ANKARA YILDIRIM BEYAZIT UNIVERSITY

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LONGITUDINAL AND LATERAL-DIRECTIONAL STATIC AND DYNAMIC STABILITY CHARACTERISTICS EVALUATION ON B60 DUKE

M.Sc. Thesis by

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We have read the thesis entitled **"LONGITUDINAL AND LATERAL-DIRECTIONAL STATIC AND DYNAMIC STABILITY CHARACTERISTICS EVALUATION ON B60 DUKE"** completed by **Hasan DOMURCUK** under the supervision of **Prof. Dr. Hüseyin CANBOLAT** and we certify that in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.

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2024, January **Hasan DOMURCUK**

LONGITUDINAL AND LATERAL-DIRECTIONAL STATIC AND DYNAMIC STABILITY CHARACTERISTICS EVALUATION ON B60 DUKE

ABSTRACT

The test crew has been assigned to assess the B60 Duke suitability for basic transport training role in terms of Longitudinal and Lateral-Directional Static and Dynamic Stability. The evaluation was performed as test techniques of stabilized method, stabilized turn, pull up, pushover, short period, phugoid, WLSS, SHSS, Dutch Roll, spiral mode and bank-to-bank in B60 with tail number C-FYWQ on 22nd July and 12th, 16th, 19th August 2022.

It was assessed as SATISFACTORY that longitudinal static stability, longitudinal maneuver stability, longitudinal dynamic stability (except phugoid mode in climb configuration), lateral-directional static stability and lateral directional dynamic stability of the aircraft were positive. It was evaluated that the B60 was suitable for basic transport training flights without any deficiency.

All test points were executed without onboard flight test instrumentation. All recorded data was collected by hand notes. Further flight tests should be executed with onboard flight test instrumentation to increase the accuracy of the test results (Highly Desirable-Mission Effectiveness).

Further flight tests in different weights, C.G, airspeeds, altitudes and configurations should be performed to completely evaluate the longitudinal and lateral-directional static and dynamic stability of the B60 Duke (Highly Desirable-Mission Effectiveness).

Aircraft met with the CS23.157, CS23.173, CS23.175, CS23.177, CS23.181, MIL-F-8785C 3.2.2.2.1, MIL-F-8785C 3.3.1.1, MIL-F-8785C 3.3.1.3, MIL-F-8785C 3.3.6.1, MIL-F-8785C 3.3.6.2 and MIL-F-8785C 3.3.6.3 requirements.

Key words: Stability, longitudinal, lateral, directional, pull up, pushover, short period, Phugoid, WLSS, SHSS, Dutch Roll.

B60 DUKE UÇAĞI ÜZERİNDE BOYLAMSAL VE YANAL YÖNLÜ STATİK VE DİNAMİK STABİLİTE ÖZELLİKLERİNİN DEĞERLENDİRİLMESİ

ÖZ

Test ekibi, B60 Duke uçağı üzerinde boylamsal ve yanal yönlü statik ve dinamik stabilite açısından temel ulaşım eğitimi rolüne uygunluğunu değerlendirmek üzere görevlendirildi. Değerlendirme 22 Temmuz, 12, 16, 19 Ağustos 2022 tarihlerinde "Stabilized Method, Stabilized Turn, Pull up, Pushover, Short Period, Phugoid, WLSS, SHSS, Dutch Roll, Spiral Mode ve Bank-to-Bank" test teknikleri kullanılarak C-FYWQ kuruk numaralı B60 uçağı üzerinde gerçekleştirilmiştir.

Uçağın boylamsal statik stabilitesi, boylamsal manevra stabilitesi, boylamsal dinamik stabilitesi (tırmanma konfigürasyonunda phugoid mod hariç), yanal yön statik stabilitesi ve yanal yön dinamik stabilitesi "YETERLİ" olarak değerlendirildi. B60'ın temel ulaştırma eğitim uçuşlarına herhangi bir bulgu olmaksızın uygun olduğu değerlendirildi.

Tüm test noktaları, uçak üzeri uçuş testi enstrümantasyonu olmadan gerçekleştirildi. Kaydedilen tüm veriler el notlarıyla toplandı. Test sonuçlarının doğruluğunu artırmak için uçak içi uçuş testi cihazlarıyla daha fazla uçuş testi gerçekleştirilmelidir. (Son Derece İstenilen - Görev Etkililiği)

B60 Duke'ün boylamsal ve yanal yönde statik ve dinamik stabilitesini tamamen değerlendirmek için farklı ağırlıklarda, CG'de, hızlarda, irtifalarda ve konfigürasyonlarda daha fazla uçuş testleri yapılmalıdır. (Son Derece İstenen Görev Etkililiği)

Uçak CS23.157, CS23.173, CS23.175, CS23.177, CS23.181, MIL-F-8785C 3.2.2.2.1, MIL-F-8785C 3.3.1.1, MIL-F-8785C 3.3.1.3, MIL-F-8785C 3.3.6.1, MIL-F-8785C 3.3.6.2 and MIL-F-8785C 3.3.6.3 isterlerini karşıladı.

Anahtar Kelimeler: Stabilite, boylamsal, yanal, yönel, pull up, pushover, short period, Phugoid, WLSS, SHSS, Dutch Roll.

CONTENTS

NOMENCLATURE

A	Aileron
AGL	Above Ground Level
App	Approach
CG	Center of Gravity
DN	Down
E	Elevator
EASA	European Union Aviation Safety Agency
ENG	Engine
FQ	Flying Qualities
FRSR	Free Return Speed Range
ft	Feet
FTE	Flight Test Engineer
FTI	Flight Test instrumentation
FTO	Flight Test Order
FTT	Flight Test Technique
FW	Fixed Wing
IFR	Instrument Flight Rules
InHg	Inch of Mercury
ITPS	International Test Pilots School
KIAS	Knots of Indicated Airspeed
LDDS	Lateral Directional Dynamic Stability
LDS	Longitudinal Dynamic Stability
LDSS	Lateral Directional Static Stability
LMS	Longitudinal Maneuvering Stability
LSS	Longitudinal Static Stability
lbs	Pounds
MAP	Manifold Pressure
MSL	Mean Sea Level
OAT	Outside Ambient Temperature
OEI	One Engine Inoperative
PFLF	Power for Level Flight
QNH	Atmospheric Pressure at Nautical Height

TP	Test Pilot
VMC	Visual Meteorological Conditions
WLSS	Wings Level Sideslip

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

This thesis was written to find the answer for the question of whether B60 Duke Aircraft is suitable for basic transport training role by means of Longitudinal and Lateral-Directional Static and Dynamic Stability. International Test Pilot School (ITPS) [1], Empire Test Pilot School (ETPS) [2], National Test Pilot School (NTPS) [3], United States Naval Test Pilot School (USNTPS) [4] and United States Air Force Test Pilot School (USAF TPS) [5] Flight Test Manuals were taken reference for theoretical review. Four sorties of flight tests were performed for the test points presented in APPENDIX A. The flight test techniques (FTTs) were used for the evaluation mentioned in ITPS flight manuals. Data which were gathered by hand notes during test flights are presented in APPENDIX B. Results were evaluated according to EASA CS23 amendment 4 [6] standards as it applied to Commuter Category Aeroplanes, and Military Specifications (MIL-F-8785) [7] considering Class II airplane (light transport trainer). Compliance status of the items is presented in APPENDIX D.

1.1 Literature Summary

1.1.1 Stability of Airplanes

The airplane is a dynamic system, i.e., it is a body in motion under the influence of forces and moments producing or changing that motion. In order to investigate the motion of the airplane, it is necessary to establish first that it can be brought into a condition of equilibrium, i.e., a condition of balance between opposing forces and moments (not necessarily a “force time” condition from the pilot's standpoint). Then the stability characteristics of the equilibrium condition can be determined. The airplane is statically stable if restoring forces and moments are created which tend to restore it to equilibrium when disturbed from equilibrium. Thus, static stability characteristics must be investigated from equilibrium flight conditions, in which all forces and moments are in balance.

The direct in-flight measurement of certain static stability parameters is not feasible in many instances. Therefore, the flight test team must be content with measuring parameters which only give indications of static stability. However, these indications are usually adequate to establish conclusively the mission effectiveness of the airplane and are more meaningful to the pilot than the numerical value of the stability derivatives.

The pilot makes changes from one equilibrium flight condition to another through one or more of the airplane's modes of motion. These changes are initiated by excitation of the modes by the pilot and terminated by suppression of the modes by the pilot. These modes of motion may also be excited by external perturbations. The study of the characteristics of these modes of motion is the study of dynamic stability.

Here the characteristics of the modes of motion of the airplane determine its dynamic stability characteristics. The most important characteristics are the frequency and damping of the motion. The frequency of the motion is defined as the “number of cycles per unit time” and is a measure of the “quickness” of the motion. The term undamped natural frequency is often used in describing airplane motion. It is the frequency of the motion if the motion exhibited zero damping.

Static and dynamic stability prevent unintentional excursions into dangerous ranges (with regard to airplane strength) of dynamic pressure, normal acceleration, and side force. The stable airplane is resistant to deviations in angle of attack, sideslip, and bank angle without action by the pilot. These characteristics not only improve flight safety but allow the pilot to perform maneuvering tasks with smoothness, precision, and a minimum of effort.

1.1.1.1 Static and Dynamic Stability of Airplanes

The airplane is said to be statically stable or to possess positive static stability if, following the removal of a disturbing force, it immediately starts to return to its original equilibrium condition based on the restoring forces and moments created. Dynamic stability is defined as the ability of the airplane to eventually regain original flight conditions after being disturbed. It is related to the time history following a disturbance from equilibrium.

In other words, dynamic stability may be also classically defined as the ability of the airplane to eventually regain original flight conditions after being disturbed. Dynamic stability characteristics are measured from nonequilibrium flight conditions during which the forces and moments acting on the airplane are not in balance.

Static and dynamic stability determine the pilot's ability to control the airplane. While static instability about any axis is generally undesirable, if not completely unacceptable, excessively strong static stability about any axis may derogate controllability to an unacceptable degree. For some pilot tasks, neutral static stability may actually be desirable because of the increased controllability which results. Obviously, the optimum level of static stability depends on the mission of the airplane.

1.1.1.2 Damping Ratio

Damping of the motion is defined as a progressive diminishing of its amplitudes and is a measure of the subsidence of the motion. The term damping ratio is often used in describing airplane motion. It is the ratio of the damping which exists to critical damping. The damping ratio of the airplane modes of motion has a profound affect on flying qualities. If it is too low, the airplane motion is too easily excited by inadvertent pilot control inputs or by atmospheric turbulence. If it is too high, the airplane motion following a control input is slow to develop and the pilot may describe the airplane as “sluggish.” The mission of the airplane again determines the optimum dynamic stability characteristics. However, the pilot always desires some level of positive damping of all the airplane's modes of motion.

1.1.2 Flying and Handling Quality of Airplanes

The terms flying qualities and handling qualities are often used interchangeably in-flight test literature to describe the general aircraft response characteristics following pilot input, and the ease with which a task or mission can be flown.

Flying qualities are defined as those stability and control characteristics which influence the ease of safely flying an airplane during steady and maneuvering flight in the execution of the total mission.

The prime reason for conducting flying qualities investigations, then, is to determine if the pilot-airplane combination can safely and precisely perform the various tasks of the total mission of the airplane. This determination can generally be made by the pure qualitative approach to stability and control testing.

Handling qualities are defined as those qualities or characteristics of an aircraft that govern the ease and precision with which a pilot is able to perform the tasks required in support of an aircraft role.

Handling qualities are based on the pilot's opinion of how the aircraft flies when an attempt is made to perform a specific flying task, such as setting a desired bank angle, maintaining airspeed during an approach, or tracking the runway centerline during the landing roll. Unlike stability and control testing, which is wholly quantitative, handling qualities are usually described with adjectives and adverbs. Where stability and control testing usually involve measuring the aircraft's response after making specific control inputs, or measuring the control inputs needed for a specific aircraft response or condition, handling qualities always involves a pilot performing a task, like capturing a localiser, tracking the centerline, etc. Evaluating handling qualities therefore involves more than a single control input.

1.2 Background

The B60 was being considered by the Air Force of the Democratic Republic of Perfect Pilot (DROPP) for the Basic Transport training role. Due to the demands of the countries where the Air Force planned to operate, the B60 had to be tested to verify compliance with EASA CS23 amendment 4 standards as it applied to Commuter Category Aeroplanes, and Military Specifications considering Class II airplane (light transport trainer). Test team was tasked with planning and executing a test campaign to evaluate these characteristics and verify specification compliance.

1.3 Aim of the Thesis

The aim of the thesis was to assess the longitudinal and lateral-directional static and dynamic stability characteristics of the B60 Duke to be used for the Basic Transport training role.

Test results were used to evaluate the following objectives:

- To evaluate the longitudinal stability characteristics of the B60 airplane for the training role.
- To determine compliance with CS 23 (amendment 4) paragraphs: 155, 173 and 175.
- To determine compliance with CS 23.157 (amendment 4) Rate of roll for flaps up/gear up take-off configuration and flaps down/gear down for landing configuration.
- To evaluate the lateral / directional stability characteristics of the B60 airplane for the training role.
- To determine compliance with CS 23.177.
- To determine compliance with CS 23.181.
- To determine compliance with MIL-F-8785C paragraphs 3.2.2.2.1, table V (as it applies to pitch maneuvering force gradient limits), 3.3.1.1 (Lateral-directional oscillations - Dutch-Roll), 3.3.1.3 (spiral stability), 3.3.6.1 (yawing moments in steady sideslips), 3.3.6.2 (side forces in steady sideslips), 3.3.6.3 (rolling moments in steady sideslips).

1.4 Assessment Philosophy

The tests were performed on the B60 Duke and focused on the test items defined in section 1.6.

Longitudinal static stability of B60 Duke was assessed by using “Stabilized Method” FTT to obtain stick forces gradient. Stabilized method FTT was chosen instead of continuous method FTT due to lack of FTI on aircraft.

Longitudinal maneuver stability of B60 Duke was assessed by using “Stabilized Turn, Pull-up and Push-over” FTTs to obtain stick force per g.

Longitudinal dynamic stability of B60 Duke was assessed by using “Short Period Oscillation and Phugoid” FTTs to obtain short period and long period longitudinal dynamic stability characteristics (damping ratio and natural frequency) of the aircraft.

Lateral directional static stability of B60 Duke was assessed by using “WLSS and SHSS” FTTs to obtain stick and rudder forces gradients while sideslip was increasing. WLSS FTT was used to determine directional static stability characteristic while SHSS for lateral static stability characteristic.

Lateral directional dynamic stability of B60 Duke was assessed by using “Dutch Roll, Spiral Mode and Roll Performance” FTTs to obtain lateral directional dynamic stability characteristics (damping ratio, natural frequency, spiral stability and roll performance).

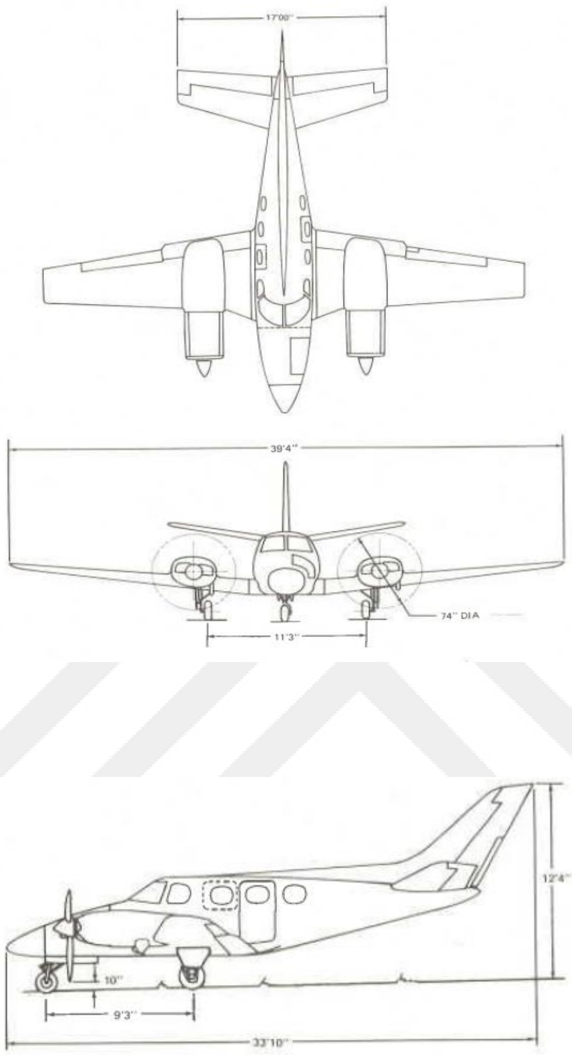
1.5 Aircraft Description

The B60 is a multi-engine, six seats, pressurized aircraft manufactured by Beechcraft. The aircraft primary mission air taxi operation. Aircraft serial number was P560 [8]. The B60 dimensions is as shown in Figure 1.1 and aircraft’s features as follows.

- The B60 is a conventional low wing cantilever airplane.
- The empennage consists of a vertical stabilizer with rudder and horizontal stabilizers with elevators.
- The airplane has a piston turbocharged engine and a three-blade propeller.
- The retractable landing gear configuration is two main gear and a tailwheel.
- The B60 cabin is pressurized.
- Equipped with Vortex Generator and Winglets. [9]

The B60 dimensions are:

Figure 1.1 Aircraft dimensions



Airplane controls include elevators, ailerons, rudder, elevator trim, rudder trim, aileron trim, flaps.

- The elevator and ailerons are controlled by the control wheel.
- The surfaces are actuated by push-pull rod and cables terminating at bell cranks.
- The rudder is controlled by the rudder pedals and cables.
- Flaps operated electrically and controlled by three positions Up, App, DN.

1.6 Scope of the Test

Tests were performed on the B60 Duke located on the schedule given in Table 1.1.

