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GVI Field Performance Certification Flight Test Plan Excerpt

(81 pages)

Gulfstream

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GVI Field Performance Certification Flight Test Plan

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REVISION HISTORY

REV	PARA	DESCRIPTION OF CHANGE
A	2.0	Initial Release, No Change (NC)Table 1, updated 14 CFR paragraph reference.
	3.1	Corrected wing area reference.
	3.2.2	Revised maximum takeoff weight and added clarification for higher weight testing.
	5.1	Second paragraph revised discussion of target pitch attitudes for V_{MU} testing and added reference to wind tunnel tests, subsequent references updated.
	5.1.1.2	Revised analysis method discussion.
	5.1.3.3	Added additional success criteria.
	5.2.4.1	Revised terminology to specify throttle chop.
	5.3.1.1	Revised test procedure to maintain pitch attitude through 35 ft AGL.
	5.3.1.3	Revised / added success criteria.
	5.3.2.1	Revised test procedure to maintain pitch attitude until out of ground effect / positive ROC.
	5.3.2.3	Revised success criteria.
	5.3.3.1	Revised test procedure to maintain pitch attitude until out of ground effect / positive ROC.
	5.3.4.1	Revised test procedure to include aft CG nose up mistrim and specify short term force limit for nose down mistrim.
	5.3.4.3	Revised success criteria.
	5.4.3.1	Revised test procedure to ensure thrust decays to idle before V1.
	5.4.5	Removed Antiskid Inoperative RTO procedure. Re-number sections 5.4.6 and 5.4.7.
	5.4.5.1	Was 5.4.6.1. Revised procedure steps 6 and 7.
	5.4.6.1	Was 5.4.7.1. Revised procedure.
	5.5.1.1	Revised procedure step 7.
	5.5.2.1	Revised procedure to add hydraulic depress and ensure thrust decays to idle before V1.
	5.5.3	Revised section title to Single T/R.
	5.5.3.1	Revised procedure to call out single T/R max reverse,add hydraulic depress and ensure thrust decays to idle before V1.
	5.6.5	Removed Antiskid Inoperative Landing procedure. Re-numbered sections 5.6.6 thru 5.6.9. Table 5, added TSHA for Landing Loss of Half Brakes.
	5.6.8	Was 5.6.9. Removed Loss of Half Brakes procedure. Refer to brake control FTP.
	7.0	Added low speed wind tunnel test report and brake control system flight test report references, and renumbered subsequent references.

	App B	Split App B into B1 Development and B2 Certification
		93-324, 93-331, 93-332, 93-333: added flight conditions
		93-334: revised procedure / added flight conditions
		93-353: revised procedure and flight conditions
		93-364: revised TSHA risk level
	App C	Revised Max KE RTO TSHA

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1.0 INTRODUCTION

This Flight Test Plan contains the Field Performance test program required for certification of the Gulfstream Model GVI. The purpose of these tests are to gather the necessary data required to develop takeoff and landing operating speed schedules and distances for the Airplane Flight Manual (AFM) and to show compliance with the regulations. Test data will be gathered, reduced and presented in a format consistent with Gulfstream Aerospace Corporation (GAC) Engineering requirements for the construction of aircraft performance charts and incorporation into the AFM Performance Section. The testing will consist of minimum unstick speed (V_{MU}), takeoff speed schedule development, all-engine takeoffs, engine-out takeoffs, abused takeoffs, rolling takeoffs, all-engine Rejected Takeoffs (RTO), engine-out RTOs, alternate dispatch case RTOs, the maximum Kinetic Energy (KE) RTO, free rolls, thrust reverser effectiveness, landing flare development, HUD landing dispersion, full stop landings, and failure case landings.

1.1 Test Objective

The objective of the testing is to gather data for use in determining performance parameters for AFM takeoff and landing expansion. Initial testing for each type of test will begin with development testing to develop aircrew techniques and determine aircraft performance characteristics (e.g. speed gains and critical engine). Certification testing will follow the development testing to gather data required for development of the AFM.

Prerequisite testing, not contained within this test plan, required for scheduling speeds and predicting climb gradients includes: in-ground effect airdata calibrations, stall speeds (V_{SR}), minimum control speeds (V_{MCG}, V_{MCA}, V_{MCL}) and climb performance. Details of the airdata calibrations are found in Reference 1. Details of the stall speeds testing are found in Reference 2. Details of the minimum control speeds testing are found in Reference 3. Details of the climb performance testing are found in Reference 4. Post flight analyses of these data are required prior to commencement of the field performance testing.

Prerequisite testing, contained within this test plan, includes minimum unstick speed, takeoff rotation development, and landing flare development. Additionally, the RTO testing will build up in KE to the completion of the maximum KE RTO.

2.0 APPLICABLE REGULATIONS AND/OR DOCUMENTATION

The applicable airworthiness and certification requirements for the Federal Aviation Administration (FAA) are presented in 14 CFR Part 25 at the amendment level as defined by Issue Paper (IP) G-1, Reference 5. The European Aviation Safety Agency (EASA) CS-25 requirements for field performance are defined by CRI A-08, Reference 6. Table 1 outlines the paragraphs of the regulations from 14 CFR Part 25 / CS-25, and the associated amendment level, for field performance testing. This flight test plan was developed to meet the requirements as outlined in the GVI Airplane Performance Certification Plan, Reference 7.

TABLE 1 – GVI FIELD PERFORMANCE 14 CFR PART 25 / CS 25 REQUIREMENTS

Regulation Paragraph Number 14 CFR Part 25 / CS-25	Amendment 14 CFR Part 25 / CS-25	Regulation Paragraph Title
25.21 (a)(1)	25-72 / 2	Proof of Compliance
25.101 (f), (h)	25-92 / 2	Performance: General
25.105 (b), (c)(1)(i)	25-92 / 2	Takeoff
25.107 (b)(1)(ii), (c)(1), (c)(2), (d), (e)(1)(iii), (e)(1)(iv), (e)(2), (e)(3), (e)(4), (f)	25-108 / 2	Takeoff Speeds
25.109 (a)(1)(i), (a)(1)(ii), (a)(1)(iii), (a)(2)(i), (a)(2)(ii), (e), (f)(2), (g), (i)	25-92 / 2	Accelerate-stop Distance
25.111 (c)(2), (d)(4)	25-115 / 2	Takeoff Path
25.113 (a), (b)(2)	25-92 / 2	Takeoff Distance and Takeoff Run
25.125 (a)(3), (a)(4), (a)(5), (b)	25-108 / 2	Landing
25.1591(b)	2	Performance Information for Operations with Contaminated Runway Surface Conditions

3.0 CONFIGURATION

The GVI, Figure 1, is a new design high altitude, long range executive jet transport from GAC that requires a new Type Certificate, and will provide enhanced speed, range, cabin volume, and accommodations beyond heritage GAC products. The aircraft design is a low, swept wing monoplane with winglets, a T-tail, and two turbofan engines mounted in nacelles on the aft fuselage. The landing gear is a conventional, retractable tricycle gear with a cantilevered type nose gear and trailing arm type main gear.

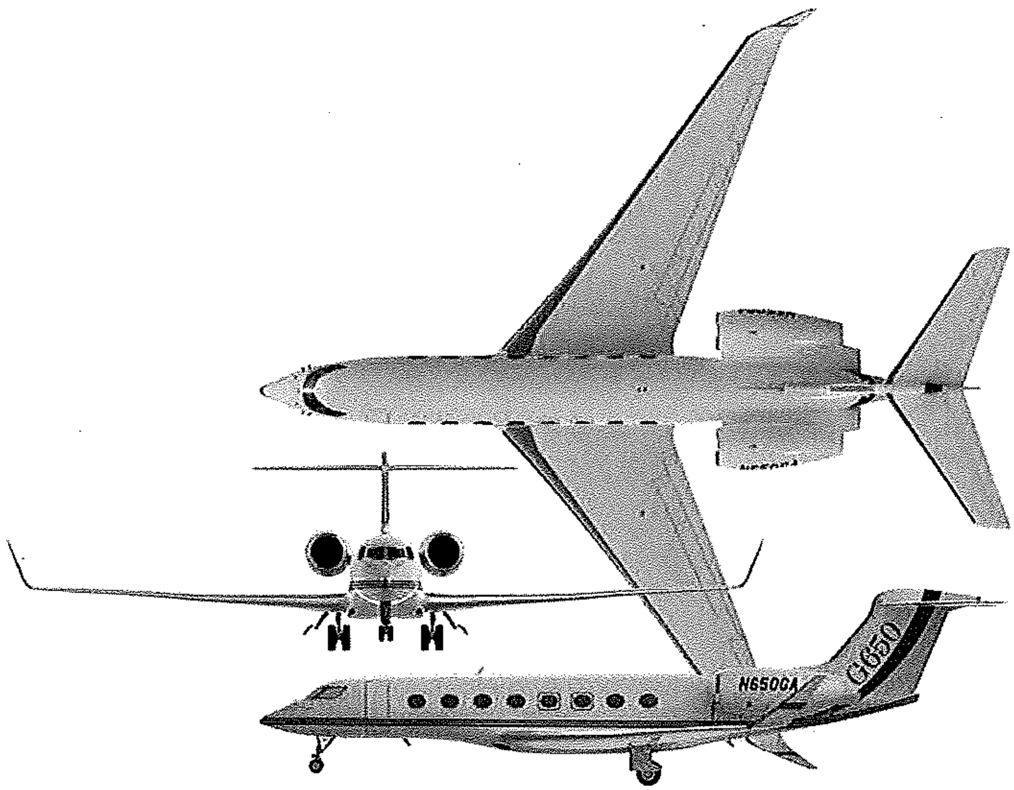

FIGURE 1 – GVI THREE-VIEW

3.1 System Description

Field performance tests are airframe level tests of the aircraft and all of the aircraft systems. GVI design features pertinent to field performance testing include the following:

Fuselage: Fuselage width is108 inches, and overall length is 98.40 feet.

Wing: Wing span is 99.62 feet, and wing area is 1282.9 ft^2. The wing airfoil shape is contoured for enhanced high speed performance with a 33° quarter chord sweep. [redacted] The GVI is equipped with Fowler-type flaps, with detent settings of cruise 0°, approach / alternate takeoff 10°, approach / normal takeoff 20°, and landing 39°. The hydraulically actuated control surfaces include one aileron and three spoiler / speed brake panels per wing. Aileron deflection limits are 19° Trailing Edge Up (TEU)/ 11° Trailing Edge Down (TED) and spoiler / speed brake deflection limits are 55° TEU.

Empennage: Horizontal Tail (HT) planform area is 277 ft^2. HT airfoil shape is also contoured, has nominal leading edge sweep of 34.17° and [redacted]. The HT comprises a trimmable stabilizer and two elevator panels. Horizontal stabilizer deflection limits are 10.5° TEU and 0.5° TED. Elevator deflection limits are 24° TEU and 13° TED. The VT is a symmetrical airfoil shape with a single rudder panel. The rudder deflection limits are ± 25°.

Air Data: Four Goodrich SmartProbes provide AOA, altitude and airspeed indications to the aircrew and to the Flight Control System (FCS). Two Goodrich Aerospace 0102LV1DF total air temperature probes provide air temperature input.

Engines: Engines are Rolls-Royce BR700-725A1-12, which are a derivative of the BR700-710C4-11. The control system is Full Authority Digital Control (FADEC). Installed thrust at Sea Level is 16,100 lb, [redacted]

Thrust Reversers: The thrust reversers are manufactured by Spirit Aero Systems and General Electric, and are controlled and monitored primarily by the engine FADECs.

Flight Control System: The new, 3-axis Fly-By-Wire (FBW) FCS is provided by Thales. The FCS includes primary and secondary flight controls, and the trimmable HT.

Ground Spoilers: Six multi-function spoiler panels (three pair) are controlled by FCS. They are automatically deployed during landing or in a rejected takeoff provided conditions for ground spoiler deployment are satisfied. The spoilers may also be deployed manually via the speed brake handle, but to a lesser deflection angle.

Head-Up Display System (HUD): The HUD is an electronic and optical system that generates and displays information in the pilot's forward field of view. The displayed information is derived from the aircraft instruments and sensor data.

Landing Gear, Wheels, Tires and Brakes: The landing gear is of a tricycle type, and is a new design for the GVI. The wheels and tires support pressure sensing, and use radial tires for the mains and bias tires for the nose. The brakes are carbon, and the antiskid is a brake-by-wire (BBW) system.

Hydraulics: A conventional 3000 psi hydraulic power system includes left main and right main hydraulic power systems. The flight control architecture incorporates electronic backup hydraulic actuators in lieu of a third hydraulic system.

3.1.1 Air Data

Four Goodrich Air Data SmartProbe (ADSP) modules are the basis of the GVI air data system. Each self-contained ADSP consists of a multi-function probe (MFP) mounted to a two-channel air data computer (ADC), which measures local total pressure, static pressure, and angle of attack. Compensation for sideslip errors and measurement of aircraft sideslip angle is accomplished through comparison of left and right side aircraft static source pressures. Each probe head includes four static source ports. The two aft are pneumatically manifolded for use in sideslip determination; the two forward are used in determination of static pressure and aircraft angle of attack. All communication between ADSP modules and other aircraft systems is done electronically and requires no pneumatic tubing. The four independent ADSP modules allow for multiple redundancies since each can function independently should one or more of the other ADSPs become inoperative.

The production ADS will use two Goodrich Aerospace dual-sensor Total Air Temperature (TAT) probes mounted below the cockpit on the left and right side of the aircraft. The upper left ADSP, upper right ADSP for cross static and the left TAT probe supply the pilot Primary Flight Display (PFD). The upper right ADSP, upper left ADSP for cross static and the right TAT probe supply copilot PFD. Each TAT probe is equipped with a 28 volt (RMS or VDC) self-adjusting heater which is selected on or off as necessary by the probe's respective ADSP. The production air data system is shown in Figure 2.

[redacted]

3.1.2 Engines

The GVI Powerplant System is a Rolls-Royce Deutschland BR700-725A1-12 engine (hereafter known as the BR725) along with an acoustically treated Air Inlet Cowl, a Nacelle (consisting of Fixed Cowl and removable Upper/Lower Fan Cowl Doors), and a target-type Thrust Reverser. The Powerplant System is side-mounted to the aircraft rear fuselage via mounting elements contained within an aerodynamically faired pylon. The arrangement is similar to that of the already certificated GV-SP aircraft. The Rolls-Royce BR725 engine is a mid-bypass turbofan engine featuring a single-stage, wide-chord, Low Pressure Compressor (LPC) fan driven by a three-stage turbine; a ten-stage HPC driven by a two-stage turbine; and an annular combustion chamber. Both LP and HP spools rotate in the clock-wise direction when viewed from the back of the engine. Since the Rolls-Royce BR700-725A1-12 is a derivative of the BR700-710C4-11 (used on the GV-SP), the major hardware and performance differences are as follows:

[redacted]

[redacted]

The engine EEC controls idle, Maximum Takeoff (MTO) and maximum reverse thrust levels. Idle thrust control is based on N2 (high pressure shaft speed) and altitude. The idle schedule includes flight, approach and ground idle schedules, and additionally the EEC schedules idle limiters of high idle, low ground idle and low in-flight idle. The idle limiter is primarily a function of altitude and bleed demand (i.e. anti-icing and ECS bleed demand). MTO thrust control is based on EPR (Engine Pressure Ratio). The MTO EPR is scheduled as function of ambient temperature, altitude, Mach number, and bleed demand (anti-ice and ECS). MTO is limited to 5 minutes of continuous operation under normal conditions and 10 minutes in the case of an emergency (single engine operation). Reverse thrust control is based on N1 (low pressure shaft speed). Similar to forward thrust reverse, thrust is primarily a function of temperature and altitude.

