86	1.223	1.234	1
24.29	25.71	1.250	1.375	1
25.71	24.29	1.344	1.430	1
25.71	24.29	1.406	1.426	1
25.71	22.86	1.426	1.410	1
25.71	24.29	1.422	1.398	1
24.29	22.86	1.398	1.391	1
24.29	22.86	1.387	1.379	1
24.29	22.86	1.379	1.371	1
25.71	24.29	1.375	1.379	1
25.71	24.29	1.383	1.383	1
25.71	24.29	1.387	1.387	1
25.71	25.71	1.391	1.394	1
25.71	25.71	1.391	1.398	1
25.71	24.29	1.398	1.402	1
25.71	25.71	1.402	1.402	1
25.71	25.71	1.402	1.402	1
25.71	24.29	1.402	1.398	1
25.71	24.29	1.398	1.394	1
25.71	24.29	1.398	1.394	1
25.71	24.29	1.398	1.391	1
25.71	24.29	1.398	1.391	1
24.29	24.29	1.394	1.391	1
25.71	24.29	1.394	1.394	1
24.29	24.29	1.394	1.398	1
25.71	24.29	1.394	1.402	1
22.86	24.29	1.391	1.398	0
17.50	18.75	1.391	1.351	0

FIGURE 11 - T3 AT/PLA/EPR FDR RESULTS 3

13. Repeat test using a manual EPR of 1.50

    RESULTS: (See Figure 12).

ENG1pla	ENG2pla	ENG1epr	ENG2epr	ATengag
16.25	17.50	1.172	1.180	0
17.50	18.75	1.180	1.195	1
17.50	18.75	1.187	1.211	1
18.75	20.00	1.199	1.223	1
25.71	25.71	1.211	1.383	1
27.14	27.14	1.363	1.531	1
27.14	24.29	1.496	1.527	1
25.71	24.29	1.523	1.504	1
25.71	24.29	1.508	1.484	1
25.71	24.29	1.500	1.476	1
27.14	25.71	1.480	1.476	1
27.14	27.14	1.484	1.476	1
27.14	25.71	1.476	1.496	1
27.14	27.14	1.488	1.496	1
27.14	25.71	1.496	1.496	1
27.14	27.14	1.500	1.496	1
27.14	27.14	1.492	1.496	1
28.57	27.14	1.500	1.492	1
27.14	27.14	1.500	1.492	1
30.00	28.57	1.488	1.496	1
28.57	28.57	1.496	1.496	1
30.00	28.57	1.488	1.496	1
30.00	28.57	1.488	1.496	1
30.00	28.57	1.496	1.492	1
30.00	28.57	1.500	1.496	1
30.00	28.57	1.500	1.496	1
30.00	28.57	1.492	1.496	1
30.00	28.57	1.496	1.496	1
30.00	28.57	1.504	1.504	1
30.00	28.57	1.504	1.504	1
30.00	28.57	1.508	1.504	1
30.00	28.57	1.492	1.496	1
30.00	28.57	1.496	1.496	0

FIGURE 12 - T3 AT/PLA/EPR FDR RESULTS 4

14. Record GL handle position.

    RESULTS: Handle remained unlatched (not fully stowed).

15. Bring throttle back to idle.

16. Remove rudder trim input. .

17. Verify GL handle is in OFF position.

7.4 Dynamic Flight Test-FPSOV/Control Surface Characterization (F1)

1. Initial A/C configuration:
   -Left and right engines on, ready for flight

-Rudder trim ZERO
-Gust lock OFF
-Yaw damper ON

2. Perform normal takeoff, reach 10k-15k ft and 250 KCAS.
3. Perform modified GIV Condition Survey Test for Manual Reversion (as described below).
4. Pull FPSOV.

   RESULTS: A/C altitude at 11256 feet, CAS at 252 knots and flaps at 0 degrees. There was very little position change to any surface (See Figure 13).