Table 1.1 Test schedule

<table>
<tr><th>Sortie</th><th>Duration</th><th>Date</th><th>Crew</th></tr>
<tr><td>1</td><td>2.1 hours</td><td>22 July 2022</td><td rowspan="4">Halil Unal (TP)
Batuhan KARA (FTE)
Hasan DOMURCUK (FTE)</td></tr>
<tr><td>2</td><td>2.0 hours</td><td>12 August 2022</td></tr>
<tr><td>3</td><td>1.5 hours</td><td>16 August 2022</td></tr>
<tr><td>4</td><td>1.2 hours</td><td>19 August 2022</td></tr>
</table>

The evaluation focused on the following items:

- Stabilized Method
- Stabilized Turn, Pull-up and Push-over
- Short Period and Phugoid
- WLSS
- SHSS
- Dutch Roll, Spiral Mode and Roll Performance

All the test points were performed at smooth atmosphere, no turbulence, no icing and no precipitation conditions.

1.7 Limitations

Limitations were as follows:

- All tests were carried out within the aircraft's normal operating envelope.
- Longitudinal Maneuver Stability tests were carried out at speed not to exceed 130 KIAS in clean configuration only, and normal acceleration to a minimum +0.5 g.
- All tests were carried out in day VMC.

- Except for take-off and landing, all tests were carried out at or above 4000 ft AGL.

1.8 Tests Made

Stabilized Method test points were performed in climb, cruise and landing configurations at different speeds and power settings to determine longitudinal static stability characteristic.

Stabilized Turn, Pull-up and Push-over test points were carried out in cruise configuration at 125 KIAS to determine longitudinal manoeuvre stability characteristic.

Short Period and Phugoid test points were executed in climb, cruise and landing configurations at different speeds and power settings to determine longitudinal dynamic stability characteristic.

WLSS test points were conducted in take-off, cruise and landing configurations at different speeds and PFLF to determine directional static stability characteristic.

SHSS test points performed in take-off, cruise and landing configurations at different speeds and power settings to determine lateral static stability characteristic.

Dutch Roll, Spiral Mode and Roll Performance test points were carried out in take-off, cruise and landing configurations at different speeds and different power settings to determine lateral directional dynamic stability characteristic.

Details of the tests are given in flight test matrix in APPENDIX A.

1.9 Instrumentation

GoPro camera, portable g meter and stopwatch were utilized as FTI equipment to gather required data for analysing the longitudinal and lateral-directional static and dynamic stability of B60 Duke.

There was not any flight data recorder on the aircraft while test points were executed. Therefore, all parameters were obtained by pilot observation and hand notes.

CHAPTER 2

RESULTS AND DISCUSSION (TEST AND EVALUATIONS)

2.1 LSS Characteristic of B60 Duke

Longitudinal static stability characteristic was assessed in B60 Duke with tail number C-FYWQ on the first sortie executed on 22nd July 2022 and second sortie executed on 12th August 2022 in the area between London International Airport (CYXU) and Centralia Aerodrome (CYCE) for first sortie and area between London International Airport (CYXU) and St. Thomas Municipal Airport (CYQS) for second sortie. Stabilized method test points were performed under the conditions given in Table 2.1 and Table 2.2 to determine the longitudinal static stability characteristic of B60 Duke. Test points 1.1 to 1.4 were performed in first sortie, test point 1.5 was performed in second sortie. OAT was between 14 and 17ºC for test points 1.1 to 1.4 and 10ºC for test point 1.5. Altimeters were set to local QNH. Yaw damper was off and cowl flaps were closed for all test points. C.G was 29% for all test points. Altitude and airspeed tolerances for all test points were ±1000 ft, and ±2 kts respectively.

Table 2.1. Test Conditions for Stabilized Method Test Points

Test Point	Trim Speed (KIAS)	Trim Pressure Altitude (ft)	RPM		MAP (inHg)	
			L ENG	R ENG	L ENG	R ENG
1.1	120	6000	2760	2740	36.3	36.4
1.2	122	6950	2520	2490	25	23.5
1.3	168	6980	2530	2520	33.4	33.3
1.4	95	5400	2750	2760	16.9	15.7
1.5	95	7100	2740	2760	7.4	7.4

Table 2.2 Test Conditions for Stabilized Method Test Points

Test Point	Weight (lbs)		Config.		Trim		
	Start	**End**	**Flap**	**Gear**	**E**	**A**	**R**
1.1	6707	6599	Up	Up	-2	0	0
1.2	6539	6497	Up	Up	-2	0	0
1.3	6455	6353	Up	Up	-8	0	0
1.4	6245	6221	30	Down	-2	0	0
1.5	6665	6629	30	Down	-5	0	0

Stick force, stick deflection, indicated airspeed, and indicated pressure altitude were noted for each stabilized point. Recorded data were presented in APPENDIX B.

Pull forces were applied to obtain and maintain speeds below the trim speeds and push forces were applied to obtain and maintain speeds above the trim speeds for all test points. There was not any force reversal, lightening or buffet for all test points. Break out plus friction force was approximately obtained as 2 pounds and friction force was approximately gathered as 1 pound for all test points. Stick forces and deflections increased while going further away from trim speed for all test points.

Stick force vs airspeed graphs were plotted as given in APPENDIX C Figure *APPENDIX C.1* to Figure *APPENDIX C.5* for every test points. Linear curve fitting was applied by using obtained stick forces and speed difference between stabilized points and trim points. Force gradients as given in Table 2.3 were gathered by using slope of the curves.

Table 2.3 Gradients for Stabilized Method Test Points

Test Point	Pull Force Gradient (Pound/Kts)	Push Force Gradient (Pound/Kts)
1.1	-0.15	-0.29
1.2	-0.34	-0.54
1.3	-0.22	-0.43
1.4	-0.45	-0.42
1.5	-0.37	-0.54

Longitudinal static stability was assessed as positive for all test points. Free return speeds for climb and landing configurations were inside of the ±10% and free return speeds for cruise configuration were inside of the ±7.5% of the trim speeds. Percentage of the difference between free return speeds and trim speeds were presented in Table 2.4.

Table 2.4 Percentage of the Difference between Free Return Speeds and Trim Speeds

Test Point	FRSR from Lower Speeds (%)	FRSR from Higher Speeds (%)
1.1	1.7	3.3
1.2	2.5	1.6
1.3	3.0	1.2
1.4	1.0	2.1
1.5	3.1	2.1

Having positive longitudinal static stability in that stick forces increases while the airspeed is going further away from trim speed will increase flight safety for basic training flights and also having low free return speed range will help maintain aircraft mission target speeds.

For the basic transport training role, it was assessed as SATISFACTORY that longitudinal static stability of the aircraft was positive, stick forces increased without any force reversal or lightening while going further away from trim speed and also FRSR was inside of the ±7.5% of the trim speed in cruise configuration and ±10% of the trim speed in climb and landing configuration.

Further flight tests in different weights, C.G, airspeeds, altitudes and configurations should be performed to completely evaluate the longitudinal static stability of the aircraft (Highly Desirable-Mission Effectiveness).

The compliance of CS23.173(a), CS23.173(b)(1), CS23.173(b)(2), CS23.173(c), CS23.175(a), CS23.175(b) and CS23.173(c) requirements was shown in APPENDIX D.

2.2 LMS Stability Characteristic of B60 Duke

Longitudinal maneuver stability characteristic was assessed in B60 Duke with tail number C-FYWQ on the second sortie executed on 12th August 2022 in the area between London International Airport (CYXU) and St. Thomas Municipal Airport (CYQS). Stabilized turn, pull up and push over test points were performed under the conditions given in Table 2.5 to determine the longitudinal maneuver stability characteristic of B60 Duke. Stabilized turn, pull up and push over test points were executed as test point 2.1, 2.2 and 2.3 respectively. Trim airspeed was 125 KIAS. OAT was between 8 and 14ºC for all test points. Altimeters were set to local QNH. Yaw damper was off and cowl flaps were closed for all test points. C.G was 29% for all test points. Load factor and airspeed tolerances for all test points were ±0.2g and ±2 kts respectively.

Table 2.5 Test conditions for stabilized turn, pull up and push over test points.

Test Point	Alt. (ft)	RPM		MAP (inHg)		Weight (lbs)		Config.		Trim		
		L ENG	R ENG	L ENG	R ENG	Start	End	Flap	Gear	E	A	R
2.1	8100	2510	2490	25.3	25	6545	6533	Up	Up	-2	0	0
2.2	7700	2510	2490	25.3	25	6521	6509	Up	Up	-2	0	0
2.3	8140	2510	2490	25.3	25	6509	6497	Up	Up	-2	0	0

Stick force, stick deflection, load factor and airspeed were noted for all test points. Bank angle was also noted for stabilized turn test points. Recorded data were given in APPENDIX B.

Pull forces were applied to obtain and maintain load factors higher than 1g and push forces were applied to obtain and maintain load factors lower than 1g for all test points. There was not any force reversal, lightening or buffet for all test points. Stick forces and deflections increased while increasing or decreasing load factor for all test points. Stick forces were obtained as same for left and right turns in stabilized turn test points. In stabilized turns, 2g load factor was achieved with 60º bank angle for both directions. Stall warning was observed at 2.3g while performing the pull up test point.

Stick force vs load factor graphs were plotted as given in APPENDIX C Figure *APPENDIX C.6* to Figure *APPENDIX C.8* for every test points. Linear curve fitting was applied by using obtained stick forces and load factors. Force gradients as given in Table 2.6 were gathered by using slope of the curves.

Table 2.6 Force Gradients for Stabilized Turn, Pull Up and Push Over Test Points

Test Point	Force Gradient (Pound/g)
2.1	30
2.2	19.8
2.3	24

Due to speed limitation given as 130 KIAS in FTO, maximum 2.3g was pulled in pull up test points and maximum 2g load factor was tested in stabilized turn due to 60º bank angle limitation of the aircraft. Therefore, the stick force was not evaluated for maximum load factor which was 3.5g.

There was not any nonlinearity in stick forces within the load factor ranges between 0.5g and 2.3g. Longitudinal maneuver stability was assessed as positive for all test points.

Having positive longitudinal maneuver stability in that stick forces increases while the load factor is increasing will increase flight safety for basic training flights and will help the student pilots performing the maneuver without exceeding the load factor limits.

For the basic transport training role, it was assessed as SATISFACTORY that longitudinal maneuver stability of the aircraft was positive and stick forces increased without any force reversal or lightening while load factor was increasing.

Further flight tests in different weights, C.G, airspeeds, altitudes, and configurations should be carried out to completely evaluate the longitudinal maneuver stability of the aircraft (Highly Desirable-Mission Effectiveness).

The compliance of CS23.155(a), CS23.155(b)(1), CS23.155(b)(2), CS23.155(c) and MIL-F-8785C 3.2.2.2.1 requirements was shown in APPENDIX D.

2.3 LDS Short Period Characteristic of B60 Duke

Longitudinal dynamic stability short period characteristic was assessed in B60 Duke with tail number C-FYWQ on the first sortie executed on 22th July 2022 and second sortie executed on 12th August 2022 in the area between London International Airport (CYXU) and Centralia Aerodrome (CYCE) for first sortie and area between London International Airport (CYXU) and St. Thomas Municipal Airport (CYQS) for second sortie. Short period oscillation test points were performed under the conditions given in Table 2.7 and Table 2.8 to determine the longitudinal dynamic stability short period characteristic of B60 Duke. Test points 3.1 to 3.4 were performed in first sortie, test point 3.5 was performed in second sortie. OAT was between 14 and 17ºC for test points 3.1 to 3.4 and 10ºC for test point 3.5. Altimeters were set to local QNH. Yaw damper was off and cowl flaps were closed for all test points. C.G was 29% for all test points. Altitude and airspeed tolerances for all test points were ±100 ft, and ±2 kts respectively.

Table 2.7 Test Conditions for Short Period Oscillation Test Points

Test Point	Trim Speed (KIAS)	Trim Pressure Altitude (ft)	RPM		MAP (inHg)	
			L ENG	R ENG	L ENG	R ENG
3.1	120	6800	2760	2740	36.3	36.4
3.2	123	7100	2520	2490	25	23.5
3.3	166	5460	2530	2520	33.4	33.3
3.4	96	8660	2750	2760	16.9	15.7
3.5	94	6900	2740	2760	7.4	7.4

Table 2.8 Test Conditions for Short Period Oscillation Test Points

Weight (lbs)		**Config.**		**Trim**		
Start	**End**	**Flap**	**Gear**	**E**	**A**	**R**
6587	6587	Up	Up	-2	0	0
6497	6497	Up	Up	-2	0	0
6353	6353	Up	Up	-8	0	0
6269	6269	30	Down	-2	0	0
6569	6569	30	Down	-5	0	0

Number of overshoots and time until damped were noted for all test points. Recorded data were given in APPENDIX B.

It was observed that the aircraft was heavily damped (deadbeat) in stick fixed and stick free positions for all test points. Therefore, damping ratio and natural frequency was not calculated.

It was evaluated that short period longitudinal dynamic stability was positive for all test points.

Having positive short period longitudinal dynamic stability with heavily damped characteristic will reduce pilot workload during high precise control input required tasks such as capturing and keeping the glide path at instrument approach procedures and also flying in turbulent (vertical gusts) weather conditions for basic training flights.

For the basic transport training role, it was assessed as SATISFACTORY that short period longitudinal dynamic stability of the aircraft was positive and short period characteristic was heavily damped.

Further flight tests in different weights, C.G, airspeeds, altitudes and configurations should be executed to completely evaluate the short period longitudinal dynamic stability of the aircraft (Highly Desirable-Mission Effectiveness).

The compliance of CS23.181(a) requirement was shown in APPENDIX D.

2.4 LDS Long Period Characteristic of B60 Duke

Longitudinal dynamic stability long period characteristic was assessed in B60 Duke with tail number C-FYWQ on the first sortie executed on 22th July 2022 and second sortie executed on 12th August 2022 in the area between London International Airport (CYXU) and Centralia Aerodrome (CYCE) for first sortie and area between London International Airport (CYXU) and St. Thomas Municipal Airport (CYQS) for second sortie. Phugoid test points were performed under the conditions given in Table 2.9 and Table 2.10 to determine the longitudinal dynamic stability long period characteristic of B60 Duke. Test points 4.1 to 4.4 were performed in first sortie, test point 4.5 was performed in second sortie. OAT was between 14 and 17ºC for test points 4.1 to 4.4 and 10ºC for test point 4.5. Altimeters were set to local QNH. Yaw damper was off and cowl flaps were closed for all test points. C.G was 29% for all test points. Bank angle tolerance for all test points was ±2º.

Table 2.9 Test Conditions for Phugoid Test Points

Test Point	**Trim Speed (KIAS)**	**Trim Pressure Altitude (ft)**	**RPM**		**MAP (inHg)**	
			L ENG	**R ENG**	**L ENG**	**R ENG**
4.1	120	7300	2760	2740	36.3	36.4
4.2	120	7180	2520	2490	25	23.5
4.3	167	7060	2530	2520	33.4	33.3
4.4	96	8660	2750	2760	16.9	15.7
4.5	94	8200	2740	2760	7.4	7.4

Table 2.10 Test Conditions for Phugoid Test Points

Weight (lbs)		Config.		Trim		
Start	**End**	**Flap**	**Gear**	**E**	**A**	**R**
6563	6551	Up	Up	-2	0	0
6485	6473	Up	Up	-2	0	0
6317	6287	Up	Up	-8	0	0
6257	6257	30	Down	-2	0	0
6569	6557	30	Down	-5	0	0

Indicated airspeed, indicated barometric altitude and time damped were noted at each overshoot for all test points. Recorded data were given in APPENDIX B.

It was observed that phugoid was oscillatory divergent in climb configuration, oscillatory convergent in cruise and landing configurations.

Airspeed vs. time graphs were plotted as given in APPENDIX C Figure *APPENDIX C.9* to Figure *APPENDIX C.13* for every test points. Curve fitting was applied to airspeed vs time graphs by using second order damped system equation given in Equation 2.1. Natural frequencies and damping ratios for all test points given in Table 2.11 were gathered by second order damped system equation. Time to double for test point 4.1 was calculated as 89.4 seconds by using damping ratio and natural frequency.

$$V = X_0 * e^{-\zeta*\omega*t} * \cos(\sqrt{1-\zeta^2}) * \omega * t) + V_T \qquad \textbf{(2.1)}$$

X_0 Initial Amplitude Difference from the Trim Airspeed

ζ Damping Ratio

ω Frequency

t Time

V_T Trim Airspeed

Table 2.11 Damping Ratio and Natural Frequency for Phugoid Test Points

Test Point	Damping Ratio	Natural Frequency (rad/sec)
4.1	-0.05	0.15
4.2	0.11	0.13
4.3	0.07	0.12
4.4	0.08	0.19
4.5	0.14	0.20

It was evaluated that long period longitudinal dynamic stability was positive for cruise and landing configurations (test point 4.2 to 4.5) and negative for climb configuration (test point 4.1).

Having convergent characteristics except climb configuration on phugoid mode will decrease required pilot compensation to maintain airspeed and altitude in IFR flights and will increase flight safety and decrease pilot workload. Having slightly divergent characteristics (time to double approximately 90 seconds) in climb configuration on phugoid mode would not have a significant effect on basic transport training flights.

For the basic transport training role, it was assessed as SATISFACTORY that long period longitudinal dynamic stability of the aircraft was positive except climb configuration and time to double amplitude was more than 55 seconds in climb configuration.

Further flight tests in different weights, C.G, airspeeds, altitudes, and configurations should be executed to completely evaluate the long period longitudinal dynamic stability of the aircraft (Highly Desirable-Mission Effectivenesss).

The compliance of CS23.181(c) and MIL-F-8785C 3.2.1.2 requirements was shown in APPENDIX D.

2.5 Directional Static Stability Characteristic of B60 Duke

Directional static stability characteristic was assessed in B60 Duke with tail number C-FYWQ on the second sortie executed on 12th August 2022 and on the fourth sortie executed on 19th August 2022 in the area between London International Airport (CYXU) and St. Thomas Municipal Airport (CYQS) for second sortie and over Stratford for fourth sortie. WLSS test points were performed under the conditions given in Table 2.12 and Table 2.13 to determine the directional static stability characteristic of B60 Duke. OAT was between 8 and 9ºC for all test points. Altimeters were set to local QNH. Cowl flaps were closed for all test points. C.G was 29% for all test points. Altitude, airspeed and bank angle tolerance for all test points were ±200 ft, ±2 kts and ±2º respectively.