Rolls-Royce has certified the engines to CS-E (Certification Specification for Engines) with EASA and the German Civil Aviation Authority (LBA, Luftfahrt-Bundesamt). The engines have also been validated to 14 CFR Part 33 (Airworthiness Standard for Aircraft Engines) by the FAA.

3.1.3 Thrust Reversers

The BR725 Thrust Reverser is hydraulically operated and electrically controlled by the FADEC. The Thrust Reverser has two hydraulically actuated pivot doors which reverse the total mixed air flow. The Thrust Reverser attaches to the aft-most flange of the fan case. The upper and lower pivot doors are made from graphite epoxy sandwich panel with BMI acoustic face sheets. The door is supported by two aluminum pivot hinges. A schematic of the BR725 Thrust Reverser unit is shown in Figure 3. The BR725 Thrust Reverser features triple-independent mechanical, hydraulic and electrical control.

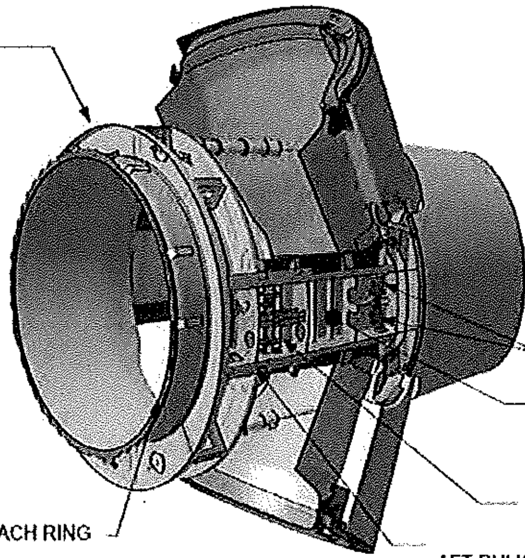

FIGURE 3 – GVI THRUST REVERSER

3.1.4 Flight Control System

The Flight Control Computers (FCCs) are the central component of the FCS. They receive sensor data from a variety of aircraft systems and control inputs from the flight deck inceptors. The FCCs process this information and transmit commands to the actuation remote electronic units (REU) located at each control surface. The actuation system includes two hydraulic systems (left and right) and one electric backup hydrostatic actuation (EBHA) system per major flight control surface. The top level summary of flight control system is shown in Figure 4.

[redacted]

The FCCs host three operational control law modes that provide different levels of flight quality: Normal, Alternate, and Direct. The Backup Flight Control Computer hosts the Backup mode used only when all four FCC channels fail. In addition to Normal mode, a First Flight mode will be made available for flight testing. The interface to control this mode is described later in this document. Field performance testing will be conducted in Normal control law operating mode. The HT is controlled through two modes: Normal mode and Secondary Mode.

3.1.4.1 Normal Mode

Normal is the default mode when all primary flight control system resources are available. This mode provides augmented pitch control through a speed and maneuver stability control law that requires angular rates, load factor, and air data signals from aircraft systems external to the FCC. When the AOA is trending toward 85% of maximum, AOA limiting is activated. Normal mode roll and yaw control is implemented such that the wheel and rudder inputs result in a gain-scheduled deflection of aileron, spoiler, and rudder surfaces. In addition, a yaw damper function is superimposed on the pilot rudder and aileron/spoiler inputs.

3.1.4.2 Normal Mode Control Law Protections

The control law provides the following features to help protect the aircraft:

- AOA limiting – stall protection function
- High speed protection – protects airplane from exceeding dive speed
- Load alleviation – commands symmetric aileron deflection to reduce loads
- Speedbrake auto-retract – retracts speedbrakes at high power settings

3.1.4.3 AOA Limiting

The control law provides the in-flight AOA limiting or high incidence protection function (HIPF). The HIPF is de-activated on the ground. The HIPF is different from a conventional pusher-shaker stall protection system. The GVI AOA limiter will limit the maximum angle of attack that can be obtained in-flight. AOA will be displayed in the cockpit and normalized by AOA at V_{MIN}. The control column position at the full aft limit will command no more than the scheduled AOA limit. Additionally, the AOA limiter will decrease longitudinal control authority during a dynamic entry to limit AOA rate, and thus limit any AOA overshoots. The final AOA limiter schedule will be determined during stall speeds testing, Reference 2, and stall characteristics testing, Reference 3. With regards to field performance, the AOA Limiter will be artificially biased to account for uncertainty in the AOA.

3.1.4.4 Horizontal Stabilizer Modes

The horizontal stabilizer has two modes, Normal and Secondary. If the FCCs are in their Normal in air mode, the Stabilizer is in its Normal Mode. Under those conditions, the stabilizer is rate commanded by the FCCs to offload the elevators. The pitch trim switches (controlled by the pilots) move the elevators. There is no direct pilot control of the Stabilizer in Normal Mode.

If the FCCs are in either Alternate Mode or Direct Mode, and there is normal communication between the FCCs and the Horizontal Stabilizer Control Unit (HSCU), the stabilizer remains in Normal Mode.

If communication between the FCCs and the HSCU is lost, the stabilizer is placed in Secondary Mode. In that mode, the pedestal-mounted pitch trim switch inputs to the HSCU are used to move the stabilizer directly.

3.1.4.5 Ground Spoilers

Automatic ground spoiler function is provided. The automatic deployment of the three pairs of spoiler panels will take place at landing touchdown or in a rejected takeoff provided the conditions to enable the ground spoiler deployment are satisfied.

3.1.5 HUD

The HUD system incorporated in the GVI design (HGS model 6250, manufactured by Rockwell Collins) was recently certified for production incorporation on GV-SP and GIV-X aircraft. The system components consist of a Processor Assembly, Overhead Unit and 42° lateral field-of-view Combiner Assembly. The combiner assembly is installed with the symbology presentation optimized to provide a 4° nose-down viewing angle, which is the same as the EVS-II (Enhanced Vision System) camera mounting and allows the symbology and EVS imagery to be aligned conformal with the pilot's view of the natural environment, when viewed from the design eye point. Major components of the HUD are shown in Figure 5.

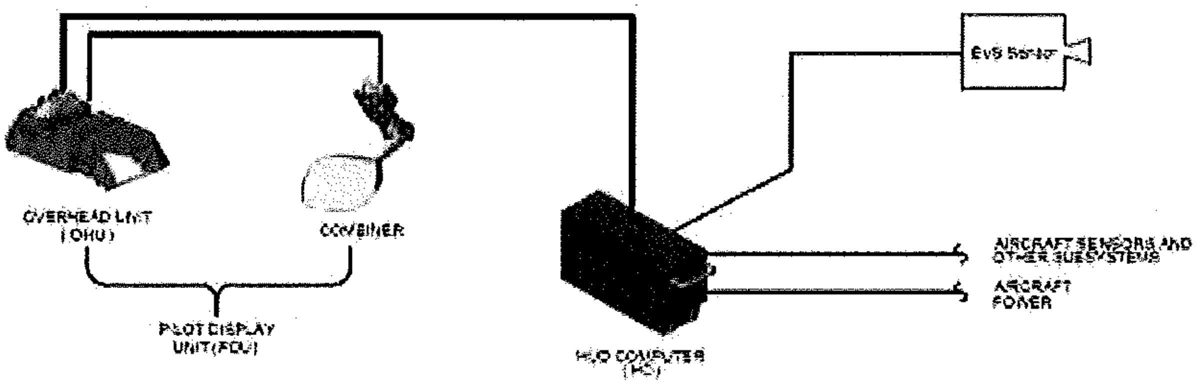

FIGURE 5 – GVI HUD MAJOR COMPONENTS

Aircraft sensor and flight guidance command data are transmitted to the HUD Processor Assembly via two redundant ARINC 429 data buses. Critical or highly dynamic sensors such as Inertial Navigation units and ADS computers provide dedicated ARINC 429 format information directly to the processor to mitigate transport lag for information from these sensors that would be present if processed through the Integrated Avionics System (IAS) Modular Avionics Units (MAU). The Processor Assembly computes the symbology display based upon the direct sensor inputs and inputs provided by the MAU. The resultant display symbology data and EVS video imagery is then transmitted to the overhead unit via Fiber Optic for projection on the pilot's Combiner Assembly.

The Processor Assembly relies upon aircraft specific data such as boresight rigging and settings values, aircraft serial number, EVS image registration values, etc., supplied by a dedicated Aircraft Personality Module (APM) that is mounted integral with the mounting tray that supports the HUD Processor Assembly. These components are all located in the Right Electronic Equipment Rack.

3.1.6 Landing Gear

The Main Landing Gear (MLG) Assembly is a new design for the GVI Aircraft. This MLG has a similar appearance to the MLG on the GV Aircraft. Figure 6 illustrates the features of this gear. The landing gear is of a tricycle type, and similar to the GV design, geometry and components. The majority of the structural components are manufactured from high strength 300M steel, or 7000 series aluminum alloy. The interface points have been modified to suit the revised GVI aircraft structure.

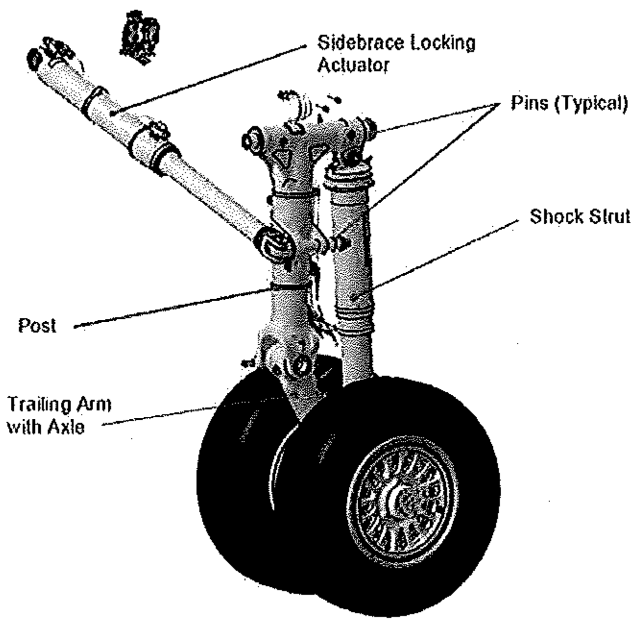

FIGURE 6 – GVI MAIN LANDING GEAR

3.1.7 Nose Landing Gear / Nose Wheel Steering

The Nose Landing Gear (NLG) Assembly is a new design for the GVI Aircraft. This NLG has a similar appearance to the NLG on the GV Aircraft. Figure 7 illustrates the features of this gear, including the twin tire arrangement. This cantilever NLG is structurally supported by a Trunnion, Folding Brace, and Drag Brace all similar to those used on the GV Aircraft. The range of loads on the NLG dictates the implementation of a dual stage shock strut.

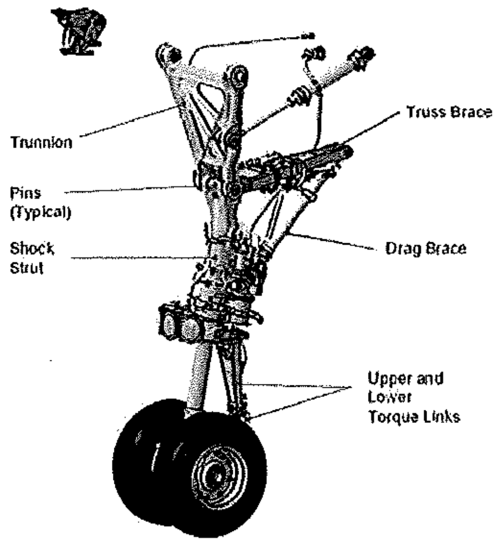

FIGURE 7 – GVI NOSE LANDING GEAR

The NWS System provides ground directional control. The GVI Aircraft has a hydraulically powered steer-by-wire NWS System, similar to that of the GV Aircraft. The NWS System draws power from left Hydraulic System. This source provides ample steering authority at taxi speeds from EDP, PTU or any auxiliary pump. The NWS System Motor provides power-off damping when the NWS is selected off or for loss of hydraulic power. The NWS System accepts input from a pilot-operated tiller and from rudder pedal displacement, both measured by rotary variable differential transformers (RVDTs).

3.1.8 Wheels, Tires and Brakes / Antiskid

The wheels, tires and brakes have been sized to accommodate the GVI gross weight. The GVI Aircraft features radial main tires using low growth technology and bias nose tires. The main wheel assemblies support tire pressure sensing and have carbon brakes. The Brake Control System (BCS) is a brake-by-wire (BBW) system with fully modulated antiskid protection for each brake, and has two independent primary brake systems.

The GVI incorporates carbon brakes that have a target RTO Brake Kinetic Energy level of 38 Million Foot Pounds (MFP) per brake. Each of the two independent Primary Brake Systems operate an inboard/outboard pair of main wheel brakes, Figure 8, and each is capable of bringing the aircraft to an antiskid protected stop at the Maximum Design Landing Weight. A Brake Temperature Monitoring System (BTMS) will provide brake temperature information to the crew.

FIGURE 8 – GVI BRAKE HYDRAULIC SCHEMATIC

[redacted]

The Brake Control Unit (BCU) controls normal brake application, reading command input from the toe pedals. The parking brake function is controlled by the parking brake handle that operates the parking brake valve. The parking brake can be used to manually modulate brake pressure. The BCU provides brake temperature monitoring and wheel spin-up signals supporting automatic control of the ground spoilers and thrust reversers, and wheel speed information supporting the Tire Pressure Monitor System (TPMS). The TPMS observes all six tire pressures to compare them to programmed limits, and provides EICAS message to the pilot for improper tire pressures. The BCU also provides a signal to stop wheel rotation during landing gear retraction and touchdown protection to protect against lock brakes at touchdown.

3.1.9 Hydraulics

The GVI has two primary hydraulic systems, left and right, and two auxiliary hydraulic power sources for the left system. The auxiliary pump and power transfer unit provide backup hydraulic power for utility, landing gear and flap hydraulic functions of the left system. Each primary flight control surface has two actuators, with each actuator being sourced by a different hydraulic system. Additionally, one of the actuators on each primary flight control surface is an electric backup hydrostatic actuation (EBHA). In general the EBHA will only be active for a dual hydraulic failure. Field performance testing will be conducted with the hydraulic systems operating and with the critical system either simulated failed or failed due to the engine failure.