5. Reset FPSOV.
6. Repeat test with flaps at 20 and airspeed at 170 kts.
7. Pull FPSOV.
8. **RESULTS:** A/C altitude, 11320 feet, and CAS at 165 Knots and flaps at 20 degrees. The surface position change is much more noticeable when the flight power shutoff system is activated. Yaw Damper disengaged only after some aircraft roll input (See Figure 13)

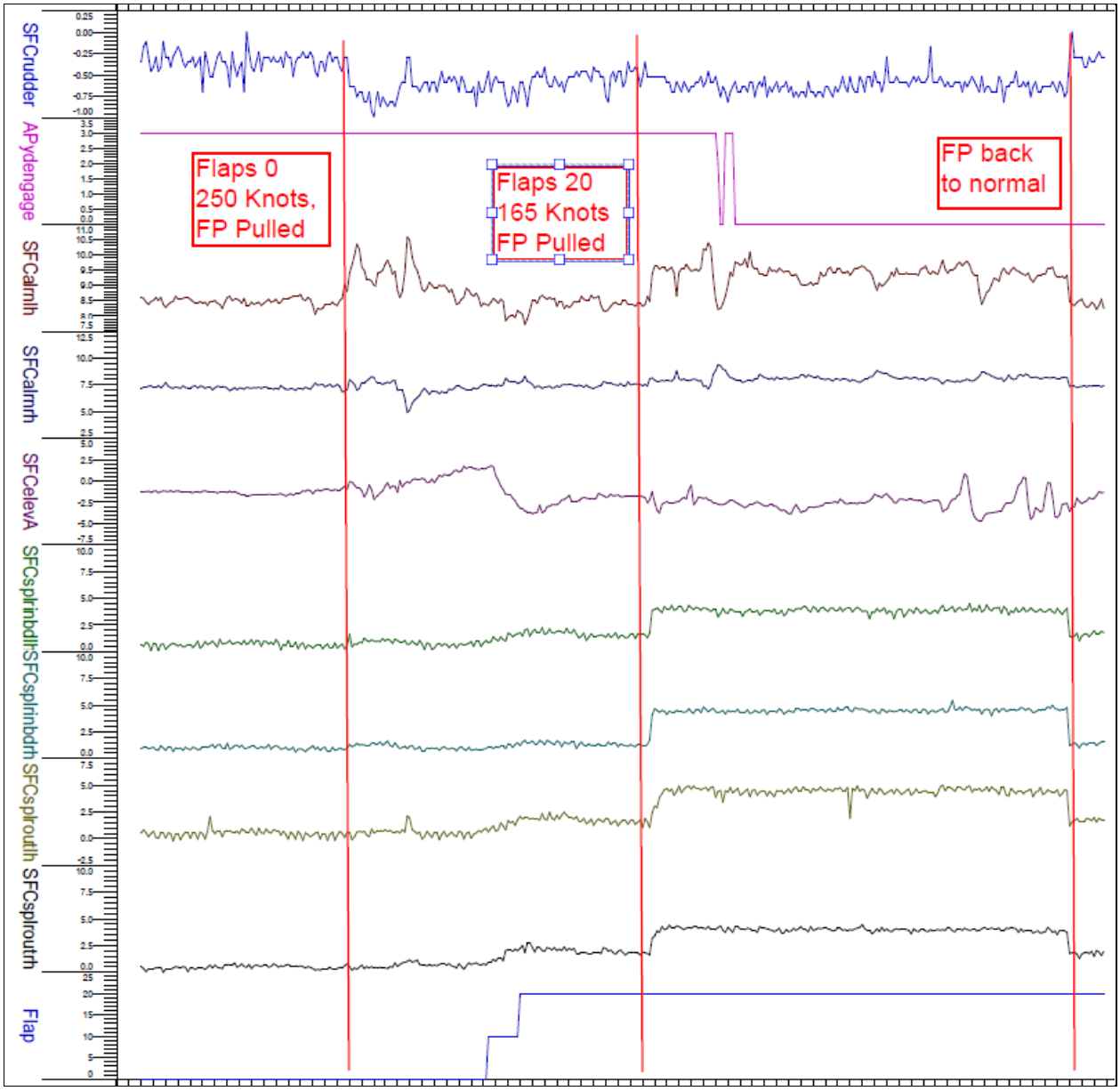

FIGURE 13 - F1 FDR RESULTS

9. Reset FPSOV.
10. Return to base.

8.0 REFERENCES

Doc. No.: GIV-GER-9977, Ground & Flight Test Plan – GIV Gust Lock System, June 19, 2014

Video: "G4-GL_Unlatch_by_Removing_Rudder_Trim.mov"

Video: "G8-GL_Unlatch_with_Flight_Power_Shutoff_Selected.mov"

Video: "G10-R_PLA_to_EPR_160_Manual_GL_ON.mov"

Video: "G10-R_PLA_Movement_Showing_GL_Movement_and_Spring_Action.mov"

Video: "T3-EPR135_AT_and_GL_Engage.mov"

Video: "T3-EPR140_AT_and_GL_Engage.mov"

Video: "T3-EPR150_AT_and_GL_Engage.mov"