Table 2.12 Test Conditions for WLSS Test Points

Test Point	**Trim Speed (KIAS)**	**Trim Pressure Altitude (ft)**	**RPM**		**MAP (inHg)**	
			L ENG	**R ENG**	**L ENG**	**R ENG**
5.1	96	8120	2520	2510	18	18.1
5.2	150	7400	2510	2490	27.2	28.3
5.3	95	6060	2720	2730	23.1	23.5
5.4	141	6700	2740	2750	36.5	36.5
5.5	86	6820	2740	2740	22.9	23.4
5.6	120	7400	2730	2750	36.5	36.5
5.7	96	7280	2520	2530	18.2	19.1
5.8	148	7400	2510	2520	28.3	27.7

Table 2.13 Test Conditions for WLSS Test Points

Weight (lbs)		Config.			Trim		
Start	End	YD	Flap	Gear	E	A	R
6497	6485	Off	Up	Up	2	0	0
6485	6461	Off	Up	Up	-5	0	0
6413	6401	Off	Up	Down	1	0	0
6461	6437	Off	Up	Down	-7	0	0
6425	6413	Off	30	Down	6	0	0
6437	6425	Off	30	Down	-4	0	0
6677	6653	On	Up	Up	2	0	0
6617	6605	On	Up	Up	-5	0	0

Rudder force, rudder deflection, aileron force and sideslip were noted for all test points. Recorded data were given in APPENDIX B.

Left sideslips were achieved by right rudder deflection and force; right sideslips were achieved by left rudder deflection and force. Rudder and aileron forces increased while sideslip was increasing. There was not any force reversal, lightening or buffet for all test points. In steady sideslip, aircraft was maintained wings level by applying opposite aileron deflection. There was tendency to recover from a wings level sideslip with the rudder free.

Light buffet was observed in cruise configuration and yaw damper off at 96 KIAS with 100% right rudder; in takeoff configuration and yaw damper off at 95 KIAS with 75% right rudder; in cruise configuration and yaw damper on with 50% right rudder. 100% right rudder test point was not performed in takeoff configuration and yaw damper off at 95 KIAS due to buffet. Moderate buffet was observed in cruise configuration and yaw damper on with 100% right rudder.

Rudder force vs sideslip and aileron force vs sideslip graphs were plotted as given in APPENDIX C Figure *APPENDIX C.14* to Figure *APPENDIX C.21* for every test points. Linear curve fitting was applied by using obtained rudder forces, aileron forces and sideslips. Force gradients as given in Table 2.14 were gathered by using slope of the curves.

Table 2.14 Force Gradients for WLSS Test Points

Test Point	Rudder Force Gradient vs β (Pound/deg)	Aileron Force Gradient vs β (Pound/deg)
5.1	-3.8	0.47
5.2	-4.1	0.52
5.3	-3.2	0.49
5.4	-4.2	0.59
5.5	-3.0	0.46
5.6	-3.7	0.31
5.7	-4.4	0.59
5.8	-4.3	0.58

Directional static stability was assessed as positive for all test points. Rudder and aileron forces in wings level sideslip slightly increased after yaw damper turned on.

Having positive directional static stability in that aircraft has a tendency to recover from a wings level sideslip with the rudder free and also rudder and aileron forces increases while sideslip is increasing will decrease the pilot workload in high sideslip tasks such as crosswind take off and landings for basic transport training role. Yaw damper did not have a significant effect on rudder and aileron forces in high sideslip tasks at cruise configuration.

For the basic transport training role, it was assessed as SATISFACTORY that directional static stability of the aircraft was positive, rudder and aileron forces linearly increased without any force reversal or lightening while sideslip was increasing.

Further flight tests in different weights, C.G, airspeeds, altitudes and configurations should be performed to completely evaluate the directional static stability of the aircraft (HIGHLY DESIRABLE-MISSION EFFECTIVENESSS).

The compliance of CS23.177(a), CS23.177(d), MIL-F-8785C 3.3.6.1, MIL-F-8785C 3.3.6.2, MIL-F-8785C 3.3.6.3 requirements was shown in APPENDIX D.

2.6 Lateral Static Stability Characteristic of B60 Duke

Lateral static stability characteristic was assessed in B60 Duke with tail number C-FYWQ on the second sortie executed on 12th August 2022 and on the fourth sortie executed on 19th August 2022 in the area between London International Airport (CYXU) and St. Thomas Municipal Airport (CYQS) for second sortie and over Stratford for fourth sortie. SHSS test points were performed under the conditions given in Table 2.15 and Table 2.16 to determine the lateral static stability characteristic of B60 Duke. OAT was between 6 and 10ºC for all test points. Altimeters were set to local QNH. C.G was 29% for all test points. Cowl flaps were closed for all test points. Altitude and airspeed tolerances for all test points were ±200 ft and ±2 kts respectively.

Table 2.15 Test Conditions for SHSS Test Points

Test Point	Trim Speed (KIAS)	Trim Pressure Altitude (ft)	RPM		MAP (inHg)	
			L ENG	R ENG	L ENG	R ENG
6.1	106	5840	2510	2500	21.2	21.3
6.2	155	5900	2490	2510	30.0	30.0
6.3	96	5800	2730	2750	23.2	23.4
6.4	123	6300	2490	2510	30.0	30.0
6.5	92	7600	2730	2750	18.2	18.1
6.6	127	7800	2740	2750	31.2	31.1
6.7	105	6900	2520	2530	19.3	19.6
6.8	148	6900	2510	2530	30.0	30.0

Table 2.16 Test Conditions for SHSS Test Points

Weight (lbs)		Config.			Trim		
Start	End	YD	Flap	Gear	E	A	R
6383	6371	Off	Up	Up	0	0	0
6371	6347	Off	Up	Up	-6	0	0
6401	6383	Off	Up	Down	2	0	0
6347	6323	Off	Up	Down	-4	0	0
6293	6269	Off	30	Down	2	0	0
6305	6293	Off	30	Down	-5	0	0
6521	6497	On	Up	Up	0	0	0
6497	6473	On	Up	Up	-5	0	0

Rudder force, rudder deflection, aileron force, bank angle and sideslip were noted for all test points. Recorded data were given in APPENDIX B.

Rudder and aileron forces increased while sideslip was increasing. There was not any force reversal, lightening or buffet for all test points. In steady sideslip, aircraft was maintained steady heading by opposite bank angle produced by aileron deflection. There was tendency to raise the low wing in sideslip with the aileron free.

Light buffet was observed in cruise configuration and yaw damper off at 106 KIAS with 75% right rudder, in landing configuration and yaw damper off at 92 KIAS with 100% right rudder, in cruise configuration and yaw damper on at 105 KIAS with 100% right rudder. 100% right rudder test point was not performed in cruise configuration and yaw damper off at 106 KIAS due to buffet.

Rudder force vs sideslip, aileron force vs sideslip and bank angle vs sideslip graphs were plotted as given in APPENDIX C Figure APPENDIX C.*22* to Figure APPENDIX C.*37* for every test points. Linear curve fitting was applied by using obtained rudder forces, aileron forces, bank angles and sideslips. Force gradients as given in Table 2.17 were gathered by using slope of the curves.

Table 2.17 Force Gradients for SHSS Test Points

Test Point	**Rudder Force Gradient vs β (Pound/deg)**	**Aileron Force Gradient vs β (Pound/deg)**
6.1	-3.8	0.81
6.2	-4.1	0.71
6.3	-3.0	0.76
6.4	-4.1	0.79
6.5	-2.3	0.68
6.6	-3.7	0.76
6.7	-3.2	0.67
6.8	-3.6	0.76

Lateral static stability was assessed as positive for all test points. Rudder and aileron forces in wings level sideslip slightly increased after yaw damper turned on.

Having positive lateral static stability in that aircraft has a tendency to raise the low wing in sideslip with the aileron free and also rudder and aileron forces increases while sideslip is increasing will decrease the pilot workload in high sideslip tasks such as crosswind take off and landings for basic transport training role. Yaw damper would not have a significant effect on rudder and aileron forces in high sideslip tasks at cruise configuration.

For the basic transport training role, it was assessed as SATISFACTORY that lateral static stability of the aircraft was positive, rudder and aileron forces linearly increased without any force reversal or lightening while sideslip was increasing.

Further flight tests in different weights, C.G, airspeeds, altitudes and configurations should be performed to completely evaluate the lateral static stability of the aircraft (Highly Desirable-Mission Effectiveness).

The compliance of CS23.177(b), CS23.177(d), MIL-F-8785C 3.3.6.1, MIL-F-8785C 3.3.6.2, MIL-F-8785C 3.3.6.3 requirements was shown in APPENDIX D.

2.7 LDDS Dutch Roll Characteristic of B60 Duke

Lateral directional dynamic stability Duch Roll characteristic was assessed in B60 Duke with tail number C-FYWQ on the third sortie executed on 16th August 2022 and on the fourth sortie executed on 19th August 2022 in the area between London International Airport (CYXU) and St. Thomas Municipal Airport (CYQS) for third sortie and over Stratford for fourth sortie. Dutch roll test points were performed under the conditions given in Table 18 and Table 19 to determine the lateral directional dynamic stability Rutch Roll characteristic of B60 Duke. OAT was between 4 and 10ºC for all test points. Altimeters were set to local QNH. Cowl flaps were closed for all test points. C.G was 29% for all test points. Altitude and airspeed tolerances for all test points were ±200 ft and ±2 kts respectively.

Table 2.18 Test Conditions for Dutch Roll Test Points

Test Point	Trim Speed (KIAS)	Trim Pressure Altitude (ft)	RPM		MAP (inHg)	
			L ENG	R ENG	L ENG	R ENG
7.1	95	7750	2510	2520	19.1	19.2
7.2	148	8500	2520	2490	29	28.7
7.3	97	8100	2750	2740	23.7	23.8
7.4	140	8800	2730	2750	36.5	36.5
7.5	84	8170	2740	2730	24.1	23.9
7.6	121	8180	2750	2750	36.5	36.5
7.7	97	6360	2500	2520	18.1	18.7
7.8	151	7120	2520	2530	28.4	28.1

Table 2.19 Test Conditions for Dutch Roll Test Points

Weight (lbs)		Config.			Trim		
Start	End	YD	Flap	Gear	E	A	R
6662	6650	Off	Up	Up	2	0	0
6638	6620	Off	Up	Up	-5	0	0
6602	6590	Off	Up	Down	1	0	0
6566	6548	Off	Up	Down	-7	0	0
6542	6530	Off	30	Down	6	0	0
6506	6488	Off	30	Down	-4	0	0
6653	6647	On	Up	Up	2	0	0
6605	6593	On	Up	Up	-5	0	0

Number of overshoots and time until damped were noted for all test points. Recorded data were given in APPENDIX B.

It was observed that Dutch Roll was oscillatory convergent for all test points. Number of overshoots without yaw damper were between 5 and 11. Number of overshoots with yaw damper was 1.

Natural frequencies and damping ratios for all test points given in Table 2.20 were gathered by using recorded number of overshoots, elapsed times and equations given in Equation 2.2 and Equation 2.3.

$$\xi_{dr} = \frac{7 - \#\ of\ Overshoots}{10} \tag{2.2}$$

$$\omega_{dr} = \frac{[\pi * (\#\ of\ Overshoots)]}{\Delta t} \tag{2.3}$$

$$\omega_{dr} = \omega_n \sqrt{1 - \zeta^2} \tag{2.4}$$

Δt Time interval

ξ_{dr} Damping Ratio

ω_{dr} Damped Natural Frequency

ω_n Undamped Natural Frequency

Table 2.20 Damping Ratio and Natural Frequency for Dutch Roll Test Points

Test Point	Damping Ratio		Natural Frequency (rad/sec)	
	Stick Fixed	Stick Free	Stick Fixed	Stick Free
7.1	0.2	0.2	1.56	1.48
7.2	Lower than 0.1	Lower than 0.1	2.42	2.54
7.3	0.2	0.2	1.47	1.44
7.4	Lower than 0.1	Lower than 0.1	2.83	2.60
7.5	0.1	Lower than 0.1	1.75	1.75
7.6	Lower than 0.1	Lower than 0.1	2.38	2.45
7.7	0.6	0.6	0.77	0.77
7.8	0.6	0.6	0.92	0.95

It was evaluated that lateral directional dynamic Dutch Roll stability was positive for all test points. Aircraft was lightly damped without yaw damper and heavily damped with yaw damper in Dutch Roll mode. Damping in Dutch Roll mode significantly increased after yaw damper turned on.

Having positive lateral directional dynamic Dutch Roll stability with lightly damped characteristic will increase pilot workload during high precise control input required tasks such as capturing and keeping the localizer flight path at instrument approach procedures and keeping the heading at standard instrument departure procedures and also flying in turbulent weather conditions for basic training flights. Having heavily damped Dutch Roll characteristic with yaw damper would have a significant positive effect that will decrease pilot workload at the tasks defined above.

For the basic transport training role, it was assessed as SATISFACTORY that lateral directional dynamic Dutch Roll stability of the aircraft was positive and in cruise configuration damping in Dutch Roll mode significantly increased with yaw damper.

Further flight tests in different weights, C.G, airspeeds, altitudes and configurations should be executed to completely evaluate the lateral directional dynamic Dutch Roll stability of the aircraft (Highly Desirable-Mission Effectiveness).

Further flight tests with yaw damper in different configurations such as takeoff and landing should be performed to completely evaluate the effectiveness of the yaw damper (Highly Desirable-Mission Effectiveness).

The compliance of CS23.181(b) and MIL-F-8785C 3.3.1.1 requirements was shown in APPENDIX D.

2.8 LDDS Spiral Mode Characteristic of B60 Duke

Lateral directional dynamic stability spiral mode characteristic was assessed in B60 Duke with tail number C-FYWQ on the third sortie executed on 16th August 2022 and on the fourth sortie executed on 19th August 2022 in the area between London International Airport (CYXU) and St. Thomas Municipal Airport (CYQS) for third sortie and over Stratford for fourth sortie. Spiral mode test points were performed under the conditions given in Table 2.21 and Table 2.22 to determine the lateral directional dynamic spiral mode characteristic of B60 Duke. OAT was between 4 and 10ºC for all test points. Altimeters were set to local QNH. Cowl flaps were closed for all test points. C.G was 29% for all test points. Bank angle and airspeed tolerances for all test points were ±1º and ±2 kts respectively.

Table 2.21 Test Conditions for Spiral Mode Test Points

Test Point	Trim Speed (KIAS)	Trim Pressure Altitude (ft)	RPM		MAP (inHg)	
			L ENG	R ENG	L ENG	R ENG
8.1	96	7640	2510	2520	19.1	19.2
8.2	149	8320	2520	2490	29	28.7
8.3	95	8050	2750	2740	23.7	23.8
8.4	140	8720	2730	2750	36.5	36.5
8.5	86	7770	2740	2730	24.1	23.9
8.6	121	7980	2750	2750	36.5	36.5
8.7	93	6160	2500	2520	18.1	18.7
8.8	150	7000	2520	2530	28.4	28.1

Table 2.22 Test Conditions for Spiral Mode Test Points

Weight (lbs)		Config.			Trim		
Start	End	YD	Flap	Gear	E	A	R
6650	6638	Off	Up	Up	2	0	0
6620	6602	Off	Up	Up	-5	0	0
6590	6572	Off	Up	Down	1	0	0
6548	6542	Off	Up	Down	-7	0	0
6530	6518	Off	30	Down	6	0	0
6488	6482	Off	30	Down	-4	0	0
6647	6635	On	Up	Up	2	0	0
6593	6581	On	Up	Up	-5	0	0

Bank angle and elapsed time were noted for all test points. Recorded data were given in APPENDIX B.

It was observed that there was not any divergent characteristic with double amplitude of bank angle in 20 seconds. Aircraft's spiral mode characteristic was given in Table 2.23.

Table 2.23 Spiral Mode Characteristic for Spiral Mode Test Points

Test Point	Airspeed	Configuration	Spiral Mode Characteristic		Spiral Mode Stability	
			Left	**Right**	**Left**	**Right**
8.1	96	Cruise/YD OFF	Convergent	Divergent	Positive	Negative
8.2	149	Cruise/YD OFF	Neutral	Convergent	Neutral	Positive
8.3	95	Takeoff/YD OFF	Convergent	Neutral	Positive	Neutral
8.4	140	Takeoff/YD OFF	Convergent	Convergent	Positive	Positive
8.5	86	Landing/YD OFF	Neutral	Divergent	Neutral	Negative
8.6	121	Landing/YD OFF	Neutral	Convergent	Neutral	Positive
8.7	93	Cruise/YD ON	Convergent	Divergent	Positive	Negative
8.8	150	Cruise/YD ON	Convergent	Divergent	Positive	Negative

It was evaluated that spiral mode stability was negatively affected by yaw damper in cruise configuration except left turn around 150 KIAS. Yaw damper effect on spiral stability could not be evaluated since there was no logical connection between yaw damper on and off test points.

Divergent spirals easily distinguishable and controllable due to having high time to double will not significantly affect the basic transport training role.

For the basic transport training role, it was assessed as SATISFACTORY that there was not any divergent spiral characteristic with double amplitude of bank angle in 20 seconds in cruise configuration and in 12 seconds in takeoff and landing configurations for lateral directional dynamic spiral stability.

Further flight tests in different weights, C.G, airspeeds, altitudes and configurations should be executed to completely evaluate the lateral directional dynamic spiral mode stability of the aircraft (Highly Desirable-Mission Effectiveness).

The compliance of MIL-F-8785C 3.3.1.3 requirement was shown in APPENDIX D.