The Left Hydraulic (System 1) is the power source for the Inboard Pair of normal and parking brakes. The Right Hydraulic (System 2) is the power source for the Outboard pair of normal and parking brakes. An accumulator is provided for each pair of brakes. A schematic of the GVI hydraulic system is shown in Figure 9.

[redacted]

3.2 Test Article Configuration

The following Table 2 summarizes the flight test installations on GVI S/N 6002, and delineates those required for these tests. Items annotated "Installed" are required to be installed and operational for the testing, and may be further annotated only for specific tests. Items annotated "As Required" are not required for the testing contained within this test plan and may or may not be installed and / or functional during the tests. Items annotated "Removed" must not be installed during the tests.

TABLE 2 – GVI FIELD PERFORMANCE FLIGHT TEST INSTALLATION REQUIREMENTS

6002 Flight Test Installations	Installed/Removed/As Required
Flight Test IADS	Installed
Flight Test Ballast System	Installed
Rolls-Royce Data Acquisition System (DAS)	As Required
Thales FCS Flight Test Interface (FTI)	Required
Flight Test Interface Box (FTIB)	Installed
Stall Recovery Parachute System	Removed (Provisional)
High-Speed Deceleration Parachute System	Removed (Provisional)
Egress System	Removed (Provisional)
Nose boom	As Required (Provisional)
Trailing Cone	As Required
Kiel Probe	Installed
Flight Test TAT	Installed
Flight Test Micro Air Data Computer (MADC)	Installed
NovAtel GPS	Installed
Electrical Load Banks	Removed
Nose Wheel Steering (NWS)	Required
Hydraulic Depressurization Mode	Installed
90% Worn Brake Set	Installed (Max BKE RTO only)

3.2.1 Cabin Layout

Figure 10 details the notional layout of the cabin floor plan and test equipment installations. There are provisions for ballast installations in the FWD and AFT portions of the cabin to ensure the aircraft CG can be ballasted to the most FWD and AFT limit of the Weight/CG envelope. Table 3 and Table 4 show the aircraft Zero Fuel Center of Gravity (ZFCG) range and defined weight bands, respectively.

Aircraft S/N 6002 is used for different types of testing; therefore, specific stations have been incorporated into the floor plan. First, Rolls-Royce has a dedicated station to monitor their DAS installation on the engines. Second, the FCS FTI station is a dedicated station for monitoring the Thales FCCs. Lastly, there are two stations located near the emergency exits on either side of the aircraft that are dedicated to Flight Test Engineers (FTEs).

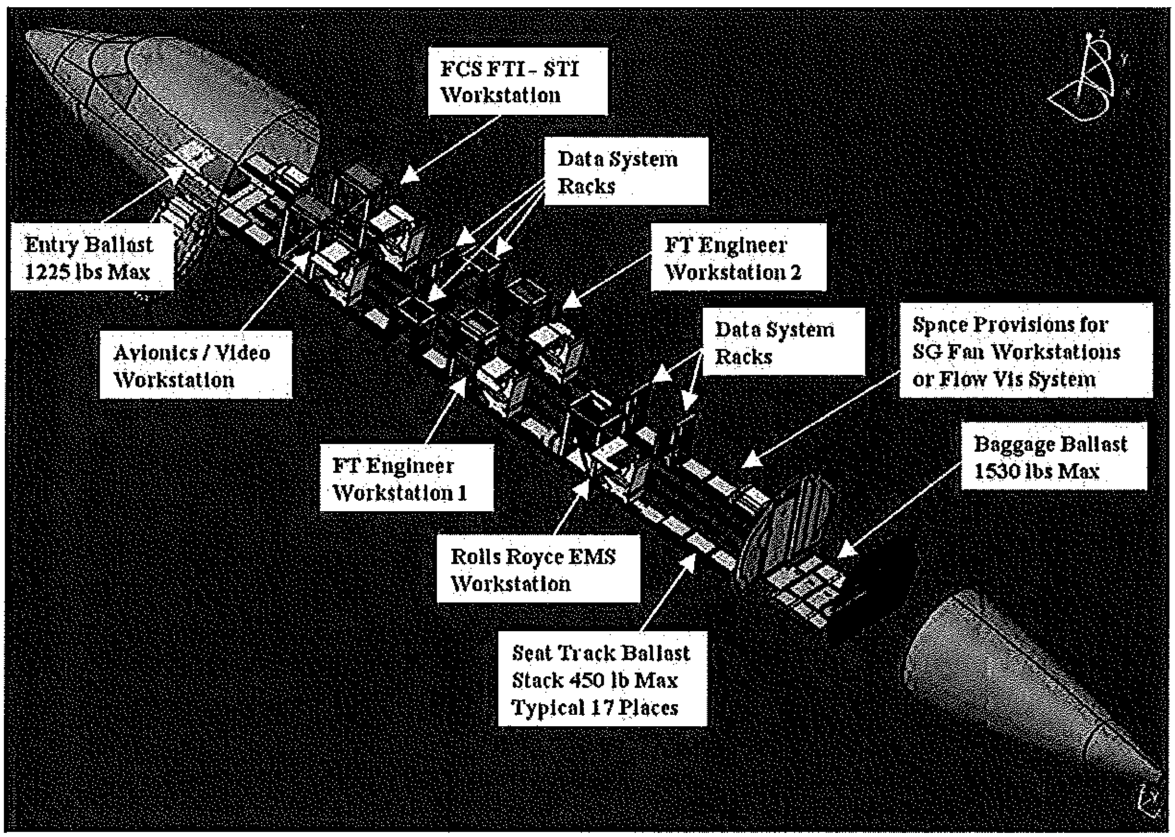

FIGURE 10 – GVI AIRCRAFT 6002 CABIN FLOOR PLAN

[redacted]

3.2.2 Aircraft Envelopes

The GVI speed and altitude flight envelope is defined in Figure 11. Takeoff and landing maximum altitude noted on the chart is 15,000 ft MSL. The certification testing covered within this test plan will be conducted at KROW, Roswell International Air Center Airport near Roswell, NM (elevation 3,672 ft). Additional engine and systems testing will be needed to allow takeoff and landing operations at higher altitudes. The GVI Weight versus CG envelope for a nominal 2° deck angle is defined in Figure 12. The Zero Fuel Weight (ZFW) envelope is defined by the blue box. The forward fuel burn limit is based on the most forward CG achieved for various ZFWs at the most forward ZFW CG. The aft fuel burn limit is [redacted]

[redacted]

3.2.3 Flight Test Interface Box (FTIB)

The FTIB has been identified as a Flight Test unique capability that is needed to safely and efficiently conduct tests of the GVI FCS. It is needed for: FCC Mode awareness and mode control, Yaw Damper control, FCC channel status and reset, and test signal injection for Parameter Identification of aerodynamic performance and key system evaluations. The FTIB allows the Flight Crew and FTE to perform the above functions via a Flight Deck Panel, Figure 13, and an FTE panel, Figure 14. A more detailed description of the FTIB and functions may be found in Reference 8. For V_{MU} and abused takeoffs testing an alternate High Incidence Protection Function (HIPF) schedule will be used to account for tolerances in the angle of attack.

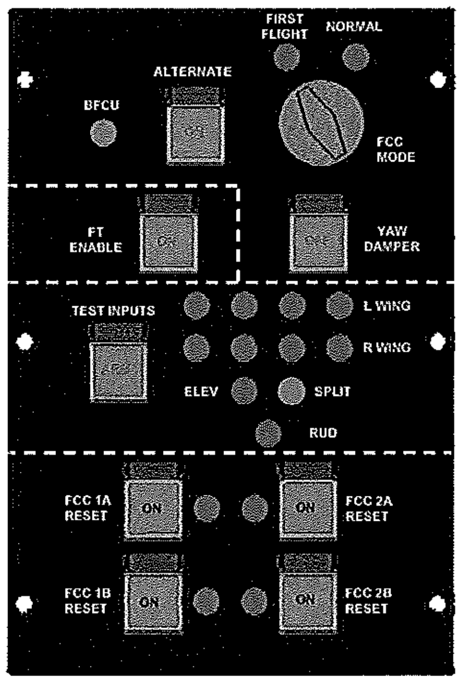

FIGURE 13 – GVI FTIB FLIGHT DECK PANEL

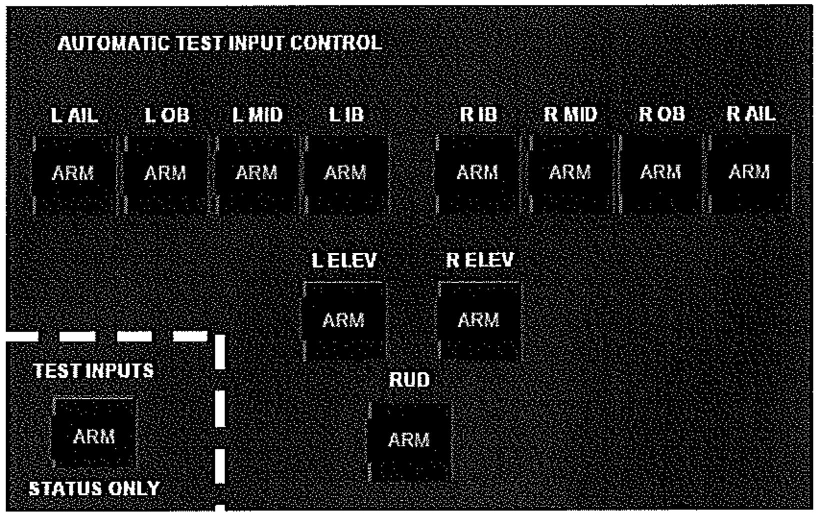

FIGURE 14 – GVI FTIB FTE PANEL

3.2.4 Kiel Probe

In order to accurately measure total air pressure during high angle of attack maneuvers, a United Sensor KFF-6 Kiel probe, Figure 15, will be mounted to the underside of the radome. This probe will extend approximately 3 ½ inches below the lower radome surface just forward of the pressure bulkhead. The Kiel probe is specified by the manufacturer to require zero correction factor (no recovery loss) over a yaw range of ± 67° and up to an angle of attack of 61°. These ranges are well beyond the aircraft alpha and beta capabilities.

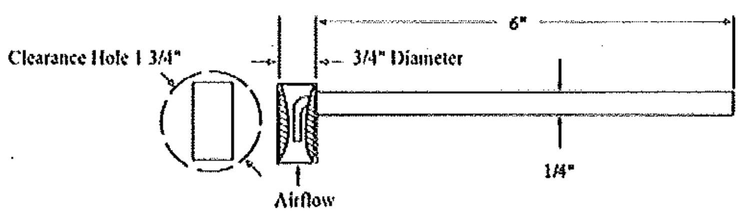

FIGURE 15 – GVI UNITED SENSOR KFF-6 KIEL PROBE

3.2.5 Flight Test Total Air Temperature

The primary source of air temperature to the flight test system will be provided by a Rosemount (Goodrich) model 102LA2AG TAT sensor, Figure 16. This probe will be mounted on a window plug installed in place of the second, right, forward passenger cabin window. The flight test TAT probe is a dual sensor, 115 VAC, electrically de-iced, aspirated TAT probe. The air supply line, used to aspirate the probe while the airplane is on the ground, will be capped and there are no plans to use this feature.

Two sensing elements within the TAT probe can provide temperature information to two separate air data systems simultaneously. Only one element will be connected to Kiel probe / trailing cone MADC.

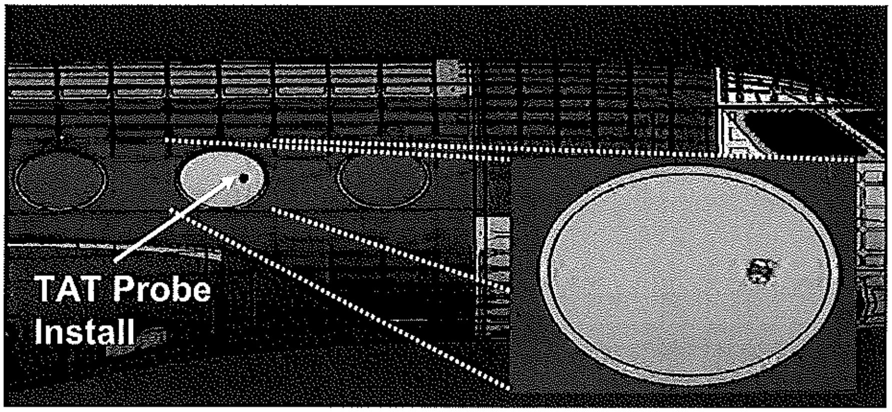

FIGURE 16 – GVI FLIGHT TEST TAT PROBE INSTALLATION

3.2.6 Flight Test MADC Installation

A Honeywell model AZ-840 (p/n 7014700-910) micro air data computer will be used as part of the flight test reference air data system. The MADC will connect to the Kiel probe for total pressure and trailing cone for static pressure. One of the two total air temperature sensors within the flight test TAT probe will connect to the MADC.

The AZ-840 type MADC is specified to function properly between 2.0 to 41.0 inHg and have an "off the shelf" minimum accuracy of 0.015 inHg. Individual units used in the GVI test program will be calibrated against a high-quality reference having an accuracy of at least 0.003 inHg or better.

When given both pressure and temperature input data, the MADC can perform a variety of real-time, sub-sonic air data calculations for display or data recording purposes. The AZ-840 MADC will calculate airspeed up to 500 knots, but Mach is only calculated up to 0.99M. The MADCs will be the source for reference system total pressures, static pressures, and total air temperature to the instrumentation data system. They will also calculate other air data parameters (altitude, airspeed, etc), but these will not have any static source error correction or total pressure recovery factor applied. Corrections will be applied later within derived parameters calculated using the IADS data analysis software.

3.2.7 Flight Test NovAtel GPS Installation

Time Space Positioning Information (TSPI) data will be provided by Differential Global Position System (DGPS) equipment provided by NovAtel and base station service by OmniSTAR. The NovAtel DL-V3 Global Navigation Satellite System (GNSS) receiver together with real-time differential service provided by OmniSTAR will provide high-accuracy position data. Gulfstream has contracted with OmniSTAR for

High Performance (HP) L1/L2 service for coverage of North America and coastal areas. The HP proprietary solutions derived within the receiver use carrier phase measurements to provide decimeter accuracy. This will allow real-time TSPI with DGPS accuracies anytime and anywhere testing is conducted without the need of a special ground station. OmniSTAR HP horizontal accuracy is < $\pm$ 0.15 m RMS (Root Mean Square). Vertical error will typically be 2 to 2.5 times greater than the horizontal error. The DGPS antenna, Figure 17, will be mounted on top of the fuselage at FS 660, BL 0 and WL 151, forward of the production GPS antennas.