2.9 Roll Performance of B60 Duke

Roll performance of B60 Duke with tail number C-FYWQ was assessed on the third sortie executed on 16th August 2022 in the area between London International Airport (CYXU) and St. Thomas Municipal Airport (CYQS). Bank to bank test points were performed under the conditions given in Table 2.24 and Table 2.25 to determine the roll performance of B60 Duke. OAT was 4 ºC for all test points. Altimeters were set to local QNH. Yaw damper was off and cowl flaps were closed for all test points. Bank angle and airspeed tolerances for all test points were ±1º and ±2 kts respectively.

Table 2.24 Test Conditions for Bank-to-Bank Test Points

Test Point	Trim Speed (KIAS)	Trim Pressure Altitude (ft)	RPM		MAP (inHg)	
			L ENG	R ENG	L ENG	R ENG
9.1	97	7600	2740	2750	12.1	36.5
9.2	98	7600	2740	2750	18.1	18.6

Table 2.25 Test Conditions for Bank-to-Bank Test Points

Weight (lbs)		Config.		Trim		
Start	End	Flap	Gear	E	A	R
6482	6464	Up	Up	0	0	Full
6464	6542	Up	Up	0	0	0

Rudder force, aileron force and elapsed time were noted for all test points. Recorded data were given in APPENDIX B.

It was obtained that left bank to right bank turns with full aileron were completed at 2.2 seconds for takeoff configuration and at 2.6 seconds for landing configuration. Right bank to left bank turns with full aileron were completed at 2 seconds for takeoff configuration and at 2.3 seconds for landing configuration.

Average roll rates were given in Table *2.26*.

Table 2.26 Roll Rates for Roll Performance Test Points

Configuration	Power	Airspeed (KIAS)	Aileron Deflection (%)	Direction	Roll Rate (deg/sec)
Flaps: UP Gears: UP	Left: IDLE Right: TO	97	50	Left to Right	9.8
Flaps: UP Gears: UP	Left: IDLE Right: TO	97	50	Right to Left	11.5
Flaps: UP Gears: UP	Left: IDLE Right: TO	97	100	Left to Right	27.2
Flaps: UP Gears: UP	Left: IDLE Right: TO	97	100	Right to Left	30.0
Flaps: 30 Gears: DOWN	3 Degree Approach	98	50	Left to Right	13.0
Flaps: 30 Gears: DOWN	3 Degree Approach	98	50	Right to Left	15.4
Flaps: 30 Gears: DOWN	3 Degree Approach	98	100	Left to Right	23.0
Flaps: 30 Gears: DOWN	3 Degree Approach	98	100	Right to Left	26.1

The roll rate of the aircraft will provide convenient performance to maintain the lateral flight path in takeoff configuration with OEI. The roll performance will help the pilot to maneuver the aircraft easily and to maintain the lateral flight path in takeoff and landing conditions.

For the basic transport training role, it was assessed as SATISFACTORY that 60º bank to bank turn was accomplished maximum 2.2 seconds with full aileron in OEI takeoff configuration and maximum 2.6 seconds with full aileron in landing configuration.

Further flight tests in different weights, C.G, airspeeds, altitudes and configurations should be executed to completely evaluate the roll performance of the aircraft (Highly Desirable-Mission Effectiveness).

The compliance of CS23.157(a)(2), CS23.157(b), CS23.157(c)(2) and CS23.157(d) requirements was shown in APPENDIX D.

CHAPTER 3

RESUTLS AND DISCUSSIONS

3.1 General Conclusion

It was evaluated that the B60 was suitable for basic transport training flights.

3.2 Specific Conclusions

3.2.1 Satisfactory

- It was assessed as SATISFACTORY that longitudinal static stability of the aircraft was positive, stick forces increased without any force reversal or lightening while going further away from trim speed and also FRSR was inside of the ±7.5% of the trim speed in cruise configuration and ±10% of the trim speed in climb and landing configuration.
- It was assessed as SATISFACTORY that longitudinal maneuver stability of the aircraft was positive and stick forces increased without any force reversal or lightening while load factor was increasing.
- It was assessed as SATISFACTORY that short period longitudinal dynamic stability of the aircraft was positive and short period characteristic was heavily damped.
- It was assessed as SATISFACTORY that long period longitudinal dynamic stability of the aircraft was positive except climb configuration and time to double amplitude was more than 55 seconds in climb configuration.
- It was assessed as SATISFACTORY that directional static stability of the aircraft was positive, rudder and aileron forces linearly increased without any force reversal or lightening while sideslip was increasing.
- It was assessed as SATISFACTORY that lateral static stability of the aircraft was positive, rudder and aileron forces linearly increased without any force reversal or lightening while sideslip was increasing.

- It was assessed as SATISFACTORY that lateral directional dynamic Dutch Roll stability of the aircraft was positive and in cruise configuration damping in Dutch Roll mode significantly increased with yaw damper.
- It was assessed as SATISFACTORY that there was not any divergent spiral characteristic with double amplitude of bank angle in 20 seconds in cruise configuration and in 12 seconds in takeoff and landing configurations for lateral directional dynamic spiral stability.
- It was assessed as SATISFACTORY that 60º bank to bank turn was accomplished maximum 2.2 seconds with full aileron in OEI takeoff configuration and maximum 2.6 seconds with full aileron in landing configuration.

3.3 General Recommendation

Longitudinal and Lateral-Directional Static and Dynamic Stability Evaluation of B60 Duke was executed without onboard flight test instrumentation. All recorded data was collected by hand notes. Further flight tests should be executed with onboard flight test instrumentation to increase the accuracy of the test results (Highly Desirable-Mission Effectiveness).

3.4 Specific Recommendation

3.4.1 Highly Desirable

- Further flight tests in different weights, C.G, airspeeds, altitudes and configurations should be performed to completely evaluate the Longitudinal And Lateral-Directional Static And Dynamic Stability Characteristics of the aircraft (Highly Desirable-Mission Effectiveness).
- Further flight tests with yaw damper in different configurations such as takeoff and landing should be performed to completely evaluate the effectiveness of the yaw damper (Highly Desirable-Mission Effectiveness).

REFERENCES

[1] International Test Pilot School Flight Test Manuel Chapter 1. Introduction to Flying Qualities, May 2022.

[2] Empire Test Pilot School Fixed-Wing Flying Qualities Testing.

[3] National Test Pilot School Professional Course Volume IV Fixed-Wing Flying Qualities Testing.

[4] U.S. Naval Test Pilot School Flight Test Manual Fixed Wing Stability and Control Theory and Flight Test Techniques, January 1997.

[5] United States Air Force Test Pilot School Flying Qualities Textbook, April 1986.

[6] CS-23 Certification Specification for Normal, Utility, Aerobatic and Commuter Aeroplanes, June 2018.

[7] MIL-F-8785C, Military Specification: Flying Qualities of Piloted Airplanes, November 1980.

[8] Beechcraft DUKE B60 Pilot’s Operating Manual, October 1990.

[9] Beechcraft Duke 60 Series AFMS Equipped with Winglet, August 1994

APPENDICES

APPENDIX A FLIGHT TEST MATRIX

Table A.1. Flight test matrix

Test Subject	Test Technique	Speed (kts)	Altitude (MSL)	Flaps	Gear
Longitudinal Static Stability	Stabilized Method	120 (Vy) 100-110-120-130-140	7000 ft	RETRACTED	RETRACTED
	Stabilized Method	120 (1.1Vs+30) 90-100-110-120-130-140-150	7000 ft	RETRACTED	RETRACTED
	Stabilized Method	170 (Vno-30-safety margin) 140-150-160-170-180-190-200	7000 ft	RETRACTED	RETRACTED
	Stabilized Method	95 (Vref) 80-85-90-95-105-115-125	7000 ft	LDG	EXTENDED
	Stabilized Method	95 (Vref) 80-90-95-105-115-125	7000 ft	LDG	EXTENDED
Longitudinal Maneuver Stability	Stabilized Turn	125 1.5g - 2.0g - 2.5g	7000 ft	RETRACTED	RETRACTED
	Pull-Up	125 1.5g - 2.0g - 2.5g	7000 ft	RETRACTED	RETRACTED
	Push-Over	125 0.8g - 0.5g	7000 ft	RETRACTED	RETRACTED
Longitudinal Dynamic Stability	Frequency Sweep	120 (Vy)	7000 ft	RETRACTED	RETRACTED
	Short Period-Stick Fixed	120 (Vy)	7000 ft	RETRACTED	RETRACTED
	Short Period-Stick Free	120 (Vy)	7000 ft	RETRACTED	RETRACTED
	Frequency Sweep	120 (1.1Vs+30)	7000 ft	RETRACTED	RETRACTED
	Short Period-Stick Fixed	120 (1.1Vs+30)	7000 ft	RETRACTED	RETRACTED
	Short Period-Stick Free	120 (1.1Vs+30)	7000 ft	RETRACTED	RETRACTED
	Frequency Sweep	170 (Vno-30-safety margin)	7000 ft	RETRACTED	RETRACTED
	Short Period-Stick Fixed	170 (Vno-30-safety margin)	7000 ft	RETRACTED	RETRACTED
	Short Period-Stick Free	170 (Vno-30-safety margin)	7000 ft	RETRACTED	RETRACTED
	Frequency Sweep	95 (Vref)	7000 ft	LDG	EXTENDED
	Short Period-Stick Fixed	95 (Vref)	7000 ft	LDG	EXTENDED
	Short Period-Stick Free	95 (Vref)	7000 ft	LDG	EXTENDED
	Frequency Sweep	95 (Vref)	7000 ft	LDG	EXTENDED
	Short Period-Stick Fixed	95 (Vref)	7000 ft	LDG	EXTENDED
	Short Period-Stick Free	95 (Vref)	7000 ft	LDG	EXTENDED
	Phugoid	120 (Vy) Decelerate to 102	7000 ft	RETRACTED	RETRACTED
	Phugoid	120 (1.1Vs+30) Decelerate to 102	7000 ft	RETRACTED	RETRACTED
	Phugoid	170 (Vno-30-safety margin) Decelerate to 145	7000 ft	RETRACTED	RETRACTED
	Phugoid	95 (Vref) Decelerate to 81	7000 ft	LDG	EXTENDED
	Phugoid	95 (Vref) Decelerate to 81	7000 ft	LDG	EXTENDED

Test Subject	Yaw Damper	Power	Relevant Req	Test Procedure	Priority
Longitudinal Static Stability	As Required	MCP	CS 23.173 CS 23.175 a	Determine Breakout Force and Friction Record stick force and Stick deflection per Speed Check FRSR	1
	As Required	PFLF	CS 23.173 CS 23.175 b	Determine Breakout Force and Friction Record stick force and Stick deflection per Speed Check FRSR	1
	As Required	PFLF	CS 23.173 CS 23.175 b	Determine Breakout Force and Friction Record stick force and Stick deflection per Speed Check FRSR	1
	As Required	Power for 3° descent	CS 23.173 CS 23.175 c	Determine Breakout Force and Friction Record stick force and Stick deflection per Speed Check FRSR	1
	As Required	IDLE	CS 23.173 CS 23.175 c	Determine Breakout Force and Friction Record stick force and Stick deflection per Speed Check FRSR	1
Longitudinal Maneuver Stability	As Required	PFLF	CS 23.155 8785C 3.2.2.2.1	Determine Stick force and stick deflection Determine Fs/G plot to obtain average and local gradients Repeat for Left and Right	1
	As Required	PFLF	8785C 3.2.2.2.1	Determine Stick force and stick deflection Determine Fs/G plot to obtain average and local gradients	1
	As Required	PFLF	8785C 3.2.2.2.1	Determine Stick force and stick deflection Determine Fs/G plot to obtain average and local gradients	1
Longitudinal Dynamic Stability	As Required	MCP	CS 23.181 a	Input Type: Doublet Determine Undamped Natural Frequency	1
	As Required	MCP	CS 23.181 a	Input Type: Doublet Determine Overshoot Number Determine Damping Time Determine Stick Force and Deflection	1
	As Required	MCP	CS 23.181 a	Input Type: Doublet Determine Overshoot Number Determine Damping Time Determine Stick Force and Deflection	1
	As Required	PFLF	CS 23.181 a	Input Type: Doublet Determine Undamped Natural Frequency	1
	As Required	PFLF	CS 23.181 a	Input Type: Doublet Determine Overshoot Number Determine Damping Time Determine Stick Force and Deflection	1
	As Required	PFLF	CS 23.181 a	Input Type: Doublet Determine Overshoot Number Determine Damping Time Determine Stick Force and Deflection	1
	As Required	PFLF	CS 23.181 a	Input Type: Doublet Determine Undamped Natural Frequency	1
	As Required	PFLF	CS 23.181 a	Input Type: Doublet Determine Overshoot Number Determine Damping Time Determine Stick Force and Deflection	1
	As Required	PFLF	CS 23.181 a	Input Type: Doublet Determine Overshoot Number Determine Damping Time Determine Stick Force and Deflection	1
	As Required	Power for 3° descent	CS 23.181 a	Input Type: Doublet Determine Undamped Natural Frequency	1
	As Required	Power for 3° descent	CS 23.181 a	Input Type: Doublet Determine Overshoot Number Determine Damping Time Determine Stick Force and Deflection	1
	As Required	Power for 3° descent	CS 23.181 a	Input Type: Doublet Determine Overshoot Number Determine Damping Time Determine Stick Force and Deflection	1
	As Required	IDLE	CS 23.181 a	Input Type: Doublet Determine Undamped Natural Frequency	1
	As Required	IDLE	CS 23.181 a	Input Type: Doublet Determine Overshoot Number Determine Damping Time Determine Stick Force and Deflection	1
	As Required	IDLE	CS 23.181 a	Input Type: Doublet Determine Overshoot Number Determine Damping Time Determine Stick Force and Deflection	1
	As Required	MCP	CS 23.181 c	Decelerate to Trim speed - %15 Observe peek of the oscillation Record speed, altitude and time at peak	1
	As Required	PFLF	CS 23.181 c	Decelerate to Trim speed - %15 Observe peek of the oscillation Record speed, altitude and time at peak	1
	As Required	PFLF	CS 23.181 c	Decelerate to Trim speed - %15 Observe peek of the oscillation Record speed, altitude and time at peak	1
	As Required	Power for 3° descent	CS 23.181 c	Decelerate to Trim speed - %15 Observe peek of the oscillation Record speed, altitude and time at peak	1
	As Required	IDLE	CS 23.181 c	Decelerate to Trim speed - %15 Observe peek of the oscillation Record speed, altitude and time at peak	1

Test Subject	Test Technique	Speed (kts)	Altitude (MSL)	Flaps	Gear
Lateral Directional Static Stability	WLSS	95 (1.2 Vs)	7000 ft	RETRACTED	RETRACTED
	WLSS	95 (1.2 Vs)	7000 ft	RETRACTED	RETRACTED
	WLSS	150 (Va - 10(safety margin))	7000 ft	RETRACTED	RETRACTED
	WLSS	150 (Va - 10(safety margin))	7000 ft	RETRACTED	RETRACTED
	WLSS	95 (1.2Vs)	7000 ft	RETRACTED	EXTENDED
	WLSS	150 (Va - 10(safety margin))	7000 ft	RETRACTED	EXTENDED
	WLSS	85 (1.2Vs)	7000 ft	LDG	EXTENDED
	WLSS	130 (Vfe - 10(safety margin))	7000 ft	LDG	EXTENDED
	SHSS	105 (1.3Vs)	7000 ft	RETRACTED	RETRACTED
	SHSS	105 (1.3Vs)	7000 ft	RETRACTED	RETRACTED
	SHSS	As obtained with power setting	7000 ft	RETRACTED	RETRACTED
	SHSS	As obtained with power setting	7000 ft	RETRACTED	RETRACTED
	SHSS	95 (1.2Vs)	7000 ft	RETRACTED	EXTENDED
	SHSS	As obtained with power setting	7000 ft	RETRACTED	EXTENDED
	SHSS	90 (1.3Vs)	7000 ft	LDG	EXTENDED
	SHSS	130 (Vfe - 10(safety margin))	7000 ft	LDG	EXTENDED

Test Subject	Yaw Damper	Power	Relevant Req	Test Procedure	Priority
Lateral Directional Static Stability	OFF	PFLF	CS 23.177 a CS 23.177 d 8785C 3.3.6.1 8785C 3.3.6.2 8785C 3.3.6.3	Check positive Directional Static Stability after rudder release Determine Rudder and aileron force Determine Rudder and aileron Deflection Verify no reverse Rudder force during maneuver Test limit :150 lbf or max rudder deflection Repeat for Right/Left Rudder Repeat for %50 %100 Rudder	1
	ON	PFLF	CS 23.177 a CS 23.177 d 8785C 3.3.6.1 8785C 3.3.6.2 8785C 3.3.6.3	Check positive Directional Static Stability after rudder release Determine Rudder and aileron force Determine Rudder and aileron Deflection Verify no reverse Rudder force during maneuver Test limit :150 lbf or max rudder deflection Repeat for Right/Left Rudder Repeat for %50 %100 Rudder	2
	OFF	PFLF	CS 23.177 a CS 23.177 d 8785C 3.3.6.1 8785C 3.3.6.2 8785C 3.3.6.3	Check positive Directional Static Stability after rudder release Determine Rudder and aileron force Determine Rudder and aileron Deflection Verify no reverse Rudder force during maneuver Test limit :150 lbf or max rudder deflection Repeat for Right/Left Rudder Repeat for %50 %100 Rudder	1
	ON	PFLF	CS 23.177 a CS 23.177 d 8785C 3.3.6.1 8785C 3.3.6.2 8785C 3.3.6.3	Check positive Directional Static Stability after rudder release Determine Rudder and aileron force Determine Rudder and aileron Deflection Verify no reverse Rudder force during maneuver Test limit :150 lbf or max rudder deflection Repeat for Right/Left Rudder Repeat for %50 %100 Rudder	2
	OFF	PFLF	CS 23.177 a CS 23.177 d 8785C 3.3.6.1 8785C 3.3.6.2 8785C 3.3.6.3	Check positive Directional Static Stability after rudder release Determine Rudder and aileron force Determine Rudder and aileron Deflection Verify no reverse Rudder force during maneuver Test limit :150 lbf or max rudder deflection Repeat for Right/Left Rudder Repeat for %50 %100 Rudder	1
	OFF	PFLF	CS 23.177 a CS 23.177 d 8785C 3.3.6.1 8785C 3.3.6.2 8785C 3.3.6.3	Check positive Directional Static Stability after rudder release Determine Rudder and aileron force Determine Rudder and aileron Deflection Verify no reverse Rudder force during maneuver Test limit :150 lbf or max rudder deflection Repeat for Right/Left Rudder Repeat for %50 %100 Rudder	1
	OFF	PFLF	CS 23.177 a CS 23.177 d 8785C 3.3.6.1 8785C 3.3.6.2 8785C 3.3.6.3	Check positive Directional Static Stability after rudder release Determine Rudder and aileron force Determine Rudder and aileron Deflection Verify no reverse Rudder force during maneuver Test limit :150 lbf or max rudder deflection Repeat for Right/Left Rudder Repeat for %50 %100 Rudder	1
	OFF	PFLF	CS 23.177 a CS 23.177 d 8785C 3.3.6.1 8785C 3.3.6.2 8785C 3.3.6.3	Check positive Directional Static Stability after rudder release Determine Rudder and aileron force Determine Rudder and aileron Deflection Verify no reverse Rudder force during maneuver Test limit :150 lbf or max rudder deflection Repeat for Right/Left Rudder Repeat for %50 %100 Rudder	1
	OFF	PFLF	CS 23.177 b 8785C 3.3.6.1 8785C 3.3.6.2 8785C 3.3.6.3	Check positive Lateral Static Stability after stick release Test limit :150 lbf or max rudder deflection Repeat for Right/Left Rudder Repeat for %50 %100 Rudder	1
	ON	PFLF	CS 23.177 b 8785C 3.3.6.1 8785C 3.3.6.2 8785C 3.3.6.3	Check positive Lateral Static Stability after stick release Test limit :150 lbf or max rudder deflection Repeat for Right/Left Rudder Repeat for %50 %100 Rudder	2
	OFF	%75 of MCP	CS 23.177 b 8785C 3.3.6.1 8785C 3.3.6.2 8785C 3.3.6.3	Check positive Lateral Static Stability after stick release Test limit :150 lbf or max rudder deflection Repeat for Right/Left Rudder Repeat for %50 %100 Rudder	1
	ON	%75 of MCP	CS 23.177 b 8785C 3.3.6.1 8785C 3.3.6.2 8785C 3.3.6.3	Check positive Lateral Static Stability after stick release Test limit :150 lbf or max rudder deflection Repeat for Right/Left Rudder Repeat for %50 %100 Rudder	2
	OFF	PFLF	CS 23.177 b 8785C 3.3.6.1 8785C 3.3.6.2 8785C 3.3.6.3	Check positive Lateral Static Stability after stick release Test limit :150 lbf or max rudder deflection Repeat for Right/Left Rudder Repeat for %50 %100 Rudder	1
	OFF	%75 of MCP	CS 23.177 b 8785C 3.3.6.1 8785C 3.3.6.2 8785C 3.3.6.3	Check positive Lateral Static Stability after stick release Test limit :150 lbf or max rudder deflection Repeat for Right/Left Rudder Repeat for %50 %100 Rudder	1
	OFF	Power for 3° descent	CS 23.177 b 8785C 3.3.6.1 8785C 3.3.6.2 8785C 3.3.6.3	Check positive Lateral Static Stability after stick release Test limit :150 lbf or max rudder deflection Repeat for Right/Left Rudder Repeat for %50 %100 Rudder	1
	OFF	Power for 3° descent	CS 23.177 b 8785C 3.3.6.1 8785C 3.3.6.2 8785C 3.3.6.3	Check positive Lateral Static Stability after stick release Test limit :150 lbf or max rudder deflection Repeat for Right/Left Rudder Repeat for %50 %100 Rudder	1

Test Subject	Test Technique	Speed (kts)	Altitude (MSL)	Flaps	Gear
Lateral Directional Dynamic Stability	Frequency Sweep	95 (1.2 Vs)	7000 ft	RETRACTED	RETRACTED
	Dutch Roll-Fixed	95 (1.2 Vs)	7000 ft	RETRACTED	RETRACTED
	Dutch Roll-Free	95 (1.2 Vs)	7000 ft	RETRACTED	RETRACTED
	Frequency Sweep	95 (1.2 Vs)	7000 ft	RETRACTED	RETRACTED
	Dutch Roll-Fixed	95 (1.2 Vs)	7000 ft	RETRACTED	RETRACTED
	Dutch Roll-Free	95 (1.2 Vs)	7000 ft	RETRACTED	RETRACTED
	Frequency Sweep	150 (Va - 10(safety margin))	7000 ft	RETRACTED	RETRACTED
	Dutch Roll-Fixed	150 (Va - 10(safety margin))	7000 ft	RETRACTED	RETRACTED
	Dutch Roll-Free	150 (Va - 10(safety margin))	7000 ft	RETRACTED	RETRACTED
	Frequency Sweep	150 (Va - 10(safety margin))	7000 ft	RETRACTED	RETRACTED
	Dutch Roll-Fixed	150 (Va - 10(safety margin))	7000 ft	RETRACTED	RETRACTED
	Dutch Roll-Free	150 (Va - 10(safety margin))	7000 ft	RETRACTED	RETRACTED
	Frequency Sweep	95 (1.2 Vs)	7000 ft	RETRACTED	EXTENDED
	Dutch Roll-Fixed	95 (1.2 Vs)	7000 ft	RETRACTED	EXTENDED
	Dutch Roll-Free	95 (1.2 Vs)	7000 ft	RETRACTED	EXTENDED
	Frequency Sweep	150 (Va - 10(safety margin))	7000 ft	RETRACTED	EXTENDED
	Dutch Roll-Fixed	150 (Va - 10(safety margin))	7000 ft	RETRACTED	EXTENDED
	Dutch Roll-Free	150 (Va - 10(safety margin))	7000 ft	RETRACTED	EXTENDED
	Frequency Sweep	85 (1.2 Vs)	7000 ft	LDG	EXTENDED
	Dutch Roll-Fixed	85 (1.2 Vs)	7000 ft	LDG	EXTENDED
	Dutch Roll-Free	85 (1.2 Vs)	7000 ft	LDG	EXTENDED
	Frequency Sweep	130 (Vfe - 10(safety margin))	7000 ft	LDG	EXTENDED
	Dutch Roll-Fixed	130 (Vfe - 10(safety margin))	7000 ft	LDG	EXTENDED
	Dutch Roll-Free	130 (Vfe - 10(safety margin))	7000 ft	LDG	EXTENDED
	Spiral Mode	95 (1.2 Vs)	7000 ft	RETRACTED	RETRACTED
	Spiral Mode	150 (Va - 10(safety margin))	7000 ft	RETRACTED	RETRACTED
	Spiral Mode	95 (1.2 Vs)	7000 ft	RETRACTED	RETRACTED
	Spiral Mode	150 (Va - 10(safety margin))	7000 ft	RETRACTED	RETRACTED
	Spiral Mode	95 (1.2 Vs)	7000 ft	RETRACTED	EXTENDED
	Spiral Mode	150 (Va - 10(safety margin))	7000 ft	RETRACTED	EXTENDED
	Spiral Mode	85 (1.2 Vs)	7000 ft	LDG	EXTENDED
	Spiral Mode	130 (Vfe - 10(safety margin))	7000 ft	LDG	EXTENDED
	Roll Mode	95 (1.2 Vs) or level flight speed (whichever is greater)	7000 ft	RETRACTED	RETRACTED
	Roll Mode	95 (Vref)	7000 ft	LDG	EXTENDED

Test Subject	Yaw Damper	Power	Relevant Req	Test Procedure	Priority
Lateral Directional Dynamic Stability	OFF	PFLF	CS 23.181 b	Input Type: Doublet Determine Undamped Natural Frequency	1
	OFF	PFLF	CS 23.181 b 8785C 3.3.1.1	Input Type: Doublet Record number of cycle and time to damp Record max bank and sideslip Determine Roll/yaw ratio	1
	OFF	PFLF	CS 23.181 b 8785C 3.3.1.1	Input Type: Doublet Record number of cycle and time to damp Record max bank and sideslip Determine Roll/yaw ratio	1
	ON	PFLF	CS 23.181 b	Input Type: Doublet Determine Undamped Natural Frequency	2
	ON	PFLF	CS 23.181 b 8785C 3.3.1.1	Input Type: Doublet Record number of cycle and time to damp Record max bank and sideslip Determine Roll/yaw ratio	2
	ON	PFLF	CS 23.181 b 8785C 3.3.1.1	Input Type: Doublet Record number of cycle and time to damp Record max bank and sideslip Determine Roll/yaw ratio	2
	OFF	MCP	CS 23.181 b	Input Type: Doublet Determine Undamped Natural Frequency	1
	OFF	MCP	CS 23.181 b 8785C 3.3.1.1	Input Type: Doublet Record number of cycle and time to damp Record max bank and sideslip Determine Roll/yaw ratio	1
	OFF	MCP	CS 23.181 b 8785C 3.3.1.1	Input Type: Doublet Record number of cycle and time to damp Record max bank and sideslip Determine Roll/yaw ratio	1
	ON	MCP	CS 23.181 b	Input Type: Doublet Determine Undamped Natural Frequency	2
	ON	MCP	CS 23.181 b 8785C 3.3.1.1	Input Type: Doublet Record number of cycle and time to damp Record max bank and sideslip Determine Roll/yaw ratio	2
	ON	MCP	CS 23.181 b 8785C 3.3.1.1	Input Type: Doublet Record number of cycle and time to damp Record max bank and sideslip Determine Roll/yaw ratio	2
	OFF	PFLF	CS 23.181 b	Input Type: Doublet Determine Undamped Natural Frequency	1
	OFF	PFLF	CS 23.181 b 8785C 3.3.1.1	Input Type: Doublet Record number of cycle and time to damp Record max bank and sideslip Determine Roll/yaw ratio	1
	OFF	PFLF	CS 23.181 b 8785C 3.3.1.1	Input Type: Doublet Record number of cycle and time to damp Record max bank and sideslip Determine Roll/yaw ratio	1
	OFF	PFLF	CS 23.181 b	Input Type: Doublet Determine Undamped Natural Frequency	1
	OFF	PFLF	CS 23.181 b 8785C 3.3.1.1	Input Type: Doublet Record number of cycle and time to damp Record max bank and sideslip Determine Roll/yaw ratio	1
	OFF	PFLF	CS 23.181 b 8785C 3.3.1.1	Input Type: Doublet Record number of cycle and time to damp Record max bank and sideslip Determine Roll/yaw ratio	1
	OFF	PFLF	CS 23.181 b	Input Type: Doublet Determine Undamped Natural Frequency	1
	OFF	PFLF	CS 23.181 b 8785C 3.3.1.1	Input Type: Doublet Record number of cycle and time to damp Record max bank and sideslip Determine Roll/yaw ratio	1
	OFF	PFLF	CS 23.181 b 8785C 3.3.1.1	Input Type: Doublet Record number of cycle and time to damp Record max bank and sideslip Determine Roll/yaw ratio	1
	OFF	PFLF	CS 23.181 b	Input Type: Doublet Determine Undamped Natural Frequency	1
	OFF	PFLF	CS 23.181 b 8785C 3.3.1.1	Input Type: Doublet Record number of cycle and time to damp Record max bank and sideslip Determine Roll/yaw ratio	1
	OFF	PFLF	CS 23.181 b 8785C 3.3.1.1	Input Type: Doublet Record number of cycle and time to damp Record max bank and sideslip Determine Roll/yaw ratio	1
	OFF	PFLF	8785C 3.3.1.1	Rudder Input 20 degree bank Determine time to double or half Test limit 20 sec Repeat for right and left	1
	OFF	MCP	8785C 3.3.1.1	Rudder Input 20 degree bank Determine time to double or half Test limit 20 sec Repeat for right and left	1
	ON	PFLF	8785C 3.3.1.1	Rudder Input 20 degree bank Determine time to double or half Test limit 20 sec Repeat for right and left	2
	ON	MCP	8785C 3.3.1.1	Rudder Input 20 degree bank Determine time to double or half Test limit 20 sec Repeat for right and left	2
	OFF	PFLF	8785C 3.3.1.1	Rudder Input 20 degree bank Determine time to double or half Test limit 20 sec Repeat for right and left	1
	OFF	PFLF	8785C 3.3.1.1	Rudder Input 20 degree bank Determine time to double or half Test limit 20 sec Repeat for right and left	1
	OFF	PFLF	8785C 3.3.1.1	Rudder Input 20 degree bank Determine time to double or half Test limit 20 sec Repeat for right and left	1
	OFF	PFLF	8785C 3.3.1.1	Rudder Input 20 degree bank Determine time to double or half Test limit 20 sec Repeat for right and left	1
	OFF	Critical Engine: IDLE (Prop:min drag) Other Engine: Takeoff Power	CS 23.157 a CS 23.157 b	Stabilize left 30° Bank Apply opposite full aileron input Determine time to reach opposite 30° Repeat test for right and left	1
	OFF	Power for 3° descent	CS 23.157 c CS 23.157 d	Stabilize left 30° Bank Apply opposite full aileron input Determine time to reach opposite 30° Repeat test for right and left	1

APPENDIX B RECORDED DATA

Table B.1. LSS data

120 KTS , CLIMB CONF., MCP			
Breakout + Friction (Pound)			2
Fe (pound)	**δe (mm)**	**Vi (kts)**	**Hi (ft)**
3	4	110	6200
5	6	100	6560
2	3	112	6720
Free Return		118	6950
Breakout + Friction (Pound)			2
Fe (pound)	**δe (mm)**	**Vi (kts)**	**Hi (ft)**
4	5	130	6100
8	10	141	6320
3	4	132	6710
Free Return		124	6920
95 KTS , LANDING CONF., 3 DEG APP.			
Breakout + Friction (Pound)			2
Fe (pound)	**δe (mm)**	**Vi (kts)**	**Hi (ft)**
3	4	91	5180
5	6	86	4900
8	10	82	4660
4	5	85	5060
2	3	90	4820
Free Return		94	4600
Breakout + Friction (Pound)			2
Fe (pound)	**δe (mm)**	**Vi (kts)**	**Hi (ft)**
5	6	106	5620
10	12	115	5100
14	18	124	4480
9	11	116	5540
4	5	107	5220
Free Return		97	4960
168 KTS , CRUISE CONF., PFLF			
Breakout + Friction (Pound)			2
Fe (pound)	**δe (mm)**	**Vi (kts)**	**Hi (ft)**
3	4	158	7110
5	6	150	7220
8	10	142	7500
4	5	149	7580
2	3	158	7520
Free Return		163	7450
Breakout + Friction (Pound)			2
Fe (pound)	**δe (mm)**	**Vi (kts)**	**Hi (ft)**
5	6	179	7100
10	12	188	6640
15	20	199	6020
9	11	192	6460
4	5	181	6980
Free Return		170	7140

122 KTS , CRUISE CONF., PFLF			
Breakout + Friction (Pound)			2
Fe (pound)	**δe (mm)**	**Vi (kts)**	**Hi (ft)**
4	5	111	7080
9	11	100	7300
12	15	92	7660
8	10	101	7760
3	4	108	7880
Free Return		119	7820
Breakout + Friction (Pound)			2
Fe (pound)	**δe (mm)**	**Vi (kts)**	**Hi (ft)**
6	7	131	7660
10	12	138	7440
17	25	150	6920
9	10	139	6940
5	6	129	7040
Free Return		124	7000
95 KTS , LANDING CONF., IDLE			
Breakout + Friction (Pound)			2
Fe (pound)	**δe (mm)**	**Vi (kts)**	**Hi (ft)**
3	4	90	6980
7	9	81	6400
2	3	88	7220
Free Return		92	6780
Breakout + Friction (Pound)			2
Fe (pound)	**δe (mm)**	**Vi (kts)**	**Hi (ft)**
6	7	104	7340
12	15	114	6820
18	25	125	6160
11	15	115	7220
5	6	106	6840
Free Return		97	6680

Table B.2. LMS data

STABILIZED TURN, 125 KTS , CRUISE CONF., PFLF				
Left Turn				
Fe (pound)	**δe (mm)**	**Vi (kts)**	**AOB (^{0})**	**G (g)**
15	25	127	47	1.5
30	50	126	60	2
Right Turn				
Fe (pound)	**δe (mm)**	**Vi (kts)**	**AOB**	**G**
15	25	125	46	1.5
30	50	127	60	2

PULL-UP, 125 KTS , CRUISE CONF., PFLF			
Fe (pound)	**δe (mm)**	**Vi (kts)**	**G (g)**
8	12	125	1.5
20	30	125	2
25	45	127	2.3
PUSH-OVER, 125 KTS , CRUISE CONF., PFLF			
Fe (pound)	**δe (mm)**	**Vi (kts)**	**G (g)**
5	8	125	0.8
12	20	127	0.5

Table B.3. LDS Short Period data

120 KTS , CLIMB CONF., MCP		
# of Overshoot	**Δtime**	**Stick**
deadbeat	N/A	Fixed
deadbeat	N/A	Free
123 KTS , CRUISE CONF., PFLF		
# of Overshoot	**Δtime**	**Stick**
deadbeat	N/A	Fixed
deadbeat	N/A	Free
166 KTS , CRUISE CONF., PFLF		
# of Overshoot	**Δtime**	**Stick**
deadbeat	N/A	Fixed
deadbeat	N/A	Free
96 KTS , LANDING CONF., 3 DEG APP.		
# of Overshoot	**Δtime**	**Stick**
deadbeat	N/A	Fixed
deadbeat	N/A	Free
94 KTS , LANDING CONF., IDLE		
# of Overshoot	**Δtime**	**Stick**
deadbeat	N/A	Fixed
deadbeat	N/A	Free