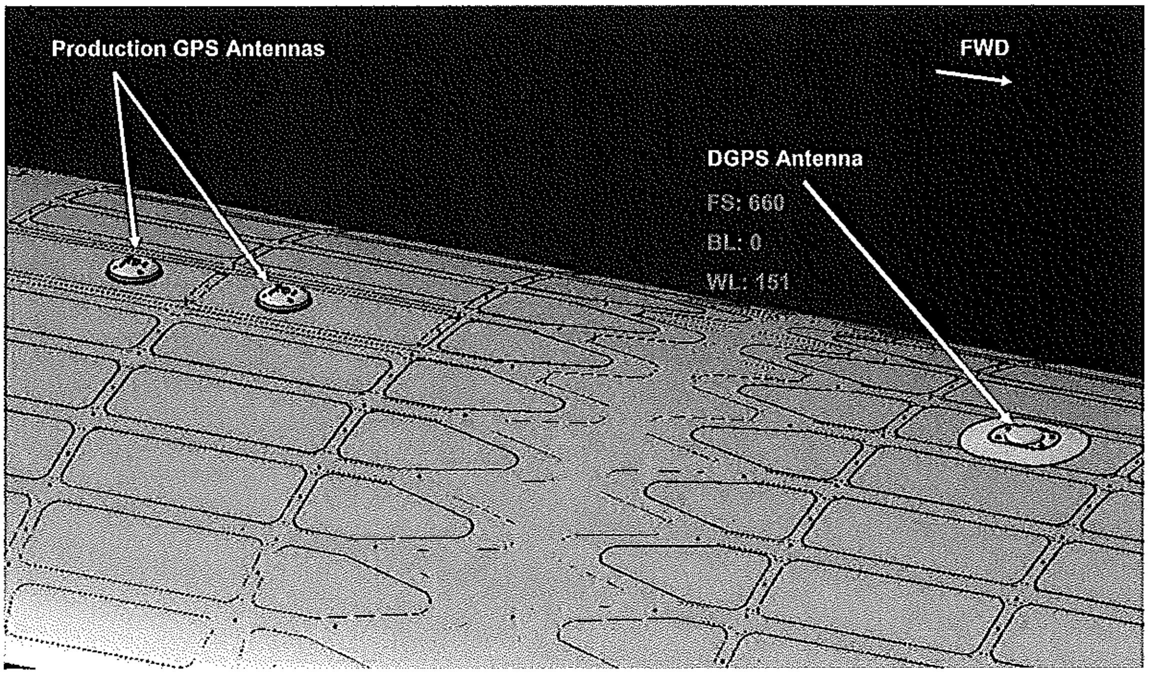

FIGURE 17 – GVI DGPS ANTENNA INSTALLATION

3.2.8 Flight Test Weather Station Uplink

Ambient field conditions including wind, speed and direction, will be uplinked to the aircraft. The weather station will be positioned near the runway for use in determining wind limits. As per AC 25-7A, Section 3) (B) a maximum of 10 knots of wind from any direction will be used as the limit for the majority of testing. A tighter limit of 5 knots maximum crosswind will be used for V_{MU} testing.

4.0 INSTRUMENTATION

The test aircraft will be equipped with specific instrumentation necessary for the flight test program. Details of the specific parameters are included in Appendix A. The data will be recorded by the Gulfstream Flight Test Interactive Analysis and Display System (IADS). The main components are the IADS server, IADS client, a CAIS Bus Data Acquisition Unit (CDAU) and Heim Data Recorder. All aircraft analog, ASCB-D, and discrete parameters are routed to the CDAU and then to the Heim Data Recorder, which feeds the IADS server. A time code is provided directly to the CDAU and the Heim Data Recorder from an external IRIG generator. The IADS client workstation will be located at the FTE multiple workstations and displays the data required for onboard analysis of the maneuvers. Two telemetry antennas will be installed to transmit all the data from the aircraft to the Gulfstream telemetry room / trailer for monitoring during HIGH risk testing, or as deemed necessary. The list of instrumentation parameters relevant to Field Performance testing is provided in Appendix A.

5.0 TEST PROCEDURES

5.1 V_{MU} Speeds

The following testing includes minimum unstick speed (V_{MU}) development, certification and V_{MU} assurance. Testing will be flown at various flap settings, gross weights, possible CGs, and thrust settings. For each weight range, symmetric thrust will be set for two engine minimum and single engine minimum gradients. All certification test points will be flown from KROW, Roswell International Air Center Airport near Roswell, NM. The goal of the V_{MU} tests is to establish the minimum liftoff speed (V_{LO}) for all-engine (AEO) takeoff, $V_{LO\text{-}AEO} \geq 110\% \ V_{MU\text{-}AEO}$ and one engine inoperative (OEI) takeoff, $V_{LO\text{-}OEI} \geq 105\% \ V_{MU\text{-}OEI}$.

The tail strike geometry limit of the GVI is 16.95°, which is greater than the stall angle of attack for both takeoff flap settings and therefore will not be limiting. Historically, Gulfstream aircraft have been limited in pitch control authority and the minimum unstick speeds have been demonstrated with the aircraft ballasted to a CG aft of the forward limit. Design analyses indicate that the GVI will also have limited pitch control authority. The development testing will be flown to determine if the GVI has sufficient tail power to demonstrate the V_{MU} at the forward CG limit, and to conduct build-up tests in pitch attitude and thrust-to-weight ratios (T/W). Once the development testing has been completed, certification tests at the required CG for V_{MU} demonstrations and the V_{MU} assurance at the FWD LIM, if required, will be conducted. The pitch attitude build-up is based the maximum angle of attack obtained during development aerodynamic stalls, Reference 2, adjusted for ground effect based on low speed wind tunnel tests, Reference 9. The maximum pitch attitudes used for the actual tests will be based on the results of the stall testing and the build-up results. Lift coefficient versus pitch attitude at liftoff will be plotted to determine the target pitch attitude / angle of attack at liftoff. A safety margin from stall similar to the free air the High Incidence Protection Function (HIPF) will be used.

5.1.1 V_{MU} Development (ATA 93-311)

The following procedure will be utilized to develop the minimum unstick speeds for the primary, Flaps 20°, and the alternate, Flaps 10°, takeoff configurations. The goal of these tests is to determine if V_{MU} can be demonstrated at a forward CG or if AFT CG is required and the associated V_{MU} assurance tests. Also the tests will determine what trim setting is required to perform the V_{MU} tests.

Reference: 14 CFR Part / CS 25.107(d)

5.1.1.1 Test Procedure

1. Configure aircraft for takeoff.
2. Align aircraft on runway and apply brakes.
3. Set L & R PWR: MTO; release brakes.
4. During the initial ground acceleration and prior to 60 KCAS, set L & R PWR: target EPR for test T/W.
5. At ~60 KCAS apply full aft control column. When aircraft begins to rotate, use control column to capture the target pitch attitude for the test condition and maintain through liftoff until out of ground effect or 100 ft AGL.
6. If target liftoff attitude is achieved, perform next pitch attitude.
7. If final pitch is achieved, perform next test condition.

Note: Some additional nose-up trim may be used if insufficient elevator power to obtain target conditions before liftoff. If additional trim is insufficient move to the AFT CG configuration.

5.1.1.2 Test Analysis Methodology

Time histories of the following data will be plotted for post-flight analyses: airspeed (KCAS/Mach), DGPS altitude and position, radar altitude, pressure altitude, wheel speeds, NLG WOW, MLG WOW, control input forces and positions, left and right engine TLA, EPR, T/W, net thrust, GW, CG, AOA, pitch rate, pitch attitude, flap and control surface positions.

For each test point, the liftoff point will be determined using wheel speeds and / or MLG WOW signals. Airspeed will be determined using the Kiel probe and a trapped static method. Thrust will be determined using the Rolls-Royce engine maps for the particular engine installed on the test aircraft for the given test point conditions (altitude, temperature and airspeed). For a given T/W ratio the pitch attitude at liftoff will be plotted versus lift coefficient. Detailed minimum unstick speeds performance equations can be found in Model GVI Data Analysis Methods, Reference 11.

5.1.1.3 Success Criteria

- Stable pitch attitude at liftoff.
- No change in thrust setting.
- No reduction in pitch attitude after liftoff until out of ground effect (~100 ft AGL).

5.1.2 V_{MU} Certification (ATA 93-312)

The following procedure will be utilized to certify the minimum unstick speeds for the primary, Flaps 20°, and the alternate, Flaps 10°, takeoff configurations. The goal of these tests is to establish the minimum liftoff speed for both AEO and OEI takeoffs. The horizontal stabilizer trim setting and aircraft CG will be based on the results of the V_{MU} development tests.

Reference: 14 CFR Part / CS 25.107(d)

5.1.2.1 Test Procedure

1. Configure aircraft for takeoff with/except: STAB TRIM: As specified

2. Align aircraft on runway and apply brakes.

3. Set L & R PWR: MTO; release brakes.

4. During the initial ground acceleration and prior to 60 KCAS, set L & R PWR: target EPR for test T/W.

5. At ~60 KCAS apply full aft control column. When aircraft begins to rotate, use control column to capture the target pitch attitude for the test condition and maintain through liftoff until out of ground effect or 100 ft AGL.

5.1.2.2 Test Analysis Methodology

Time histories of the following data will be plotted for post-flight analyses: airspeed (KCAS/Mach), DGPS altitude and position, radar altitude, pressure altitude, wheel speeds, NLG WOW, MLG WOW, control input forces and positions, left and right engine TLA, EPR, T/W, net thrust, GW, CG, AOA, pitch rate, pitch attitude, flap and control surface positions.

For each test point, the liftoff point will be determined using wheel speeds and / or MLG WOW signals. Airspeed will be determined using the Kiel probe and a trapped static method. Thrust will be determined using the Rolls-Royce engine maps for the particular engine installed on the test aircraft for the given test point conditions (altitude, temperature and airspeed). The T/W ratio at liftoff will be plotted versus liftoff airspeed corrected for CG and weight normalized. Detailed minimum unstick speeds performance equations can be found in Model GVI Data Analysis Methods, Reference 11.

5.1.2.3 Success Criteria

- Stable pitch attitude at liftoff.

- No change in thrust setting.
- No reduction in pitch attitude after liftoff until out of ground effect (~100 ft AGL).

5.1.3 V_{MU} Assurance (ATA 93-313)

The following procedure will be utilized in the event that V_{MU} testing at the forward limit cannot be achieved for the primary, Flaps 20°, and the alternate, Flaps 10°, takeoff configurations. The goal of these tests are to demonstrate liftoff speeds, V_{LO}, 5 knots less than the normally scheduled liftoff speed both AEO and OEI with the CG at the forward limit.

Reference: 14 CFR Part / CS 25.107(d)

5.1.3.1 Test Procedure

1. Configure aircraft for takeoff.

2. Align aircraft on runway and apply brakes.

3. Set L & R PWR: MTO; release brakes.

4. During the initial ground acceleration and prior to 60 KCAS, set L & R PWR: target EPR for test T/W.

5. At ~60 KCAS apply full aft control column. When aircraft begins to rotate, use control column to capture the target pitch attitude for the test condition. Maintain liftoff attitude until out of ground effect or 100 ft AGL.

    a. Elevator input may be adjusted to not over-rotate, but liftoff attitude must be maintained until out of ground effect or 100 ft AGL.

5.1.3.2 Test Analysis Methodology

Time histories of the following data will be plotted for using in post-flight analyses: airspeed (KCAS/Mach), DGPS altitude and position, radar altitude, pressure altitude, wheel speed, NLG WOW, MLG WOW, control input forces and positions, left and right engine PLA, EPR, T/W, net thrust, GW, CG, AOA, pitch rate, pitch attitude, flap and control surface positions.

For each test point, the liftoff point will be determined using wheel speeds and / or MLG WOW signals. Airspeed will be determined using the Kiel probe and a trapped static method. Thrust will be determined using the Rolls-Royce engine maps for the particular engine installed on the test aircraft for the given test point conditions (altitude, temperature and airspeed). The T/W ratio at liftoff will be plotted versus liftoff airspeed corrected for CG and weight normalized. Detailed minimum unstick speeds performance equations can be found in Model GVI Data Analysis Methods, Reference 11.

5.1.3.3 Success Criteria

- Stable pitch attitude at liftoff.
- No change in thrust setting.
- No reduction in pitch attitude after liftoff until out of ground effect (~100 ft AGL).
- Demonstrated liftoff speed is at least 5 knots less than the normally scheduled liftoff for the critical AEO and OEI T/W.

5.2 Takeoff Performance

The following testing includes takeoff technique development and takeoff performance. Takeoff performance includes all-engine, engine-out and rolling start takeoffs, and will be flown at various flap settings, gross weights and thrust settings. For each weight range thrust will be set for low, medium and maximum gradients. All certification test points will be flown from KROW, Roswell International Air Center Airport near Roswell, NM. The data will be analyzed in segments as illustrated for all-engine takeoff, Figure 18 and failed engine continued takeoff, Figure 19. Nomenclature for the Flight Test reduction and Flight Sciences expansion (boxed symbols) are annotated on the charts. Detailed description of the Flight Test Reduction methodology can be found in Reference 11.

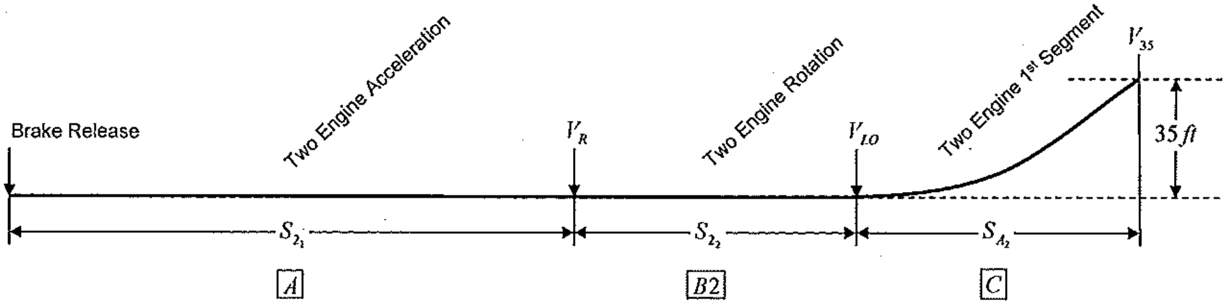

FIGURE 18 – GVI ALL-ENGINE TAKEOFF SEGMENTS

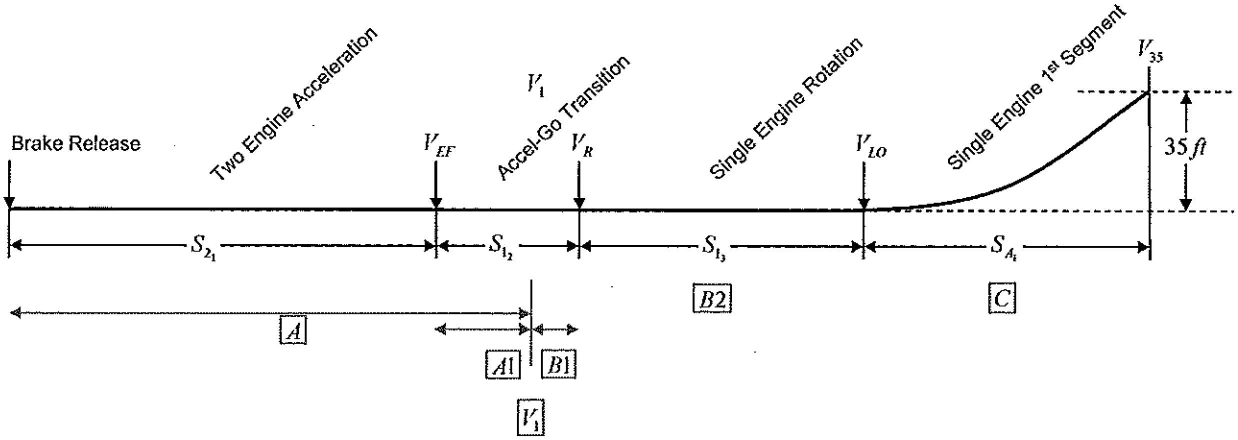

FIGURE 19 – GVI FAILED ENGINE CONTINUED TAKEOFF SEGMENTS

5.2.1 Takeoff – Technique Development Rotation Rate (ATA 93-321)

The following procedure will be utilized for development of the best technique to develop the desired rotation rate. The goal of the rotation rate tests is to establish a pilot technique to obtain the desired rotation rate at liftoff.

Reference: 14 CFR Part / CS 25.101, 25.105, 25.107

5.2.1.1 Test Procedure

1. Configure aircraft for takeoff with/except: R HYD DEPRESS: as specified
2. Align aircraft on runway and apply brakes
3. Set L & R PWR: as specified; release brakes
4. For engine-out runs, at target V_{EF}, fail RH engine using a throttle chop.
   a. Use rudder and NWS control as required for directional control
5. Rotate at V_R at target rotation rate to target pitch attitude.
6. Maintain target pitch attitude until target climb speed (V_2 or V_2+10 as appropriate) is achieved.
7. Retract gear after positive rate-of-climb (ROC) is established.
8. Adjust pitch attitude to maintain target climb speed (V_2 or V_2+10 as appropriate) to the lesser of gear retraction complete or 400 ft AGL.

5.2.1.2 Test Analysis Methodology

Time histories of the following data will be plotted for post-flight analyses: airspeed (KCAS/Mach), DGPS altitude and position, radar altitude, pressure altitude, wheel speeds, NLG WOW, MLG WOW, control input forces and positions, left and right engine TLA, EPR, T/W, net thrust, GW, CG, AOA, pitch rate, pitch attitude, flap and control surface positions.

For each test point, the rotation, liftoff, 15-foot and 35-foot points will be determined. Airspeed will be determined using the Kiel probe and a trapped static method. Thrust will be determined using the Rolls-Royce engine maps for the particular engine installed on the test aircraft for the given test point conditions (altitude, temperature and airspeed). The liftoff T/W ratio will be plotted versus the airspeed stall ratio at each point. Acceleration factor will be plotted versus T/W ratio. Runs will be separated into all-engine and engine-out. Detailed continuous takeoff performance equations can be found in Model GVI Data Analysis Methods, Reference 11.

5.2.1.3 Success Criteria

- Rotation speed within ±2 kts of target.
- Target pitch rate within ± 1 deg/sec of target.
- No change in thrust setting.
- No reduction in pitch attitude after liftoff up to 35 ft AGL.

5.2.2 Takeoff – Technique Development Pitch Attitude (ATA 90-322)

The following procedure will be utilized for development of the best pitch attitude target to meet the liftoff and 35-foot speed targets for a given rotation speed. The goal of the pitch attitude tests is to establish the target pitch attitudes that will obtain the scheduled liftoff speed, V_{LO}, and obstacle height speed, V_{35}, for the rotation speed, V_R, as a function of T/W for AEO and OEI continuous takeoffs.

Reference: 14 CFR Part / CS 25.101, 25.105, 25.107

5.2.2.1 Test Procedure

1. Configure aircraft for takeoff with/except: R HYD DEPRESS: As specified
2. Align aircraft on runway and apply brakes
3. Set L & R PWR: as specified; release brakes
4. For engine-out runs, at target V_{EF}, fail RH engine using a throttle chop.
    a. Use rudder and NWS control as required for directional control
5. Rotate at V_R at a normal rotation rate (3-5 degs/sec) to target pitch attitude.
6. Maintain target pitch attitude until target climb speed (V_2 or V_2+10 as appropriate) is achieved.
7. Retract gear after positive ROC is established.
8. Adjust pitch attitude to maintain target climb speed (V_2 or V_2+10 as appropriate) to the lesser of gear retraction complete or 400 ft AGL.

5.2.2.2 Test Analysis Methodology

Time histories of the following data will be plotted for post-flight analyses: airspeed (KCAS/Mach), DGPS altitude and position, radar altitude, pressure altitude, wheel speeds, NLG WOW, MLG WOW, control input forces and positions, left and right engine TLA, EPR, T/W, net thrust, GW, CG, AOA, pitch rate, pitch attitude, flap and control surface positions.

For each test point, the rotation, liftoff, 15-foot and 35-foot points will be determined. Airspeed will be determined using the Kiel probe and a trapped static method. Thrust will be determined using the Rolls-Royce engine maps for the particular engine installed on the test aircraft for the given test point conditions (altitude, temperature and airspeed). The liftoff T/W ratio will be plotted versus the airspeed stall ratio at each point. Acceleration factor will be plotted versus T/W ratio. Runs will be separated into all-engine and engine-out. Detailed continuous takeoff performance equations can be found in Model GVI Data Analysis Methods, Reference 11.

5.2.2.3 Success Criteria

- Rotation speed within ±2 kts of target.
- Pitch attitude within ± 1 deg of target.
- No change in thrust setting.
- No reduction in pitch attitude after liftoff up to 35 ft AGL.

5.2.3 Takeoff – AEO (ATA 93-323)

The following procedure will be utilized for certification of all-engine takeoff performance for the primary, Flaps 20°, and the alternate, Flaps 10°, takeoff configurations. The goal of the testing is to gather sufficient AEO takeoffs at various gross weights and thrust-to-weight ratios to adequately model the performance for AFM expansion.

Reference: 14 CFR Part / CS 25.101(f), (h)(1-3); 25.105(b); 25.107(b)(1)(ii), (c)(1-2), (e)(1)(iii, iv), (e)(2), (f); 25.109(a)(1)(i), (a)(2)(i); 25.113(a)(2), (b)(2)

5.2.3.1 Test Procedure

1. Configure aircraft for takeoff.
2. Align aircraft on runway and apply brakes
3. Set L &R PWR: as specified
4. Release brakes
5. Rotate at V_R at a normal rotation rate (3-5 degs/sec) to target pitch attitude.
6. Maintain target pitch attitude until target climb speed (V_2+10) is achieved.
7. Retract gear after positive ROC is established.
8. Adjust pitch attitude to maintain target climb speed (V_2+10) to the lesser of gear retraction complete or 400 ft AGL.

5.2.3.2 Test Analysis Methodology

Time histories of the following data will be plotted for post-flight analyses: airspeed (KCAS/Mach), DGPS altitude and position, radar altitude, pressure altitude, wheel speeds, NLG WOW, MLG WOW, control input forces and positions, left and right engine TLA, EPR, T/W, net thrust, GW, CG, AOA, pitch rate, pitch attitude, flap and control surface positions.

For each test point, the rotation, liftoff, 15-foot and 35-foot points will be determined. Airspeed will be determined using the Kiel probe and a trapped static method. Thrust will be determined using the Rolls-Royce engine maps for the particular engine installed on the test aircraft for the given test point conditions (altitude, temperature and airspeed). The liftoff T/W ratio will be plotted versus the airspeed stall ratio at each point. Acceleration factor will be plotted versus T/W ratio. Data from brake release to rotation will be used to determine an effective rolling coefficient. Detailed continuous takeoff performance equations can be found in Model GVI Data Analysis Methods, Reference 11.

5.2.3.3 Success Criteria

- Rotation and 35-foot speed within $\pm$2 kts of target
- Liftoff speed greater than or equal to 110% AEO V_{MU}
- Pitch attitude within $\pm$ 1 deg of target
- Pitch rate within $\pm$ 1 deg/sec of target
- No change in thrust setting
- No reduction in pitch attitude after liftoff up to 35 ft AGL

5.2.4 Takeoff – OEI (ATA 93-324)

The following procedure will be utilized for certification engine-out takeoff performance for the primary, Flaps 20°, and the alternate, Flaps 10°, takeoff configurations. The goal of these tests is to gather sufficient OEI takeoffs at various gross weights and thrust-to-weight ratios to adequately model the performance for AFM expansion. Additionally, sufficient engine cuts at the critical configuration will tested to demonstrate similarity to the throttle chops.

Reference: 14 CFR Part / CS 25.101(f), (h)(1-3); 25.105(b); 25.107(b)(1)(ii), (c)(1, 2), (e)(1)(iii, iv), (e)(2), (f); 25.109(a)(1)(i, ii), (a)(2)(i); 25.113(a)(1)

5.2.4.1 Test Procedure

1. Configure aircraft for takeoff with/except: for throttle chop points R HYD DEPRESS: MAN DEPRESS
2. Align aircraft on runway and apply brakes
3. Set L & R PWR: as specified
4. Release brakes
5. At target Vef, fail RH engine using a throttle chop or fuel cut via FUEL CONTROL: OFF as specified.
    a. Use rudder and NWS control as required for directional control
6. Rotate at Vr to target pitch attitude at a normal rotation rate (3-5 degs/sec).
7. Maintain target pitch attitude until target climb speed (V_2) is achieved.
8. Retract gear after positive ROC is established.
9. Adjust pitch attitude to maintain target climb speed (V_2) to the lesser of gear retraction complete or 400 ft AGL.

5.2.4.2 Test Analysis Methodology

Time histories of the following data will be plotted for post-flight analyses: airspeed (KCAS/Mach), DGPS altitude and position, radar altitude, pressure altitude, wheel speeds, NLG WOW, MLG WOW, control input forces and positions, left and right engine TLA, EPR, T/W, net thrust, GW, CG, AOA, pitch rate, pitch attitude, flap and control surface positions.

For each test point, the rotation, liftoff, 15-foot and 35-foot points will be determined. Airspeed will be determined using the Kiel probe and a trapped static method. Thrust will be determined using the Rolls-Royce engine maps for the particular engine installed on the test aircraft for the given test point conditions (altitude, temperature and airspeed). The liftoff T/W ratio will be plotted versus the airspeed stall ratio at each point. Acceleration factor will be plotted versus T/W ratio. Detailed continuous takeoff performance equations can be found in Model GVI Data Analysis Methods, Reference 11.

5.2.4.3 Success Criteria

- Rotation and 35-foot speed within ±2 kts of target
- Liftoff speed greater than or equal to 105% OEI V_{MU}
- Pitch attitude within ± 1 deg of target
- Pitch rate within ± 1 deg/sec of target
- No change in thrust setting
- No reduction in pitch attitude after liftoff up to 35 ft AGL

5.2.5 Takeoff – Company Development (ATA 93-325)

The following procedure will be utilized for company development takeoffs of Flaps 0° continued takeoff performance.

Reference: 14 CFR Part / CS 25.101, 25.105, 25.107, 25.109, 25.113

5.2.5.1 Test Procedure

1. Configure aircraft for takeoff with/except: R HYD DEPRESS: As specified
2. Align aircraft on runway and apply brakes
3. Set L & R PWR: MTO
4. Release brakes
5. For engine-out runs, at target V_{EF}, fail RH engine using a throttle chop.
   a. Use rudder and NWS control as required for directional control
6. Rotate at V_R at a normal rotation rate (3-5 degs/sec) to target pitch attitude.
7. Maintain target pitch attitude until target climb speed (V_2 or V_2+10 as appropriate) is achieved.
8. Retract gear after positive ROC is established.
9. Adjust pitch attitude to maintain target climb speed (V_2 or V_2+10 as appropriate) to the lesser of gear retraction complete or 400 ft AGL.

5.2.5.2 Test Analysis Methodology

Time histories of the following data will be plotted for post-flight analyses: airspeed (KCAS/Mach), DGPS altitude and position, radar altitude, pressure altitude, wheel speeds, NLG WOW, MLG WOW, control input forces and positions, left and right engine TLA, EPR, T/W, net thrust, GW, CG, AOA, pitch rate, pitch attitude, flap and control surface positions.

For each test point, the rotation, liftoff, 15-foot and 35-foot points will be determined. Airspeed will be determined using the Kiel probe and a trapped static method. Thrust will be determined using the Rolls-Royce engine maps for the particular engine installed on the test aircraft for the given test point conditions (altitude, temperature and airspeed). Runs will be separated into all-engine and engine-out. The liftoff T/W ratio will be plotted versus the airspeed stall ratio at each point. Acceleration factor will be plotted versus T/W ratio. Detailed continuous takeoff performance equations can be found in Model GVI Data Analysis Methods, Reference 11.

5.2.5.3 Success Criteria

- Rotation speed within ±2 kts of target.
- Pitch attitude within ± 1 deg of target.
- No change in thrust setting.
- No reduction in pitch attitude after liftoff up to 35 ft AGL.

5.3 Abused Takeoff Assessment

Abused takeoff assessments include takeoffs at the following conditions: engine-out and early rotation, all-engine early over-rotation and rapid-rotation, and out-of-trim. Tests will be flown at various flap settings and gross weights. For each weight range, thrust will be set to MTO. All certification test points will be flown from KROW, Roswell International Air Center Airport near Roswell, NM. The data will be analyzed in segments similar to the performance takeoffs.

5.3.1 Abused Takeoff – OEI V_R-5 (ATA 93-331)

The following procedure will be utilized to certify acceptable takeoff characteristics during an abused engine-out takeoff for the primary, Flaps 20°, and the alternate, Flaps 10°, takeoff configurations.

Reference: 14 CFR Part / CS 25.107(e)(3), 25.109(a)(1)(ii)

5.3.1.1 Test Procedure

1. Configure aircraft for takeoff, with/except: R HYD DEPRESS: MAN DEPRESS.
2. Align aircraft on runway and apply brakes
3. Set L & R PWR: MTO
4. Release brakes
5. At target V_{EF}, fail RH engine using a throttle chop.
    a. Use rudder and NWS control as required for directional control
6. Rotate at V_R-5 kts at a normal rotation rate (3-5 degs/sec) to target pitch attitude.
7. Maintain target pitch attitude through 35 feet AGL to achieve target climb speed (V_2-5 to V_2).
8. Retract gear after positive ROC is established.
9. Adjust pitch attitude to maintain target climb speed (V_2) to the lesser of gear retraction complete or 400 ft AGL.

5.3.1.2 Test Analysis Methodology

Time histories of the following data will be plotted for post-flight analyses: airspeed (KCAS/Mach), DGPS altitude and position, radar altitude, pressure altitude, wheel speeds, NLG WOW, MLG WOW, control input forces and positions, left and right engine TLA, EPR, T/W, net thrust, GW, CG, AOA, pitch rate, pitch attitude, flap and control surface positions.