Table B.4. LDS Phugoid data

120 KTS , CLIMB CONF., MCP			120 KTS , CRUISE CONF., PFLF		
Vi (kts)	**Hi (ft)**	**Time**	**Vi (kts)**	**Hi (ft)**	**Time**
102	8900	0	102	7580	0
140	8060	21.1	131	7300	23.2
96	9600	41.7	112	7530	48.4
149	8600	62.5	125	7380	71.6
KTS , LANDING CONF., 3 DEG AP			**94 KTS , LANDING CONF., IDLE**		
Vi (kts)	**Hi (ft)**	**Time**	**Vi (kts)**	**Hi (ft)**	**Time**
81	7760	0	80	7700	0
108	7380	17.2	102	7200	15.1
87	7180	34.3	88	6740	30.3
103	6700	49.7	98	6860	45.6
90	6620	67.5	92	5820	59.1
167 KTS , CRUISE CONF., PFLF					
Vi (kts)	**Hi (ft)**	**Time**			
197	5660	0			
141	6620	25.8			
186	5720	51.3			
151	6380	76.8			

Table B.5. LDSS - WLSS data

96 KTS , CRUISE CONF., PFLF, YD OFF				95 KTS , TAKEOFF CONF., PFLF, YD OFF			
Rudder Def. (%)	**Fr (pound)**	**Fa (pound)**	**Sideslip (deg)**	**Rudder Def. (%)**	**Fr (pound)**	**Fa (pound)**	**Sideslip (deg)**
50% L	10	2	4	50% L	10	3	4
100% L	35	5	12	100% L	35	5	11
50% R	15	3	-5	50% R	20	4	-6
100% R	50	7	-12	75% R	50	7	-15
150 KTS , CRUISE CONF., PFLF, YD OFF				**141 KTS , TAKEOFF CONF., PFLF, YD OFF**			
Rudder Def. (%)	**Fr (pound)**	**Fa (pound)**	**Sideslip (deg)**	**Rudder Def. (%)**	**Fr (pound)**	**Fa (pound)**	**Sideslip (deg)**
50% L	15	3	5	50% L	20	4	5
100% L	50	6	12	100% L	50	7	14
50% R	25	5	-7	50% R	30	5	-5
100% R	70	8	-15	100% R	70	9	-15
86 KTS , LANDING CONF., PFLF, YD OFF				**96 KTS , CRUISE CONF., PFLF, YD ON**			
Rudder Def. (%)	**Fr (pound)**	**Fa (pound)**	**Sideslip (deg)**	**Rudder Def. (%)**	**Fr (pound)**	**Fa (pound)**	**Sideslip (deg)**
50% L	10	2	5	50% L	15	3	4
100% L	35	4	14	100% L	40	6	10
50% R	20	5	-6	50% R	20	4	-4
100% R	50	8	-14	100% R	60	7	-13
120 KTS , LANDING CONF., PFLF, YD OFF				**148 KTS , CRUISE CONF., PFLF, YD ON**			
Rudder Def. (%)	**Fr (pound)**	**Fa (pound)**	**Sideslip (deg)**	**Rudder Def. (%)**	**Fr (pound)**	**Fa (pound)**	**Sideslip (deg)**
50% L	15	2	5	50% L	20	4	4
100% L	40	3	11	100% L	50	7	15
50% R	20	2	-5	50% R	30	5	-5
100% R	50	4	-13	100% R	80	10	-16

Table B.6. LDSS SHSS data

106 KTS , CRUISE CONF., PFLF, YD OFF					96 KTS , TAKEOFF CONF., PFLF, YD OFF				
Rudder Def. (%)	Fr (pound)	Fa (pound)	Φ (°)	Sideslip (deg)	Rudder Def. (%)	Fr (pound)	Fa (pound)	Φ (°)	Sideslip (deg)
50% L	15	4	5	5	50% L	10	5	5	6
100% L	40	11	11	12	100% L	30	9	11	11
50% R	20	5	-5	-5	50% R	15	6	-6	-5
75% R	60	10	-10	-14	100% R	50	10	-12	-15
155 KTS , CRUISE CONF., PFLF, YD OFF					**123 KTS , TAKEOFF CONF., PFLF, YD OFF**				
Rudder Def. (%)	Fr (pound)	Fa (pound)	Φ (°)	Sideslip (deg)	Rudder Def. (%)	Fr (pound)	Fa (pound)	Φ (°)	Sideslip (deg)
50% L	15	5	5	7	50% L	15	4	6	4
100% L	50	10	10	13	100% L	40	9	10	10
50% R	30	4	-6	-6	50% R	20	5	-6	-7
100% R	70	10	-11	-15	100% R	60	9	-11	-13
92 KTS , LANDING CONF., 3 DEG APP., YD OFF					**105 KTS , CRUISE CONF., PFLF, YD ON**				
Rudder Def. (%)	Fr (pound)	Fa (pound)	Φ (°)	Sideslip (deg)	Rudder Def. (%)	Fr (pound)	Fa (pound)	Φ (°)	Sideslip (deg)
50% L	10	3	5	5	50% L	15	5	5	4
100% L	30	10	10	16	100% L	40	9	11	14
50% R	15	5	-6	-5	50% R	15	4	-5	-6
100% R	40	10	-12	-14	100% R	60	11	-10	-17
127 KTS , LANDING CONF., 3 DEG APP., YD OFF					**148 KTS , CRUISE CONF., PFLF, YD ON**				
Rudder Def. (%)	Fr (pound)	Fa (pound)	Φ (°)	Sideslip (deg)	Rudder Def. (%)	Fr (pound)	Fa (pound)	Φ (°)	Sideslip (deg)
50% L	20	4	5	7	50% L	15	5	6	5
100% L	40	9	10	13	100% L	40	11	10	15
50% R	25	4	-6	-5	50% R	30	4	-6	-5
100% R	60	12	-12	-14	100% R	70	12	-12	-16

Table B.7. LDDS Dutch Roll data

95 KTS , CRUISE CONF., PFLF, YD OFF				84 KTS , LANDING CONF., PFLF, YD OFF			
# of Overshoot	Δtime	Stick	Roll to Yaw Ratio	# of Overshoot	Δtime	Stick	Roll to Yaw Ratio
5	10.1	Fixed	2:1	6	10.8	Fixed	1:1
5	10.6	Free	2:1	7	12.6	Free	1:1
148 KTS , CRUISE CONF., PFLF, YD OFF				**121 KTS , LANDING CONF., PFLF, YD OFF**			
# of Overshoot	Δtime	Stick	Roll to Yaw Ratio	# of Overshoot	Δtime	Stick	Roll to Yaw Ratio
7	9.1	Fixed	2:1	10	13.2	Fixed	1:1
8	9.9	Free	2:1	11	14.1	Free	1:1
97 KTS , TAKEOFF CONF., PFLF, YD OFF				**97 KTS , CRUISE CONF., PFLF, YD ON**			
# of Overshoot	Δtime	Stick	Roll to Yaw Ratio	# of Overshoot	Δtime	Stick	Roll to Yaw Ratio
5	10.7	Fixed	1.5:1	1	4.1	Fixed	2:1
5	10.9	Free	1.5:1	1	4.1	Free	2:1
140 KTS , TAKEOFF CONF., PFLF, YD OFF				**151 KTS , CRUISE CONF., PFLF, YD ON**			
# of Overshoot	Δtime	Stick	Roll to Yaw Ratio	# of Overshoot	Δtime	Stick	Roll to Yaw Ratio
10	11.1	Fixed	1.5:1	1	3.4	Fixed	2:1
10	12.1	Free	1.5:1	1	3.3	Free	2:1

Table B.8. LDDS Spiral Mode data

96 KTS , CRUISE CONF., PFLF, YD OFF			86 KTS , LANDING CONF., PFLF, YD OFF		
Time (sec)	Bank Angle (°)	Direction	Time (sec)	Bank Angle (°)	Direction
19.5	10	Left	20	20	Left
20	25	Right	20	32	Right
149 KTS , CRUISE CONF., PFLF, YD OFF			**121 KTS , LANDING CONF., PFLF, YD OFF**		
Time (sec)	Bank Angle (°)	Direction	Time (sec)	Bank Angle (°)	Direction
20	20	Left	20	20	Left
16.7	10	Right	15.6	10	Right
95 KTS , TAKEOFF CONF., PFLF, YD OFF			**93 KTS , CRUISE CONF., PFLF, YD ON**		
Time (sec)	Bank Angle (°)	Direction	Time (sec)	Bank Angle (°)	Direction
9.7	10	Left	20	16.9	Left
20	20	Right	20	38	Right
140 KTS , TAKEOFF CONF., PFLF, YD OFF			**150 KTS , CRUISE CONF., PFLF, YD ON**		
Time (sec)	Bank Angle (°)	Direction	Time (sec)	Bank Angle (°)	Direction
20	14	Left	20	12	Left
12.9	10	Right	20	32	Right

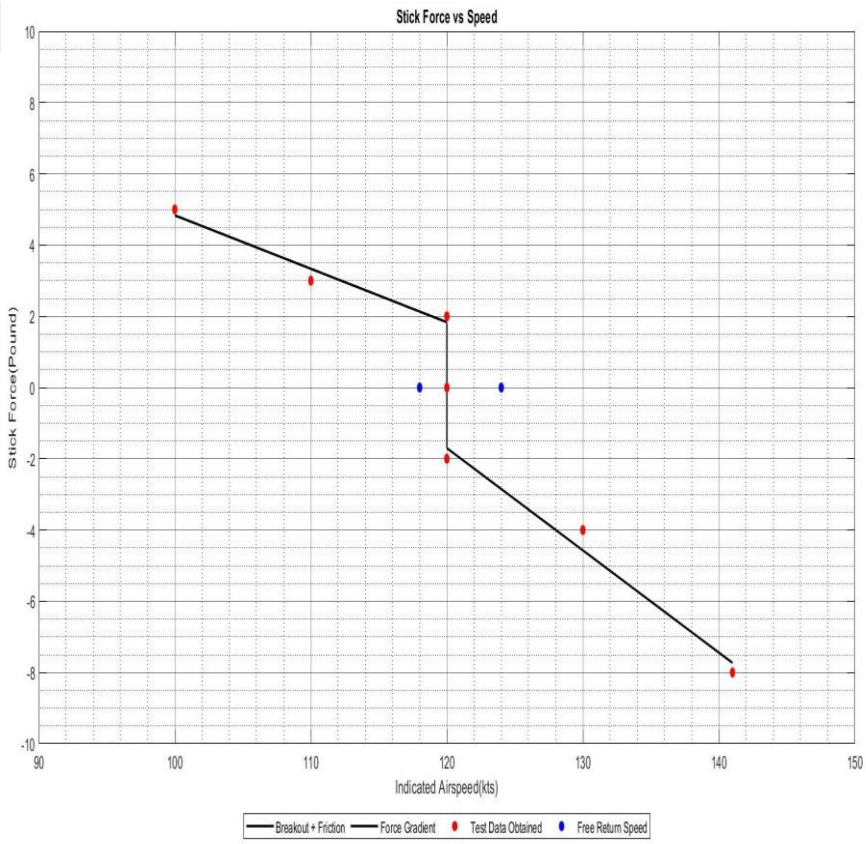
Table B.9. Roll performance data

97 KTS , CLEAN CONF., OEI (R:Takeoff, L:Idle)				
Aileron Deflection (%)	**Fa (pound)**	**Fr (pound)**	**Time for 60º Roll**	**Direction**
50%	15	8R	6.1	Left to Right
50%	10	9R	5.2	Right to Left
100%	30	10R	2.2	Left to Right
100%	20	12R	2	Right to Left
98 KTS , LANDING CONF., 3 DEG APP.				
Aileron Deflection (%)	**Fa (pound)**	**Fr (pound)**	**Time for 60º Roll**	**Direction**
50%	20	2L	4.6	Left to Right
50%	20	3R	3.9	Right to Left
100%	30	3L	2.6	Left to Right
100%	30	3R	2.3	Right to Left

APPENDIX C DATA PRESENTATION WITH GRAPH

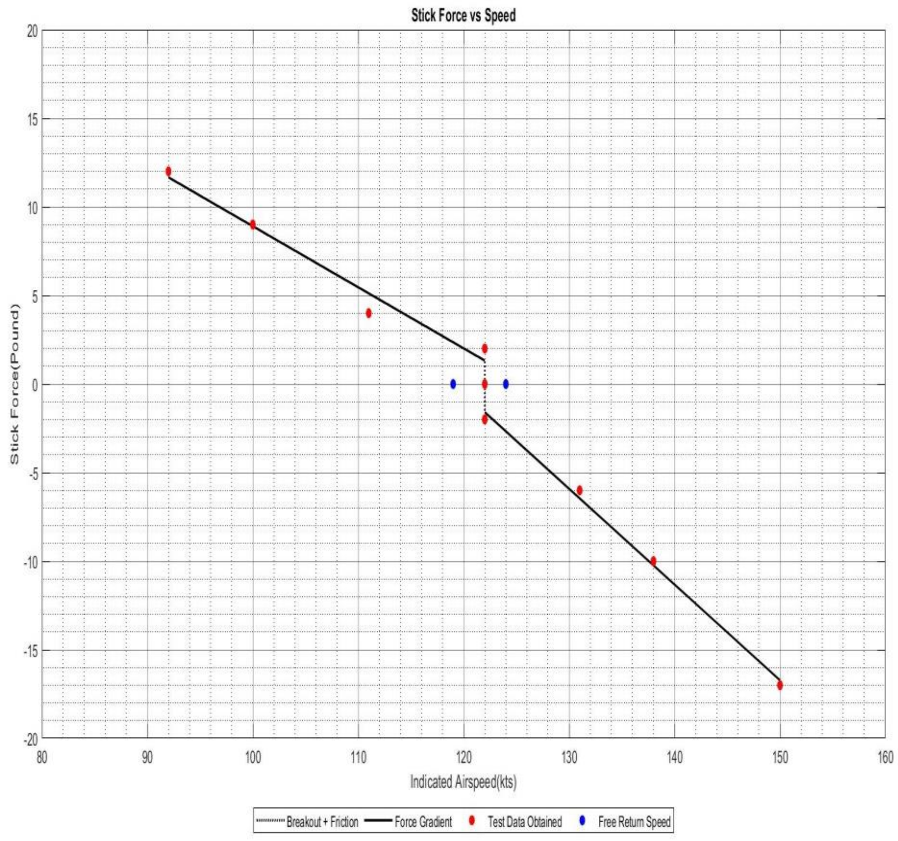
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	22th July 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	120 KIAS
WEIGHT	6707 lbs	**ALTITUDE**	6000 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Alt: ±1000 ft & Speed: ±2 kts
ENGINE SETTINGS (RPM/MAP)	L: 2760/36.3 & R: 2740/36.4	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS UP & LG UP	**FLIGHT TEST TECHNIQUE**	STABILIZED METHOD

Figure APPENDIX C.1 Stabilized method stick forces vs speed at 120 kias in climb configuration



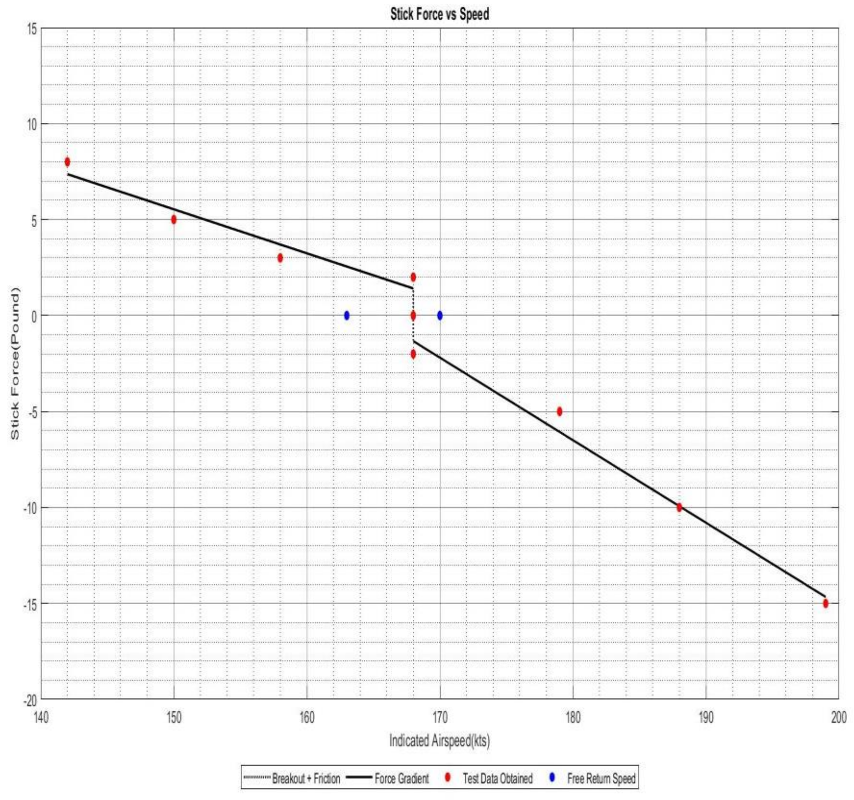
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	22th July 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	122 KIAS
WEIGHT	6539 lbs	**ALTITUDE**	6950 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Alt: ±1000 ft & Speed: ±2 kts
ENGINE SETTINGS (RPM/MAP)	L: 2520/25 & R: 2490/23.5	**AIRCRAFT CONFIGURATION**	FLAPS UP & LG UP
TEST CREW	TP: HAL – FTE:BAT&HAS	**FLIGHT TEST TECHNIQUE**	STABILIZED METHOD

Figure APPENDIX C.2 stabilized method stick forces vs speed at 122 kias in cruise configuration