For each test point, the rotation, liftoff, and 35-foot points will be determined. Airspeed will be determined using the Kiel probe and a trapped static method. Thrust will be determined using the Rolls-Royce engine maps for the particular engine installed on the test aircraft for the given test point conditions (altitude, temperature and airspeed).

5.3.1.3 Success Criteria

- Rotation and 35-foot speed within +0/-2 kts of target
- Pitch attitude within $\pm$ 1 deg of target
- Pitch rate within $\pm$ 1 deg/sec of target
- No change in thrust setting
- No adverse engine operating characteristics
- Intentional tail contact is unacceptable
- No stall warning
- Speed at 35 feet above the runway > V_2-5 kts

5.3.2 Abused Takeoff – AEO V_R-10 Over Rotation (ATA 93-332)

The following procedure will be utilized to certify acceptable takeoff characteristics during an abused all-engine takeoff for the primary, Flaps 20°, and the alternate, Flaps 10°, takeoff configurations.

Reference: 14 CFR Part / CS 25.107(e)(4)

5.3.2.1 Test Procedure

1. Configure aircraft for takeoff.
2. Align aircraft on runway and apply brakes
3. Set L & R PWR: MTO
4. Release brakes
5. Rotate at the lesser absolute speed of V_R-10 kts or V_R-7% at a normal rotation rate (3-5 degs/sec) to 2° above the normal takeoff pitch attitude.
6. Maintain pitch attitude until out of ground effect and positive ROC is established to achieve target climb speed (V_2 to V_2+10).
7. Retract gear after positive ROC is established.
8. Adjust pitch attitude to maintain target climb speed (V_2+10) to the lesser of gear retraction complete or 400 ft AGL.

5.3.2.2 Test Analysis Methodology

Time histories of the following data will be plotted for post-flight analyses: airspeed (KCAS/Mach), DGPS altitude and position, radar altitude, pressure altitude, wheel speeds, NLG WOW, MLG WOW, control input forces and positions, left and right engine TLA, EPR, T/W, net thrust, GW, CG, AOA, pitch rate, pitch attitude, flap and control surface positions.

For each test point, the rotation, liftoff, and 35-foot points will be determined. Airspeed will be determined using the Kiel probe and a trapped static method. Thrust will be determined using the Rolls-Royce engine maps for the particular engine installed on the test aircraft for the given test point conditions (altitude, temperature and airspeed).

5.3.2.3 Success Criteria

- Rotation and 35-foot speed within +0/-2 kts of target

- Pitch attitude within +1/-0 deg of target
- Pitch rate within $\pm$ 1 deg/sec of target
- No change in thrust setting
- Demonstrated takeoff distance $\leq$ 101% scheduled AFM takeoff distance for test condition
- No adverse engine operating characteristics
- No stall warning

5.3.3 Abused Takeoff – AEO V_R-10 Rapid Rotation (ATA 93-333)

The following procedure will be utilized to certify acceptable takeoff characteristics during an abused all-engine takeoff for the primary, Flaps 20°, and the alternate, Flaps 10°, takeoff configurations.

Reference: 14 CFR Part / CS 25.107(e)(4)

5.3.3.1 Test Procedure

1. Configure aircraft for takeoff.
2. Align aircraft on runway and apply brakes
3. Set L & R PWR: MTO
4. Release brakes
5. Rotate at the lesser absolute speed of V_R-10 kts or V_R-7% at an aggressive rotation rate (5-7 degs/sec) to target pitch attitude.
6. Maintain target pitch attitude until out of ground effect and positive ROC is established to achieve target climb speed (V_2 to V_2+10).
7. Retract gear after positive ROC is established.
8. Adjust pitch attitude to maintain target climb speed (V_2+10) to the lesser of gear retraction complete or 400 ft AGL.

5.3.3.2 Test Analysis Methodology

Time histories of the following data will be plotted for post-flight analyses: airspeed (KCAS/Mach), DGPS altitude and position, radar altitude, pressure altitude, wheel speeds, NLG WOW, MLG WOW, control input forces and positions, left and right engine TLA, EPR, T/W, net thrust, GW, CG, AOA, pitch rate, pitch attitude, flap and control surface positions.

For each test point, the rotation, liftoff, and 35-foot points will be determined. Airspeed will be determined using the Kiel probe and a trapped static method. Thrust will be determined using the Rolls-Royce engine maps for the particular engine installed on the test aircraft for the given test point conditions (altitude, temperature and airspeed).

5.3.3.3 Success Criteria

- Rotation and 35-foot speed within ± 2 kts of target

- Pitch attitude within ± 1 deg of target
- Pitch rate within ± 1 deg/sec of target
- No change in thrust setting
- Demonstrated takeoff distance ≤ 101% scheduled AFM takeoff distance for the test condition
- No adverse engine operating characteristics
- No stall warning

5.3.4 Abused Takeoff – AEO Out-of-Trim (ATA 93-334)

The following procedure will be utilized to certify acceptable takeoff characteristics during an abused out-of-trim all-engine takeoff for the primary, Flaps 20°, and the alternate, Flaps 10°, takeoff configurations.

Reference: 14 CFR Part / CS 25.107(e)(4)

5.3.4.1 Test Procedure

1. Configure aircraft for takeoff, with/except: set takeoff trim as specified without a takeoff configuration warning.
2. Align aircraft on runway and apply brakes.
3. Set L & R PWR: MTO
4. Release brakes
5. Rotate at V_R to target pitch attitude at a normal rotation rate (3-5 degs/sec).
    a. Do not exceed the short term two hand force limit (75 lb).
6. Maintain target pitch attitude until target climb speed (V_2+10) is achieved.
7. Retract gear after positive ROC is established.
8. Adjust pitch attitude to maintain target climb speed (V_2+10) to the lesser of gear retraction complete or 400 ft AGL.

5.3.4.2 Test Analysis Methodology

Time histories of the following data will be plotted for post-flight analyses: airspeed (KCAS/Mach), DGPS altitude and position, radar altitude, pressure altitude, wheel speeds, NLG WOW, MLG WOW, control input forces and positions, left and right engine TLA, EPR, T/W, net thrust, GW, CG, AOA, pitch rate, pitch attitude, flap and control surface positions.

For each test point, the rotation, liftoff, and 35-foot points will be determined. Airspeed will be determined using the Kiel probe and a trapped static method. Thrust will be determined using the Rolls-Royce engine maps for the particular engine installed on the test aircraft for the given test point conditions (altitude, temperature and airspeed).

5.3.4.3 Success Criteria

- Rotation and 35-foot speed within ±2 kts of target
- No change in thrust setting
- No reduction in pitch attitude after liftoff up to 35 ft AGL.
- Demonstrated takeoff distance ≤ 101% scheduled AFM takeoff distance for the test condition
- No adverse engine operating characteristics
- No hazardous flight characteristics
- No stall warning

6.0 RISK ASSESSMENT

A general risk assessment is listed here for each test documented in this plan. A preliminary Test Safety Hazard Analysis (TSHA) is required for individual tests that are rated either medium or high risk. In accordance with Reference 13, some testing contained in this test plan are determined to be HIGH risk, as shown in Table 5. A Safety Review Board (SRB) will be required to support the testing herein. The TSHA is located in Appendix C.

Table 5 – Test Hazard Assessment

Test	Hazard Level
Field Performance - V_{MU}	HIGH
Field Performance – Engine-out Takeoffs (OEI)	HIGH
Field Performance – Accelerate Stops	MEDIUM
Field Performance – Maximum KE RTO / Fuseplug Demonstration	HIGH
Field Performance – Thrust Reverser Effectiveness Single TR	MEDIUM
Field Performance – Landing Performance	MEDIUM

7.0 REFERENCES

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APPENDIX B 1 - DEVELOPMENT TEST POINTS

Test: 93 - 311 Performance: Field: Vmu Development

Risk: High **Maneuver:** Vmu Devleopment

Regulations:

25.107

Procedure: **Field Performance**

1. Configure aircraft for takeoff.
2. Align aircraft on runway and apply brakes.
3. Set L & R PWR: MTO; release brakes.
4. During the initial ground acceleration and prior to 60 KCAS, set L & R PWR: target EPR for test T/W.
5. At 60 KCAS apply full aft control column. When aircraft begins to rotate, use control column to capture the target pitch attitude for the test condition and maintain through liftoff until out of ground effect or 100 ft AGL.
6. If target liftoff attitude is achieved, perform next pitch attitude.
7. If final pitch is achieved, perform next test condition.

Note: Some additional nose-up trim may be used if insufficient elevator power to obtain target conditions before liftoff. If additional trim is insufficient move to the AFT CG configuration.

ITEM	REPS	GEAR	FLAP	WEIGHT	CG	L PWR	R PWR	ALT	AIRSPEED	BLEED	PITCH	SUPPLEMENTAL NOTES
.01	1	EXT	20	HEAVY	FWD LIM	NOTED	NOTED	0	0	ECS	7 to 8	L & R PWR: two eng min T/W
.02	1	EXT	20	HEAVY	FWD LIM	NOTED	NOTED	0	0	ECS	8 to 9	L & R PWR: two eng min T/W
.03	1	EXT	20	HEAVY	FWD LIM	NOTED	NOTED	0	0	ECS	9 to 10	L & R PWR: two eng min T/W
.04	1	EXT	20	HEAVY	FWD LIM	NOTED	NOTED	0	0	ECS	9 to 10	L & R PWR: single eng min T/W
.05	1	EXT	20	MEDIUM	FWD LIM	NOTED	NOTED	0	0	ECS	9 to 10	L & R PWR: two eng min T/W
.06	1	EXT	20	MEDIUM	FWD LIM	NOTED	NOTED	0	0	ECS	9 to 10	L & R PWR: single eng min T/W
.07	1	EXT	20	HEAVY	AFT	NOTED	NOTED	0	0	ECS	7 to 8	Optional CG: AFT to as req'd to demo VMU; L & R PWR: two eng min T/W
.08	1	EXT	20	HEAVY	AFT	NOTED	NOTED	0	0	ECS	8 to 9	Optional CG: AFT to as req'd to demo VMU; L & R PWR: two eng min T/W
.09	1	EXT	20	HEAVY	AFT	NOTED	NOTED	0	0	ECS	9 to 10	Optional CG: AFT to as req'd to demo VMU; L & R PWR: two eng min T/W
.10	1	EXT	20	HEAVY	AFT	NOTED	NOTED	0	0	ECS	9 to 10	Optional CG: AFT to as req'd to demo VMU; L & R PWR: single eng min T/W
.11	1	EXT	20	MEDIUM	AFT	NOTED	NOTED	0	0	ECS	9 to 10	Optional CG: AFT to as req'd to demo VMU; L & R PWR: two eng min T/W
.12	1	EXT	20	MEDIUM	AFT	NOTED	NOTED	0	0	ECS	9 to 10	Optional CG: AFT to as req'd to demo VMU; L & R PWR: single eng min T/W
.13	1	EXT	10	HEAVY	FWD LIM	NOTED	NOTED	0	0	ECS	8 to 9	L & R PWR: two eng min T/W
.14	1	EXT	10	HEAVY	FWD LIM	NOTED	NOTED	0	0	ECS	9 to 10	L & R PWR: two eng min T/W
.15	1	EXT	10	HEAVY	FWD LIM	NOTED	NOTED	0	0	ECS	10 to 11	L & R PWR: two eng min T/W
.16	1	EXT	10	HEAVY	FWD LIM	NOTED	NOTED	0	0	ECS	10 to 11	L & R PWR: single eng min T/W
.17	1	EXT	10	MEDIUM	FWD LIM	NOTED	NOTED	0	0	ECS	10 to 11	L & R PWR: two eng min T/W
.18	1	EXT	10	MEDIUM	FWD LIM	NOTED	NOTED	0	0	ECS	10 to 11	L & R PWR: single eng min T/W

Test: 93 - 311 Performance: Field: Vmu Development **Risk:** High **Maneuver:** Vmu Devleopment

ITEM	REPS	GEAR	FLAP	WEIGHT	CG	L PWR	R PWR	ALT	AIRSPEED	BLEED	PITCH	SUPPLEMENTAL NOTES
.19	1	EXT	10	HEAVY	AFT	NOTED	NOTED	0	0	ECS	8 to 9	Optional CG: AFT to as req'd to demo VMU; L & R PWR: two eng min T/W
.20	1	EXT	10	HEAVY	AFT	NOTED	NOTED	0	0	ECS	9 to 10	Optional CG: AFT to as req'd to demo VMU; L & R PWR: two eng min T/W
.21	1	EXT	10	HEAVY	AFT	NOTED	NOTED	0	0	ECS	10 to 11	Optional CG: AFT to as req'd to demo VMU; L & R PWR: two eng min T/W
.22	1	EXT	10	HEAVY	AFT	NOTED	NOTED	0	0	ECS	10 to 11	Optional CG: AFT to as req'd to demo VMU; L & R PWR: single eng min T/W
.23	1	EXT	10	MEDIUM	AFT	NOTED	NOTED	0	0	ECS	10 to 11	Optional CG: AFT to as req'd to demo VMU; L & R PWR: two eng min T/W
.24	1	EXT	10	MEDIUM	AFT	NOTED	NOTED	0	0	ECS	10 to 11	Optional CG: AFT to as req'd to demo VMU; L & R PWR: single eng min T/W

Test: 93 - 321 Performance: Field: Takeoff: Rotation Rate Development

Risk: Medium **Maneuver:** Takeoff Rotation Rate

Procedure: **Field Performance**

Regulations:

25.101
25.105
25.107

1. Configure aircraft for takeoff with/except: R HYD DEPRESS: as specified
2. Align aircraft on runway and apply brakes
3. Set L & R PWR: as specified; release brakes
4. For engine-out runs, at target VEF, fail RH engine using a throttle chop.
a. Use rudder and NWS control as required for directional control
5. Rotate at VR at target rotation rate to target pitch attitude.
6. Maintain target pitch attitude until target climb speed (V2 or V2+10 as appropriate) is achieved.
7. Retract gear after positive rate-of-climb (ROC) is established.
8. Adjust pitch attitude to maintain target climb speed (V2 or V2+10 as appropriate) to the lesser of gear retraction complete or 400 ft AGL.

ITEM	REPS	GEAR	FLAP	WEIGHT	CG	L PWR	R PWR	ALT	AIRSPEED	BLEED	PITCH	PITCH RATE	R HYD DEPRESS	SUPPLEMENTAL NOTES
.01	1	EXT	20	HEAVY	FWD LIM	MTO	MTO	0	VR	ECS	10	3 to 4	NORM	
.02	1	EXT	20	HEAVY	FWD LIM	MTO	MTO	0	VR	ECS	10	4 to 5	NORM	
.03	1	EXT	20	HEAVY	FWD LIM	MTO	MTO	0	VR	ECS	10	5 to 6	NORM	
.04	1	EXT	20	HEAVY	FWD LIM	MTO	IDLE	0	VEF	ECS	10	2 to 3	MAN DEPRESS	
.05	1	EXT	20	HEAVY	FWD LIM	MTO	IDLE	0	VEF	ECS	10	3 to 4	MAN DEPRESS	
.06	1	EXT	20	HEAVY	FWD LIM	MTO	IDLE	0	VEF	ECS	10	4 to 5	MAN DEPRESS	

Test: 93 - 322 Performance: Field: Takeoff: Pitch Attitude Development

Risk: Medium **Maneuver:** Pitch Attitude Development

Procedure: **Field Performance**

Regulations:

25.101
25.105
25.107

1. Configure aircraft for takeoff with/except: R HYD DEPRESS: As specified
2. Align aircraft on runway and apply brakes
3. Set L & R PWR: as specified; release brakes
4. For engine-out runs, at target VEF, fail RH engine using a throttle chop.
a. Use rudder and NWS control as required for directional control
5. Rotate at VR at a normal rotation rate (3-5 degs/sec) to target pitch attitude.
6. Maintain target pitch attitude until target climb speed (V2 or V2+10 as appropriate) is achieved.
7. Retract gear after positive ROC is established.
8. Adjust pitch attitude to maintain target climb speed (V2 or V2+10 as appropriate) to the lesser of gear retraction complete or 400 ft AGL.

ITEM	REPS	GEAR	FLAP	WEIGHT	CG	L PWR	R PWR	ALT	AIRSPEED	BLEED	PITCH	R HYD DEPRESS	SUPPLEMENTAL NOTES
.01	1	EXT	20	HEAVY	FWD LIM	MTO	MTO	0	0	ECS	8 to 9	NORM	
.02	1	EXT	20	HEAVY	FWD LIM	MTO	MTO	0	0	ECS	9 to 10	NORM	
.03	1	EXT	20	HEAVY	FWD LIM	MTO	MTO	0	0	ECS	10 to 11	NORM	
.04	1	EXT	20	HEAVY	FWD LIM	NOTED	NOTED	0	0	ECS	6 to 7	MAN DEPRESS	L PWR: single eng min T/W
.05	1	EXT	20	HEAVY	FWD LIM	NOTED	NOTED	0	0	ECS	7 to 8	MAN DEPRESS	L PWR: single eng min T/W
.06	1	EXT	20	HEAVY	FWD LIM	NOTED	NOTED	0	0	ECS	8 to 9	MAN DEPRESS	L PWR: single eng min T/W
.07	1	EXT	20	LIGHT	FWD LIM	MTO	MTO	0	0	ECS	8 to 9	NORM	
.08	1	EXT	20	LIGHT	FWD LIM	MTO	MTO	0	0	ECS	9 to 10	NORM	
.09	1	EXT	20	LIGHT	FWD LIM	MTO	MTO	0	0	ECS	10 to 11	NORM	
.10	1	EXT	20	LIGHT	FWD LIM	NOTED	NOTED	0	0	ECS	6 to 7	MAN DEPRESS	L PWR: single eng min T/W
.11	1	EXT	20	LIGHT	FWD LIM	NOTED	NOTED	0	0	ECS	7 to 8	MAN DEPRESS	L PWR: single eng min T/W
.12	1	EXT	20	LIGHT	FWD LIM	NOTED	NOTED	0	0	ECS	8 to 9	MAN DEPRESS	L PWR: single eng min T/W
.13	1	EXT	10	HEAVY	FWD LIM	MTO	MTO	0	0	ECS	9 to 10	NORM	
.14	1	EXT	10	HEAVY	FWD LIM	MTO	MTO	0	0	ECS	10 to 11	NORM	
.15	1	EXT	10	HEAVY	FWD LIM	MTO	MTO	0	0	ECS	11 to 12	NORM	
.16	1	EXT	10	HEAVY	FWD LIM	NOTED	NOTED	0	0	ECS	7 to 8	MAN DEPRESS	L PWR: single eng min T/W
.17	1	EXT	10	HEAVY	FWD LIM	NOTED	NOTED	0	0	ECS	8 to 9	MAN DEPRESS	L PWR: single eng min T/W
.18	1	EXT	10	HEAVY	FWD LIM	NOTED	NOTED	0	0	ECS	9 to 10	MAN DEPRESS	L PWR: single eng min T/W

Test: 93 - 322 Performance: Field: Takeoff: Pitch Attitude Development **Risk:** Medium **Maneuver:** Pitch Attitude Development

ITEM	REPS	GEAR	FLAP	WEIGHT	CG	L PWR	R PWR	ALT	AIRSPEED	BLEED	PITCH	R HYD DEPRESS	SUPPLEMENTAL NOTES
.19	1	EXT	10	LIGHT	FWD LIM	MTO	MTO	0	0	ECS	9 to 10	NORM	
.20	1	EXT	10	LIGHT	FWD LIM	MTO	MTO	0	0	ECS	10 to 11	NORM	
.21	1	EXT	10	LIGHT	FWD LIM	MTO	MTO	0	0	ECS	11 to 12	NORM	
.22	1	EXT	10	LIGHT	FWD LIM	NOTED	NOTED	0	0	ECS	7 to 8	MAN DEPRESS	L PWR: single eng min T/W
.23	1	EXT	10	LIGHT	FWD LIM	NOTED	NOTED	0	0	ECS	8 to 9	MAN DEPRESS	L PWR: single eng min T/W
.24	1	EXT	10	LIGHT	FWD LIM	NOTED	NOTED	0	0	ECS	9 to 10	MAN DEPRESS	L PWR: single eng min T/W

Test: 93 - 325 Performance: Field: Takeoff: Company Development

Risk: Low **Maneuver:** Takeoff Company Development

Procedure: **Field Performance**

Regulations:

25.101
25.105
25.107
25.109
25.113

1. Configure aircraft for takeoff with/except: R HYD DEPRESS: As specified
2. Align aircraft on runway and apply brakes
3. Set L & R PWR: MTO
4. Release brakes
5. For engine-out runs, at target VEF, fail RH engine using a throttle chop.
a. Use rudder and NWS control as required for directional control
6. Rotate at VR at a normal rotation rate (3-5 degs/sec) to target pitch attitude.
7. Maintain target pitch attitude until target climb speed (V2 or V2+10 as appropriate) is achieved.
8. Retract gear after positive ROC is established.
9. Adjust pitch attitude to maintain target climb speed (V2 or V2+10 as appropriate) to the lesser of gear retraction complete or 400 ft AGL.

ITEM	REPS	GEAR	FLAP	WEIGHT	CG	L PWR	R PWR	ALT	AIRSPEED	BLEED	R HYD DEPRESS	SUPPLEMENTAL NOTES
.01	2	EXT	0	HEAVY	FWD LIM	MTO	MTO	0	0	ECS	NORM	
.02	2	EXT	0	HEAVY	FWD LIM	MTO	MTO	0	0	ECS	MAN DEPRESS	Throttle Chop @ VEF
.03	2	EXT	0	LIGHT	FWD LIM	MTO	MTO	0	0	ECS	NORM	
.04	2	EXT	0	LIGHT	FWD LIM	MTO	MTO	0	0	ECS	MAN DEPRESS	Throttle Chop @ VEF

Test: 93 - 312 Performance: Field: Vmu: Vmu Certificaton

Risk: High **Maneuver:** Vmu Certification

Procedure: **Field Performance**

Regulations:

25.107

1. Configure aircraft for takeoff with/except: STAB TRIM: As specified
2. Align aircraft on runway and apply brakes.
3. Set L & R PWR: MTO; release brakes.
4. During the initial ground acceleration and prior to 60 KCAS, set L & R PWR: target EPR for test T/W.
5. At 60 KCAS apply full aft control column. When aircraft begins to rotate, use control column to capture the target pitch attitude for the test condition and maintain through liftoff until out of ground effect or 100 ft AGL.

ITEM	REPS	GEAR	FLAP	WEIGHT	CG	L PWR	R PWR	ALT	AIRSPEED	BLEED	PITCH	SUPPLEMENTAL NOTES
.01	1	EXT	20	HEAVY	A/R	NOTED	NOTED	3600	0	ECS	9 to 10	CG: per dev tests, L & R PWR: two eng min T/W
.02	1	EXT	20	HEAVY	A/R	NOTED	NOTED	3600	0	ECS	9 to 10	CG: per dev tests, L & R PWR: single eng min T/W
.03	1	EXT	20	MEDIUM	A/R	NOTED	NOTED	3600	0	ECS	9 to 10	CG: per dev tests, L & R PWR: two eng min T/W
.04	1	EXT	20	MEDIUM	A/R	NOTED	NOTED	3600	0	ECS	9 to 10	CG: per dev tests, L & R PWR: single eng min T/W
.05	1	EXT	10	HEAVY	A/R	NOTED	NOTED	3600	0	ECS	10 to 11	CG: per dev tests, L & R PWR: two eng min T/W
.06	1	EXT	10	HEAVY	A/R	NOTED	NOTED	3600	0	ECS	10 to 11	CG: per dev tests, L & R PWR: single eng min T/W
.07	1	EXT	10	MEDIUM	A/R	NOTED	NOTED	3600	0	ECS	10 to 11	CG: per dev tests, L & R PWR: two eng min T/W
.08	1	EXT	10	MEDIUM	A/R	NOTED	NOTED	3600	0	ECS	10 to 11	CG: per dev tests, L & R PWR: single eng min T/W

Test: 93 - 313 Performance: Field: Vmu: Vmu Assurance

Risk: High **Maneuver:** Vmu Assurance

Procedure: Field Performance

Regulations: 25.107

1. Configure aircraft for takeoff.
2. Align aircraft on runway and apply brakes.
3. Set L & R PWR: MTO; release brakes.
4. During the initial ground acceleration and prior to 60 KCAS, set L & R PWR: target EPR for test T/W.
5. At 60 KCAS apply full aft control column. When aircraft begins to rotate, use control column to capture the target pitch attitude for the test condition. Maintain liftoff attitude until out of ground effect or 100 ft AGL.

a. Elevator input may be adjusted to not over-rotate, but liftoff attitude must be maintained until out of ground effect or 100 ft AGL.

ITEM	REPS	GEAR	FLAP	WEIGHT	CG	L PWR	R PWR	ALT	AIRSPEED	BLEED	PITCH	SUPPLEMENTAL NOTES
.01	1	EXT	20	MTOW	FWD LIM	NOTED	NOTED	3600	0	ECS	9 to 10	L & R PWR: two eng min T/W
.02	1	EXT	20	MTOW	FWD LIM	NOTED	NOTED	3600	0	ECS	9 to 10	L & R PWR: single eng min T/W
.03	1	EXT	10	MTOW	FWD LIM	NOTED	NOTED	3600	0	ECS	10 to 11	L & R PWR: two eng min T/W
.04	1	EXT	10	MTOW	FWD LIM	NOTED	NOTED	3600	0	ECS	10 to 11	L & R PWR: single eng min T/W

Test: 93 - 323 Performance: Field: Takeoff: AEO

Risk: Low **Maneuver:** Takeoff AEO

Procedure: **Field Performance**

Regulations:

25.101
25.105
25.107
25.109
25.113

1. Configure aircraft for takeoff.
2. Align aircraft on runway and apply brakes
3. Set L &R PWR: as specified
4. Release brakes
5. Rotate at VR at a normal rotation rate (3-5 degs/sec) to target pitch attitude.
6. Maintain target pitch attitude until target climb speed (V2+10) is achieved.
7. Retract gear after positive ROC is established.
8. Adjust pitch attitude to maintain target climb speed (V2+10) to the lesser of gear retraction complete or 400 ft AGL.

ITEM	REPS	GEAR	FLAP	WEIGHT	CG	L PWR	R PWR	ALT	AIRSPEED	BLEED	SUPPLEMENTAL NOTES
.01	1	EXT	20	MTOW	FWD LIM	NOTED	NOTED	3600	0	ECS	L & R PWR: Low Gradient
.02	1	EXT	20	MTOW	FWD LIM	NOTED	NOTED	3600	0	ECS	L & R PWR: Med Gradient
.03	1	EXT	20	MTOW	FWD LIM	MTO	MTO	3600	0	ECS	
.04	1	EXT	20	MEDIUM	FWD LIM	NOTED	NOTED	3600	0	ECS	L & R PWR: Low Gradient
.05	1	EXT	20	MEDIUM	FWD LIM	NOTED	NOTED	3600	0	ECS	L & R PWR: Med Gradient
.06	1	EXT	20	MEDIUM	FWD LIM	MTO	MTO	3600	0	ECS	
.07	1	EXT	20	LIGHT	FWD LIM	NOTED	NOTED	3600	0	ECS	L & R PWR: Low Gradient
.08	1	EXT	20	LIGHT	FWD LIM	NOTED	NOTED	3600	0	ECS	L & R PWR: Med Gradient
.09	1	EXT	20	LIGHT	FWD LIM	MTO	MTO	3600	0	ECS	
.10	1	EXT	10	MTOW	FWD LIM	NOTED	NOTED	3600	0	ECS	L & R PWR: Low Gradient
.11	1	EXT	10	MTOW	FWD LIM	NOTED	NOTED	3600	0	ECS	L & R PWR: Med Gradient
.12	1	EXT	10	MTOW	FWD LIM	MTO	MTO	3600	0	ECS	
.13	1	EXT	10	MEDIUM	FWD LIM	NOTED	NOTED	3600	0	ECS	L & R PWR: Low Gradient
.14	1	EXT	10	MEDIUM	FWD LIM	NOTED	NOTED	3600	0	ECS	L & R PWR: Med Gradient
.15	1	EXT	10	MEDIUM	FWD LIM	MTO	MTO	3600	0	ECS	
.16	1	EXT	10	LIGHT	FWD LIM	NOTED	NOTED	3600	0	ECS	L & R PWR: Low Gradient
.17	1	EXT	10	LIGHT	FWD LIM	NOTED	NOTED	3600	0	ECS	L & R PWR: Med Gradient
.18	1	EXT	10	LIGHT	FWD LIM	MTO	MTO	3600	0	ECS	

Test: 93 - 324 Performance: Field: Takeoff: OEI

Risk: High **Maneuver:** Takeoff OEI

Procedure: **Field Performance**

Regulations:

25.101
25.105
25.107
25.113

1. Configure aircraft for takeoff with/except: for throttle chop points R HYD DEPRESS: MAN DEPRESS
2. Align aircraft on runway and apply brakes
3. Set L & R PWR: as specified
4. Release brakes
5. At target Vef, fail RH engine using a throttle chop or fuel cut via FUEL CONTROL: OFF as specified.
a. Use rudder and NWS control as required for directional control
6. Rotate at Vr to target pitch attitude at a normal rotation rate (3-5 degs/sec).
7. Maintain target pitch attitude until target climb speed (V2) is achieved.
8. Retract gear after positive ROC is established.
9. Adjust pitch attitude to maintain target climb speed (V2) to the lesser of gear retraction complete or 400 ft AGL.