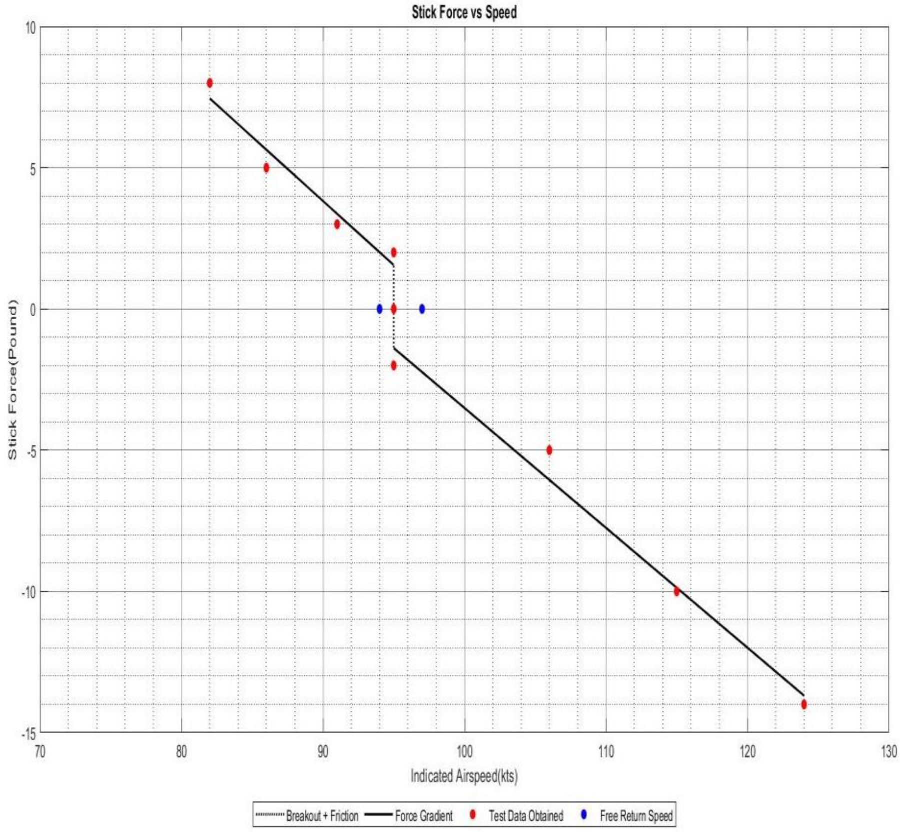
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	22th July 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	168 KIAS
WEIGHT	6455 lbs	**ALTITUDE**	6980 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Alt: ±1000 ft & Speed: ±2 kts
ENGINE SETTINGS (RPM/MAP)	L: 2530/33.4 & R: 2520/33.3	**AIRCRAFT CONFIGURATION**	FLAPS UP & LG UP
TEST CREW	TP: HAL – FTE:BAT&HAS	**FLIGHT TEST TECHNIQUE**	STABILIZED METHOD

Figure APPENDIX C.3 stabilized method stick forces vs speed at 168 kias in cruise configuration



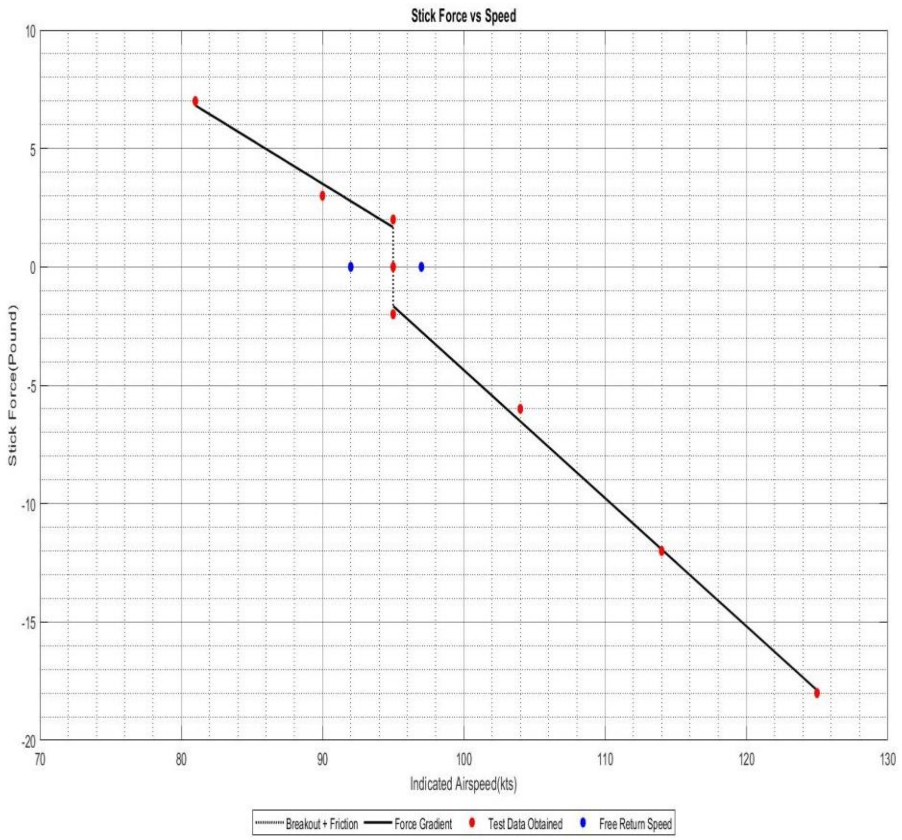
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	22[th] July 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	95 KIAS
WEIGHT	6245 lbs	**ALTITUDE**	5400 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Alt: ±1000 ft & Speed: ±2 kts
ENGINE SETTINGS (RPM/MAP)	L: 2750/16.9 & R: 2760/15.7	**TEST CREW**	TP: HAL – FTE: BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS 30 & LG DOWN	**FLIGHT TEST TECHNIQUE**	STABILIZED METHOD

Figure APPENDIX C.4 Stabilized method stick forces vs speed at 95 kias in landing configuration with 3° approach power



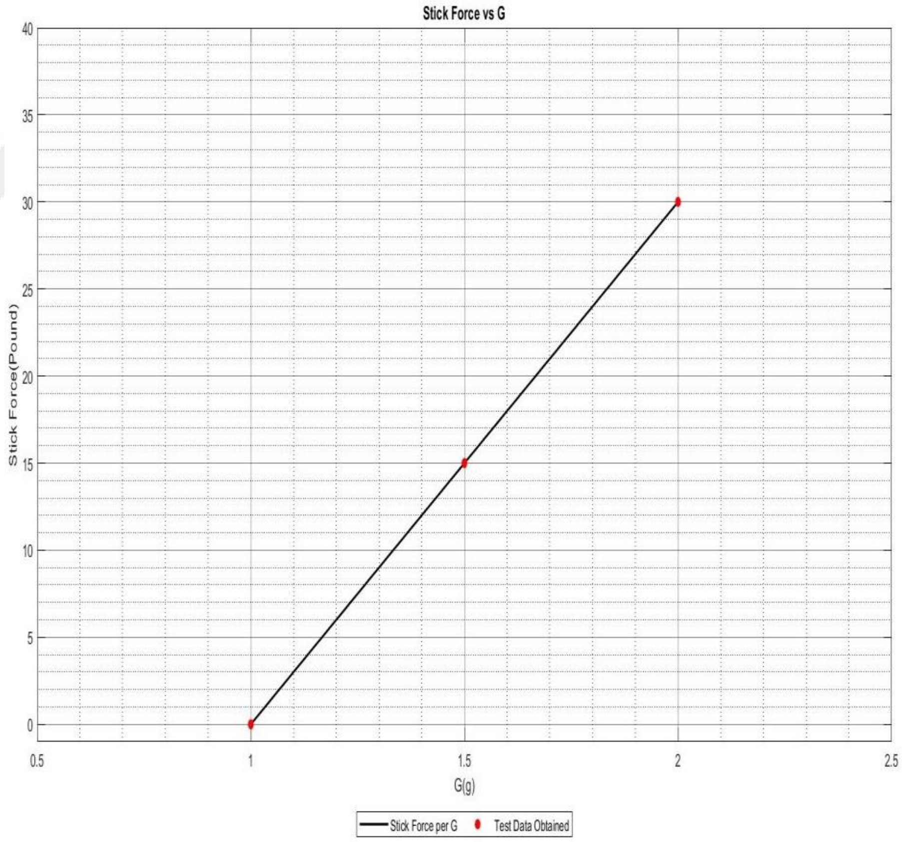
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	12th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	95 KIAS
WEIGHT	6665 lbs	**ALTITUDE**	7100 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Alt: ±1000 ft & Speed: ±2 kts
ENGINE SETTINGS (RPM/MAP)	L: 2740/7.4 & R: 2760/7.4	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS 30 & LG DOWN	**FLIGHT TEST TECHNIQUE**	STABILIZED METHOD

Figure APPENDIX C.5 Stabilized method stick forces vs speed at 95 kias in landing configuration with idle power



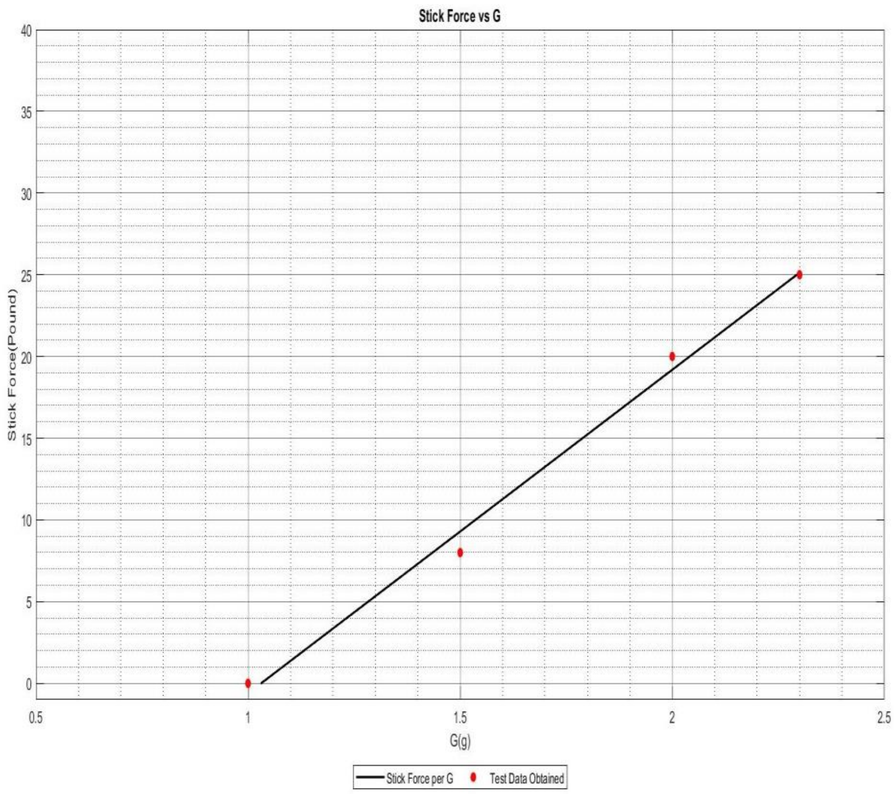
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	12th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	125 KIAS
WEIGHT	6545 lbs	**ALTITUDE**	8100 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Load Factor: ±0.2 g & Speed: ±2 kts
ENGINE SETTINGS (RPM/MAP)	L: 2510/25.3 & R: 2490/25	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS UP & LG UP	**FLIGHT TEST TECHNIQUE**	STABILIZED TURN

Figure APPENDIX C.6 Stabilized Turn Stick Forces vs Load Factor at 125 KIAS in Cruise Configuration



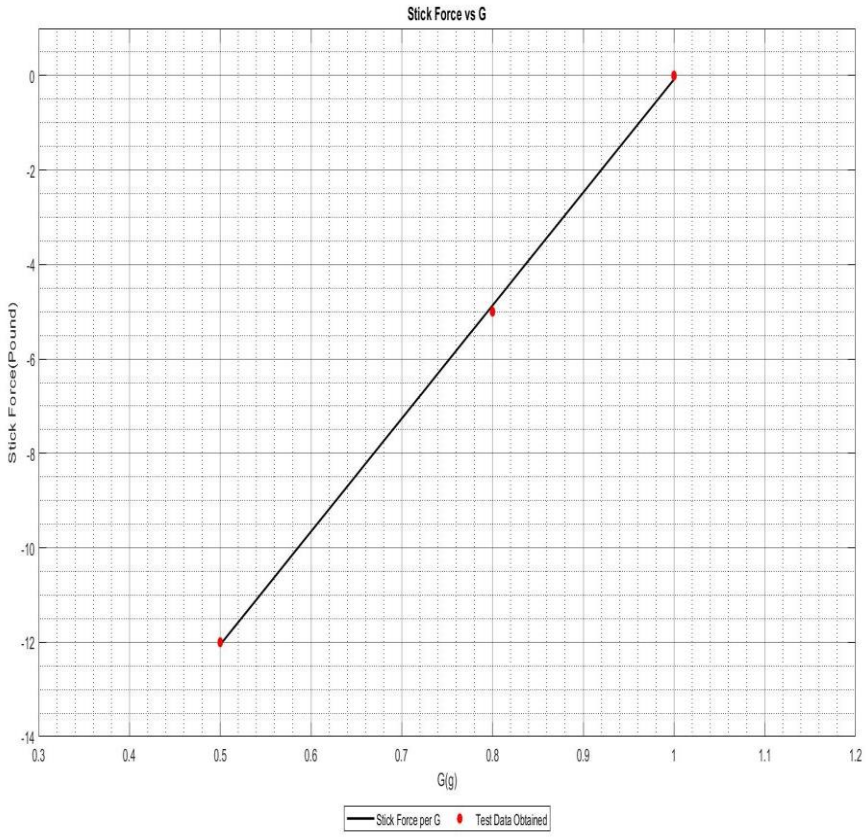
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	12th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	125 KIAS
WEIGHT	6521 lbs	**ALTITUDE**	7700 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Load Factor: ±0.2 g & Speed: ±2 kts
ENGINE SETTINGS (RPM/MAP)	L: 2510/25.3 & R: 2490/25	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS UP & LG UP	**FLIGHT TEST TECHNIQUE**	PULL UP

Figure APPENDIX C.7 Pull up stick forces vs load factor at 125 kias in cruise configuration



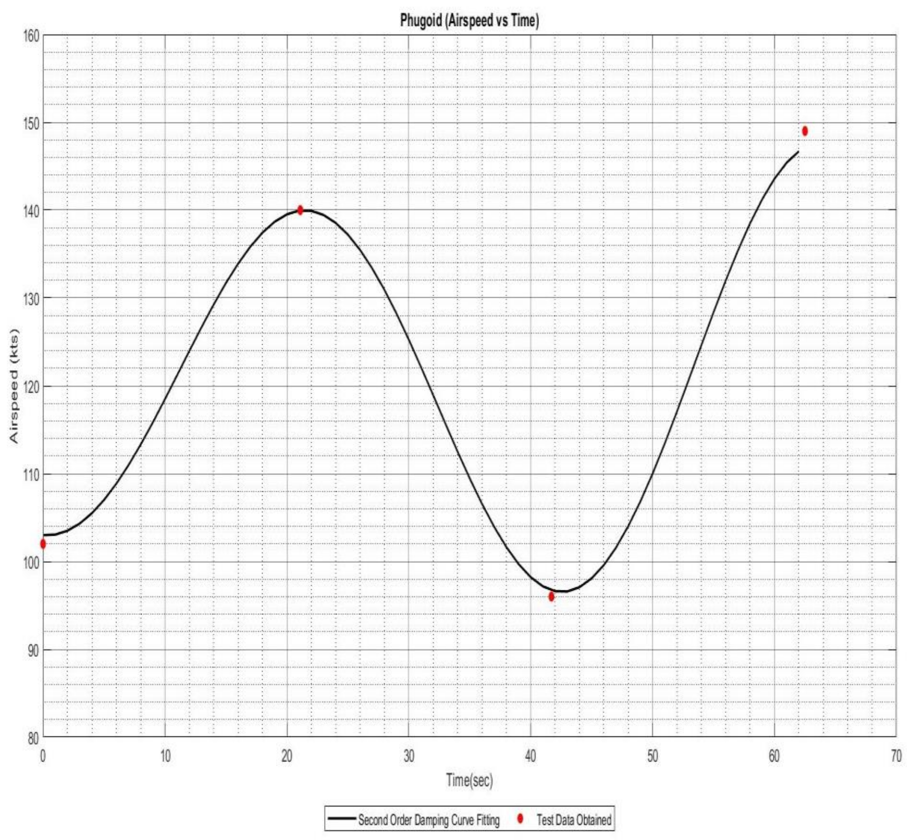
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	12th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	125 KIAS
WEIGHT	6509 lbs	**ALTITUDE**	8140 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Load Factor: ±0.2 g & Speed: ±2 kts
ENGINE SETTINGS (RPM/MAP)	L: 2510/25.3 & R: 2490/25	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS UP & LG UP	**FLIGHT TEST TECHNIQUE**	PUSH OVER

Figure APPENDIX C.8 Push over stick forces vs load factor at 125 kias in cruise configuration



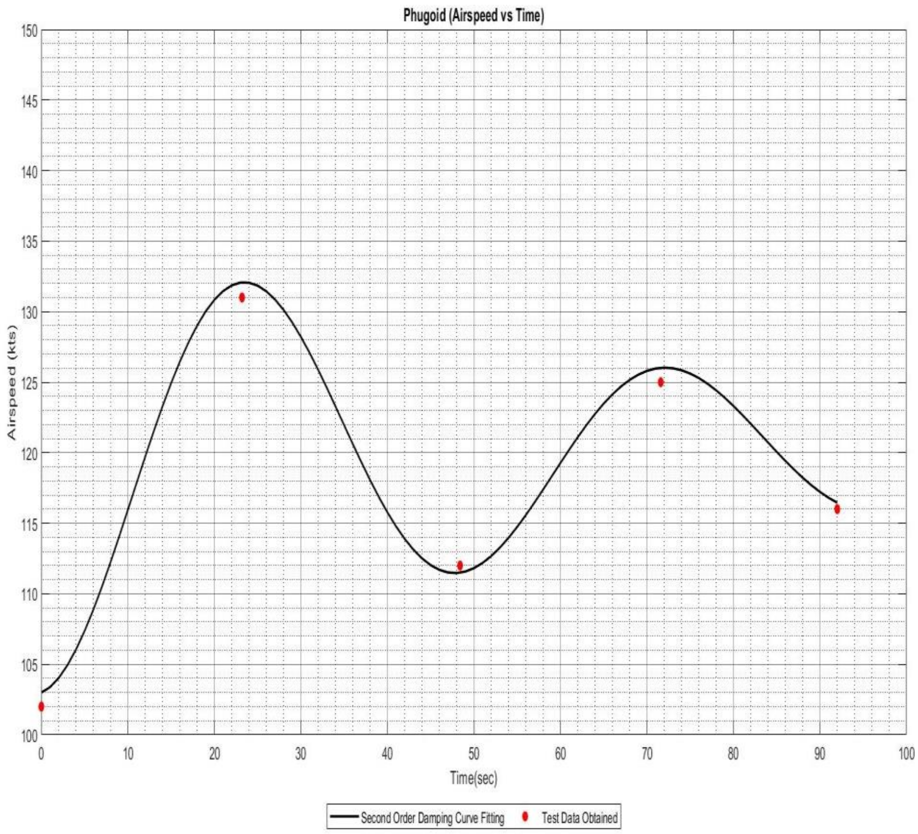
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	22th July 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	120 KIAS
WEIGHT	6563 lbs	**ALTITUDE**	7300 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Bank Angle: ±2º
ENGINE SETTINGS (RPM/MAP)	L: 2760/36.3 & R: 2740/36.4	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS UP & LG UP	**FLIGHT TEST TECHNIQUE**	PHUGOID