ITEM	REPS	GEAR	FLAP	WEIGHT	CG	L PWR	R PWR	ALT	AIRSPEED	BLEED	R HYD DEPRESS	SUPPLEMENTAL NOTES
.01	1	EXT	20	LIGHT	FWD LIM	MTO	NOTED	3600	0	ECS	MAN DEPRESS	R PWR: MTO to throttle chop
.02	1	EXT	20	LIGHT	FWD LIM	NOTED	NOTED	3600	0	ECS	MAN DEPRESS	L PWR: Med Gradient, R PWR: Med Gradent to throttle chop
.03	1	EXT	20	LIGHT	FWD LIM	NOTED	NOTED	3600	0	ECS	NORM	L PWR: Med Gradient, R PWR: Med Gradent to FUEL CUT
.04	1	EXT	20	LIGHT	FWD LIM	NOTED	NOTED	3600	0	ECS	NORM	L PWR: Low Gradient, R PWR: Low Gradent to FUEL CUT
.05	1	EXT	20	MEDIUM	FWD LIM	MTO	NOTED	3600	0	ECS	MAN DEPRESS	R PWR: MTO to throttle chop
.06	1	EXT	20	MEDIUM	FWD LIM	NOTED	NOTED	3600	0	ECS	MAN DEPRESS	L PWR: Med Gradient, R PWR: Med Gradent to throttle chop
.07	1	EXT	20	MEDIUM	FWD LIM	NOTED	NOTED	3600	0	ECS	NORM	L PWR: Med Gradient, R PWR: Med Gradent to FUEL CUT
.08	1	EXT	20	MEDIUM	FWD LIM	NOTED	NOTED	3600	0	ECS	NORM	L PWR: Low Gradient, R PWR: Low Gradent to FUEL CUT
.09	1	EXT	20	MTOW	FWD LIM	MTO	NOTED	3600	0	ECS	MAN DEPRESS	R PWR: MTO to throttle chop
.10	1	EXT	20	MTOW	FWD LIM	NOTED	NOTED	3600	0	ECS	MAN DEPRESS	L PWR: Med Gradient, R PWR: Med Gradent to throttle chop
.11	1	EXT	20	MTOW	FWD LIM	NOTED	NOTED	3600	0	ECS	NORM	L PWR: Med Gradient, R PWR: Med Gradent to FUEL CUT
.12	1	EXT	20	MTOW	FWD LIM	NOTED	NOTED	3600	0	ECS	NORM	L PWR: Low Gradient, R PWR: Low Gradent to FUEL CUT
.13	1	EXT	10	LIGHT	FWD LIM	MTO	NOTED	3600	0	ECS	MAN DEPRESS	R PWR: MTO to throttle chop
.14	1	EXT	10	LIGHT	FWD LIM	NOTED	NOTED	3600	0	ECS	MAN DEPRESS	L PWR: Med Gradient, R PWR: Med Gradent to throttle chop
.15	1	EXT	10	LIGHT	FWD LIM	NOTED	NOTED	3600	0	ECS	NORM	L PWR: Med Gradient, R PWR: Med Gradent to FUEL CUT
.16	1	EXT	10	LIGHT	FWD LIM	NOTED	NOTED	3600	0	ECS	NORM	L PWR: Low Gradient, R PWR: Low Gradent to FUEL CUT
.17	1	EXT	10	MEDIUM	FWD LIM	MTO	NOTED	3600	0	ECS	MAN DEPRESS	R PWR: MTO to throttle chop

Test: 93 - 324 Performance: Field: Takeoff: OEI

Risk: High   Maneuver: Takeoff OEI

ITEM	REPS	GEAR	FLAP	WEIGHT	CG	L PWR	R PWR	ALT	AIRSPEED	BLEED	R HYD DEPRESS	SUPPLEMENTAL NOTES
.18	1	EXT	10	MEDIUM	FWD LIM	NOTED	NOTED	3600	0	ECS	MAN DEPRESS	L PWR: Med Gradient, R PWR: Med Gradent to throttle chop
.19	1	EXT	10	MEDIUM	FWD LIM	NOTED	NOTED	3600	0	ECS	NORM	L PWR: Med Gradient, R PWR: Med Gradent to FUEL CUT
.20	1	EXT	10	MEDIUM	FWD LIM	NOTED	NOTED	3600	0	ECS	NORM	L PWR: Low Gradient, R PWR: Low Gradent to FUEL CUT
.21	1	EXT	10	MTOW	FWD LIM	MTO	NOTED	3600	0	ECS	MAN DEPRESS	R PWR: MTO to throttle chop
.22	1	EXT	10	MTOW	FWD LIM	NOTED	NOTED	3600	0	ECS	MAN DEPRESS	L PWR: Med Gradient, R PWR: Med Gradent to throttle chop
.23	1	EXT	10	MTOW	FWD LIM	NOTED	NOTED	3600	0	ECS	NORM	L PWR: Med Gradient, R PWR: Med Gradent to FUEL CUT
.24	1	EXT	10	MTOW	FWD LIM	NOTED	NOTED	3600	0	ECS	NORM	L PWR: Low Gradient, R PWR: Low Gradent to FUEL CUT

Test: 93 - 331 Performance: Field: Abused Takeoff: OEI Vr-5

Risk: Medium **Maneuver:** Abused Takeoff, OEI Vr-5

Procedure: Field Performance

Regulations:

25.107
25.109

1. Configure aircraft for takeoff, with/except: R HYD DEPRESS: MAN DEPRESS.
2. Align aircraft on runway and apply brakes
3. Set L & R PWR: MTO
4. Release brakes
5. At target VEF, fail RH engine using a throttle chop.
a. Use rudder and NWS control as required for directional control
6. Rotate at VR-5 kts at a normal rotation rate (3-5 degs/sec) to target pitch attitude.
7. Maintain target pitch attitude through 35 feet AGL to achieve target climb speed (V2-5 to V2).
8. Retract gear after positive ROC is established.
9. Adjust pitch attitude to maintain target climb speed (V2) to the lesser of gear retraction complete or 400 ft AGL.

ITEM	REPS	GEAR	FLAP	WEIGHT	CG	L PWR	R PWR	ALT	AIRSPEED	BLEED	R HYD DEPRESS	SUPPLEMENTAL NOTES
.01	1	EXT	20	MTOW	FWD LIM	MTO	MTO	3600	0	ECS	MAN DEPRESS	
.02	1	EXT	20	LIGHT	FWD LIM	MTO	MTO	3600	0	ECS	MAN DEPRESS	
.03	1	EXT	10	MTOW	FWD LIM	MTO	MTO	3600	0	ECS	MAN DEPRESS	
.04	1	EXT	10	LIGHT	FWD LIM	MTO	MTO	3600	0	ECS	MAN DEPRESS	
.05	1	EXT	20	MTOW	FWD LIM	NOTED	NOTED	3600	0	ECS	MAN DEPRESS	L & R PWR: Min Gradient
.06	1	EXT	20	LIGHT	FWD LIM	NOTED	NOTED	3600	0	ECS	MAN DEPRESS	L & R PWR: Min Gradient
.07	1	EXT	10	MTOW	FWD LIM	NOTED	NOTED	3600	0	ECS	MAN DEPRESS	L & R PWR: Min Gradient
.08	1	EXT	10	LIGHT	FWD LIM	NOTED	NOTED	3600	0	ECS	MAN DEPRESS	L & R PWR: Min Gradient

Test: 93 - 332 Performance: Field: Abused Takeoff: AEO Vr-10 Over Rotation

Risk: Medium **Maneuver:** Abused Takeoff, AEO Vr-10 Over Rotation

Procedure: **Field Performance**

Regulations:

25.107

1. Configure aircraft for takeoff.
2. Align aircraft on runway and apply brakes
3. Set L & R PWR: MTO
4. Release brakes
5. Rotate at the lesser absolute speed of VR-10 kts or VR-7% at a normal rotation rate (3-5 degs/sec) to 2o above the normal takeoff pitch attitude.
6. Maintain pitch attitude until out of ground effect and positive ROC is established to achieve target climb speed (V2 to V2+10). 7. Retract gear after positive ROC is established.
8. Adjust pitch attitude to maintain target climb speed (V2+10) to the lesser of gear retraction complete or 400 ft AGL.

ITEM	REPS	GEAR	FLAP	WEIGHT	CG	L PWR	R PWR	ALT	AIRSPEED	BLEED	SUPPLEMENTAL NOTES
.01	1	EXT	20	MTOW	FWD LIM	NOTED	NOTED	3600	0	ECS	L & R PWR: Low Gradient
.02	1	EXT	10	LIGHT	FWD LIM	NOTED	NOTED	3600	0	ECS	L & R PWR: Low Gradient

Test: 93 - 333 Performance: Field: Abused Takeoff: AEO Vr-10 Rapid Rotation

Risk: Medium **Maneuver:** Abused Takeoff, AEO Vr-10 Rapid Rotation

Procedure: **Field Performance**

Regulations:

25.107

1. Configure aircraft for takeoff.
2. Align aircraft on runway and apply brakes
3. Set L & R PWR: MTO
4. Release brakes
5. Rotate at the lesser absolute speed of VR-10 kts or VR-7% at an aggressive rotation rate (5-7 degs/sec) to target pitch attitude.
6. Maintain target pitch attitude until outf of ground effect and postive ROC is established to achieve target climb speed (V2 to V2+10).
7. Retract gear after positive ROC is established.
8. Adjust pitch attitude to maintain target climb speed (V2+10) to the lesser of gear retraction complete or 400 ft AGL.

ITEM	REPS	GEAR	FLAP	WEIGHT	CG	L PWR	R PWR	ALT	AIRSPEED	BLEED	SUPPLEMENTAL NOTES
.01	1	EXT	20	MTOW	FWD LIM	NOTED	NOTED	3600	0	ECS	L & R PWR: Low Gradient
.02	1	EXT	10	MTOW	FWD LIM	NOTED	NOTED	3600	0	ECS	L & R PWR: Low Gradient

Test: 93 - 334 Performance: Field: Abused Takeoff: AEO Out-of-Trim

Risk: Medium **Maneuver:** Abused Takeoff, AEO Out-of-Trim

Procedure: **Field Performance**

Regulations:

25.107

1. Configure aircraft for takeoff, with/except: set takeoff trim as specified without a takeoff configuration warning.
2. Align aircraft on runway and apply brakes.
3. Set L & R PWR: MTO
4. Release brakes
5. Rotate at VR to target pitch attitude at a normal rotation rate (3-5 degs/sec).
a. Do not exceed the short term two hand force limit (75 lb).
6. Maintain target pitch attitude until target climb speed (V2+10) is achieved.
7. Retract gear after positive ROC is established.
8. Adjust pitch attitude to maintain target climb speed (V2+10) to the lesser of gear retraction complete or 400 ft AGL.

ITEM	REPS	GEAR	FLAP	WEIGHT	CG	L PWR	R PWR	ALT	AIRSPEED	BLEED	SUPPLEMENTAL NOTES
.01	1	EXT	20	MTOW	FWD LIM	MTO	MTO	3600	0	ECS	Trim: max nose down
.02	1	EXT	20	LIGHT	AFT LIM	MTO	MTO	3600	0	ECS	Trim: max nose up
.03	1	EXT	10	MTOW	FWD LIM	MTO	MTO	3600	0	ECS	Trim: max nose down
.04	1	EXT	10	LIGHT	AFT LIM	MTO	MTO	3600	0	ECS	Trim: max nose up

APPENDIX C TEST SAFETY HAZARD ANALYSIS

TEST SAFETY HAZARD ANALYSIS (TSHA)

TEST: Field Performance - V_{MU}
RISK LEVEL: HIGH

HAZARD: Aircraft Departs Runway/Inadvertent Ground Contact
CAUSE: Excessive rotation force/over rotation at low airspeed, low altitude stall, loss of an engine at low T/W conditions
EFFECT: Loss of aircraft/loss of crew.

PREVENTIVE ACTIONS / MINIMIZING PROCEDURES:

1. Testing will be conducted while winds at the runway are below 5 knots from any direction and not gusting.
2. Alpha limiter will remain TBD during the testing.
3. All testing shall be conducted under day VMC conditions on a smooth, hard-surfaced dry runway. Tests shall be conducted at KROW on Runway 3/21 which is 13000'x300'.
4. Only crewmembers deemed essential for conduct of the test shall be onboard.
5. V_{MU} testing will be approached in a build-up manner. Testing will begin at AEO high T/W conditions and proceed to the lower T/W conditions required. The number of required build-ups and repeat testing will be determined by the on-site test team.
6. OEI testing will be conducted by simulating the OEI condition, using the equivalent OEI total thrust divided between both operating engines.
7. Pitch attitude will be limited to TBD.
8. Inspect struts, brakes and tires prior to each test run. Service to recommended limits.
9. Brief local fire and rescue crews on test conditions.

OTHER:

1. If the aircraft is airborne and an engine fails, decrease pitch attitude, establish a stable bank angle, and advance the operative engine PLA so the aircraft will accelerate and then climb to desired altitude. Minimize asymmetric thrust if possible. Make turns into the operating engine and climb at no less than V_2 until 1500 ft AGL.
2. If the aircraft is over-rotated, or rotated early and stalls, decrease pitch attitude, maintain wings level, advance PLA on both engines, accelerate and then climb to desired altitude.

COG ENGR:________________________**TEST CONDUCTOR/COORDINATOR:**____________________

PILOT:____________________________**MANAGER:**______________________________

TEST SAFETY HAZARD ANALYSIS (TSHA)

TEST: Field Performance – Engine-out Takeoffs (OEI)
RISK LEVEL: HIGH

HAZARD: Aircraft Departs Runway/Inadvertent Ground Contact
CAUSE: Engine Failure/Loss of Control
EFFECT: Loss of aircraft/loss of crew.

PREVENTIVE ACTIONS / MINIMIZING PROCEDURES:

1. Testing with engine cuts will be proceeded by testing using a throttle chop to idle power. No engine shutdowns will be conducted without conducting a build-up test. The number of required build-ups and repeat testing will be determined by the on-site test team.
2. All testing shall be conducted under day VMC conditions on a smooth, hard-surfaced dry runway. Tests shall be conducted at KROW, on Runway 3/21 which is 13000'x300'.
3. Only crewmembers deemed essential for conduct of the test shall be onboard.
4. Brief local fire and rescue crews on test conditions.
5. Brief dual engine-out emergency procedures.
6. Winds will be limited to 10 knots total and components of 5 knots cross wind and 2 knots tail wind.

OTHER:

1. For throttle chops: if the aircraft is airborne and one engine fails, advance PLA as required, decrease pitch attitude, establish a stable bank angle, accelerate and climb to any altitude. Minimize asymmetric thrust if possible.
2. For fuel cuts: if the aircraft is airborne and operative engine fails, restart shutdown engine, if possible. Conduct dual engine-out landing procedures.
3. Make all turns into the operating engine and climb at no less than V_2 until 1500 ft AGL.

COG ENGR:____________________ **TEST CONDUCTOR/COORDINATOR:**____________________

PILOT:____________________ **MANAGER:**____________________