Figure APPENDIX C.9 Phugoid airspeed vs time at 120 kias in climb configuration



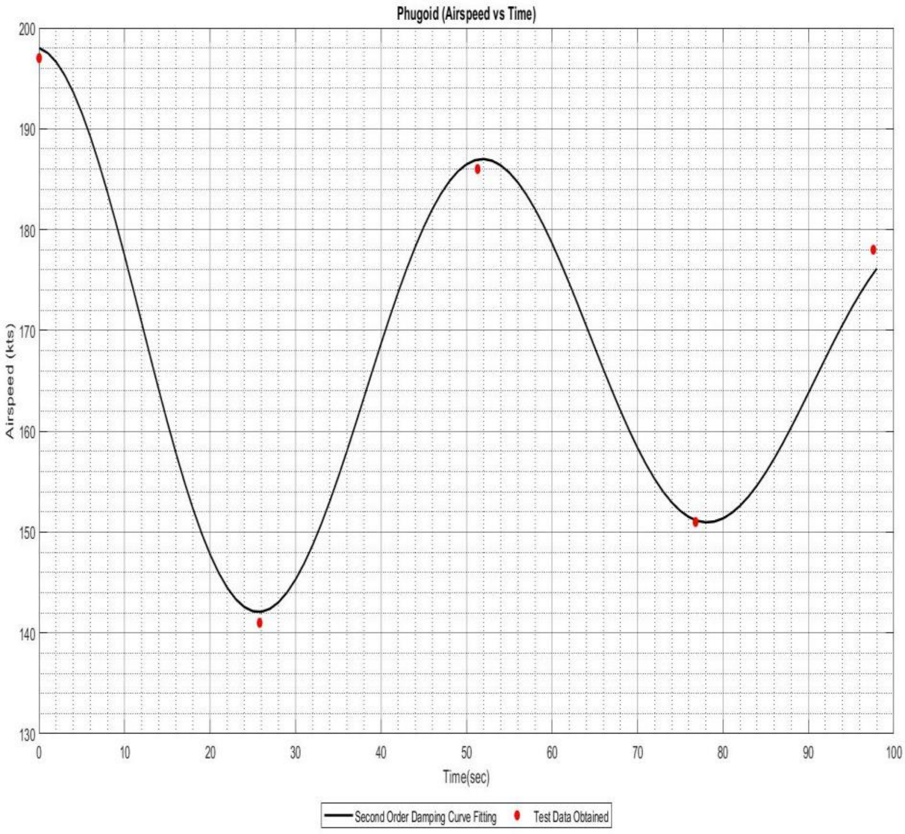
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	22th July 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	120 KIAS
WEIGHT	6563 lbs	**ALTITUDE**	7180 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Bank Angle: ±2º
ENGINE SETTINGS (RPM/MAP)	L: 2520/25 & R: 2490/23.5	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS UP & LG UP	**FLIGHT TEST TECHNIQUE**	PHUGOID

Figure APPENDIX C.10 Phugoid airspeed vs time at 120 kias in cruise configuration



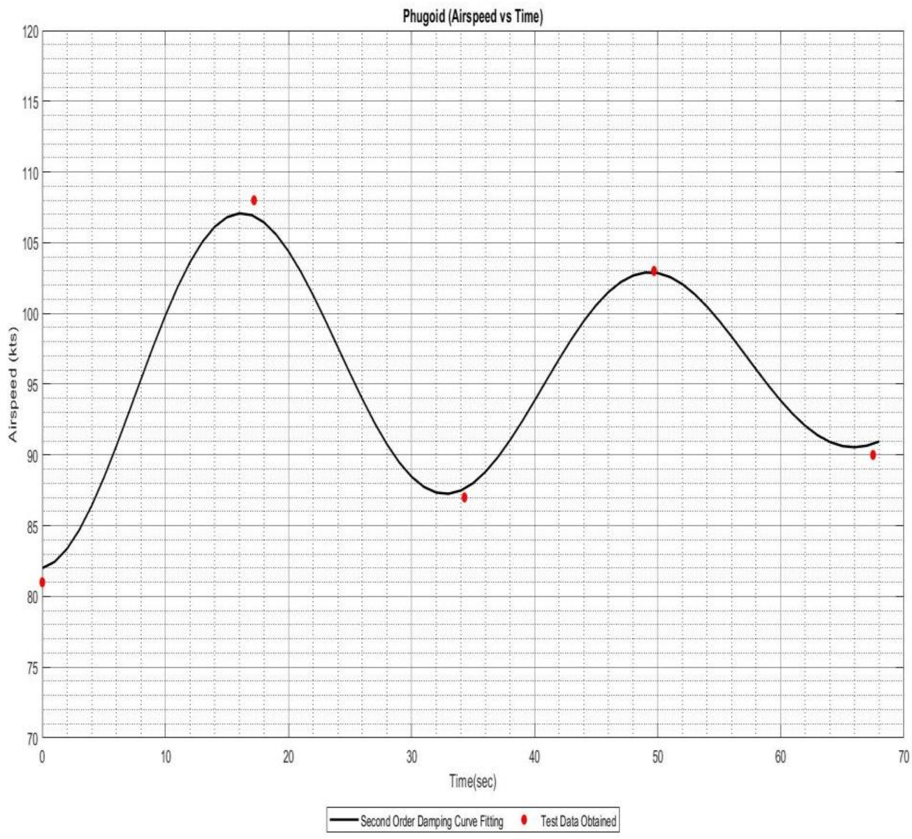
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	22th July 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	167 KIAS
WEIGHT	6317 lbs	**ALTITUDE**	7060 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Bank Angle: ±2º
ENGINE SETTINGS (RPM/MAP)	L: 2530/33.4 & R: 2520/33.3	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS UP & LG UP	**FLIGHT TEST TECHNIQUE**	PHUGOID

Figure APPENDIX C.11 Phugoid airspeed vs time at 167 kias in cruise configuration



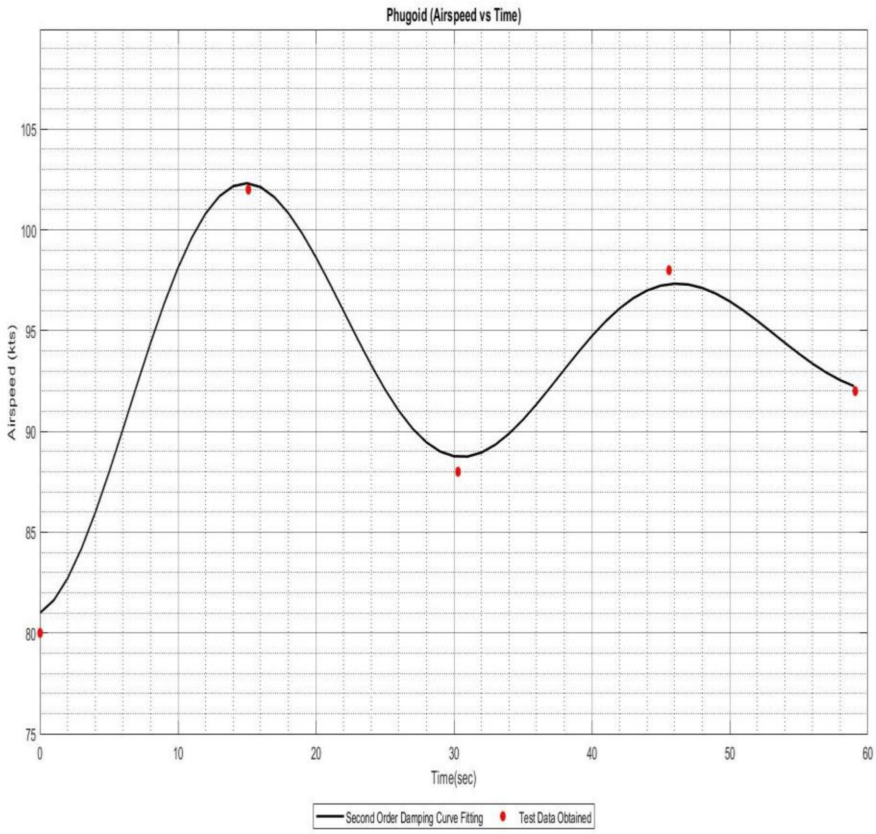
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	22th July 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	96 KIAS
WEIGHT	6257 lbs	**ALTITUDE**	8660 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Bank Angle: ±2º
ENGINE SETTINGS (RPM/MAP)	L: 2750/16.9 & R: 2760/15.7	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS 30 & LG DOWN	**FLIGHT TEST TECHNIQUE**	PHUGOID

Figure APPENDIX C.12 Phugoid airspeed vs time at 96 kias in landing configuration with 3º approach power



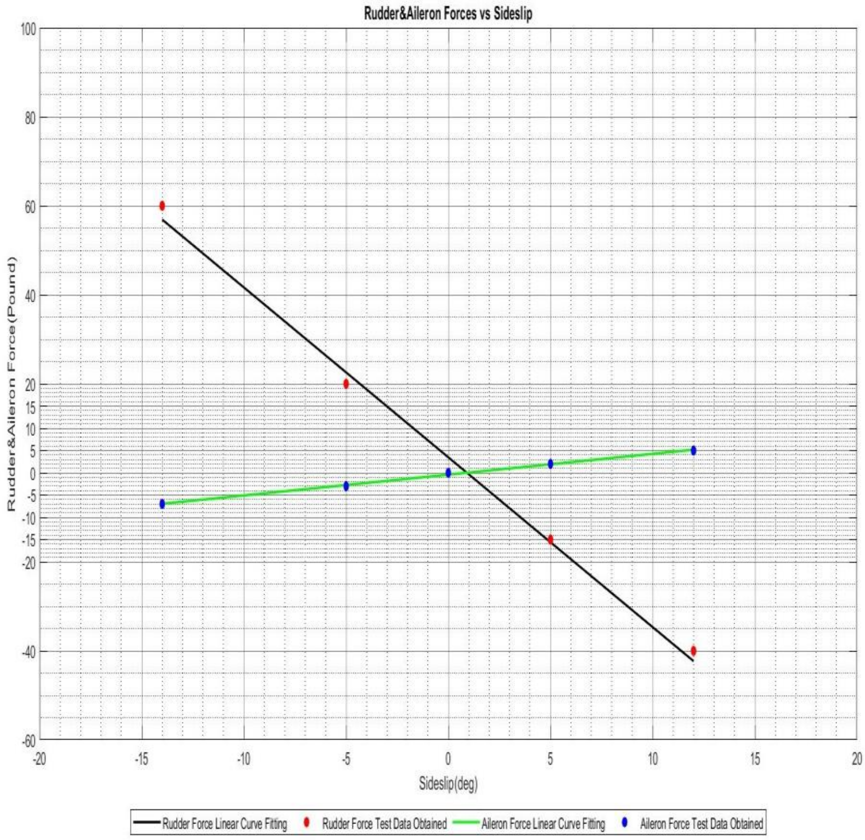
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	12th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	94 KIAS
WEIGHT	6569 lbs	**ALTITUDE**	8200 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Bank Angle: ±2º
ENGINE SETTINGS (RPM/MAP)	L: 2740/7.4 & R: 2760/7.4	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS 30 & LG DOWN	**FLIGHT TEST TECHNIQUE**	PHUGOID

Figure APPENDIX C.13 Phugoid airspeed vs time at 94 kias in landing configuration with idle power



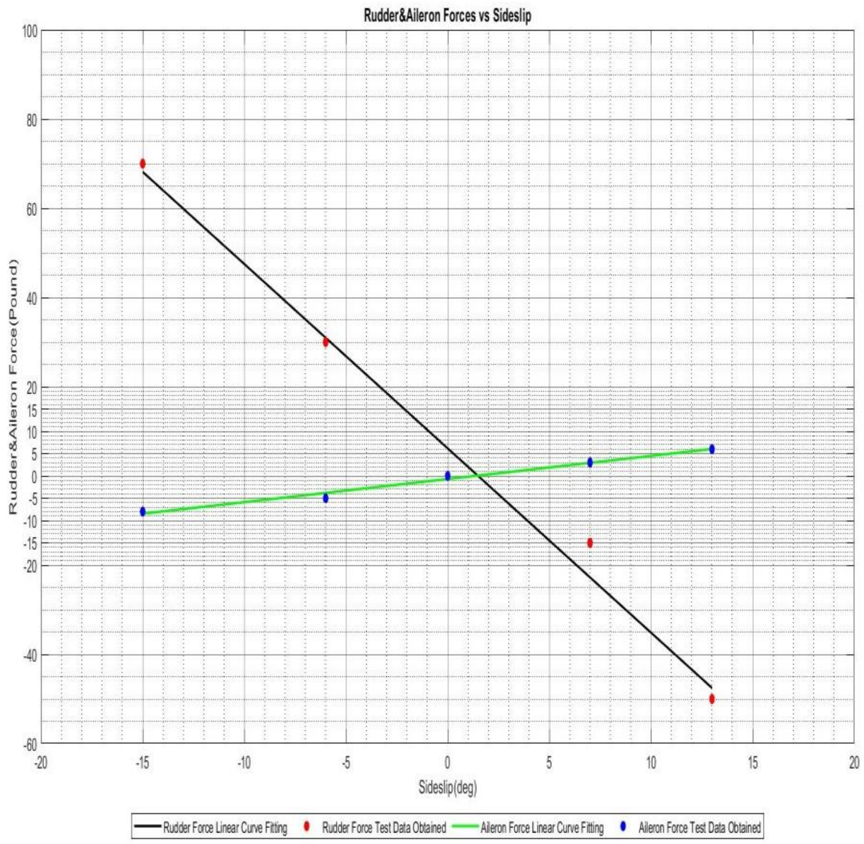
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	12th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	96 KIAS
WEIGHT	6497 lbs	**ALTITUDE**	8120 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Altitude: ±200 ft & Airspeed: ±2 kts & Φ: ±2°
ENGINE SETTINGS (RPM/MAP)	L: 2520/18 & R: 2510/18.1	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS UP & LG UP	**FLIGHT TEST TECHNIQUE**	WLSS

Figure APPENDIX C.14 WLSS rudder & aileron forces vs sideslip at 96 kias in cruise configuration without yaw damper



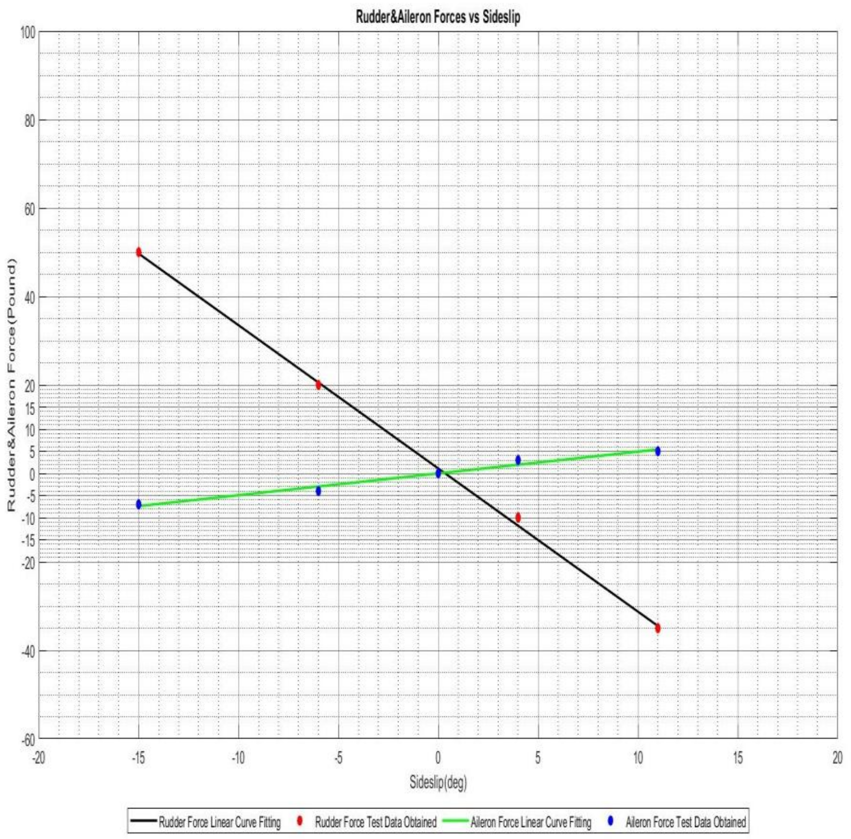
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	12th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	150 KIAS
WEIGHT	6485 lbs	**ALTITUDE**	7400 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Altitude: ±200 ft & Airspeed: ±2 kts & Φ: ±2º
ENGINE SETTINGS (RPM/MAP)	L: 2510/27.2 & R: 2490/28.3	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS UP & LG UP	**FLIGHT TEST TECHNIQUE**	WLSS

Figure APPENDIX C.15 WLSS rudder & aileron forces vs sideslip at 150 kias in cruise configuration without yaw damper



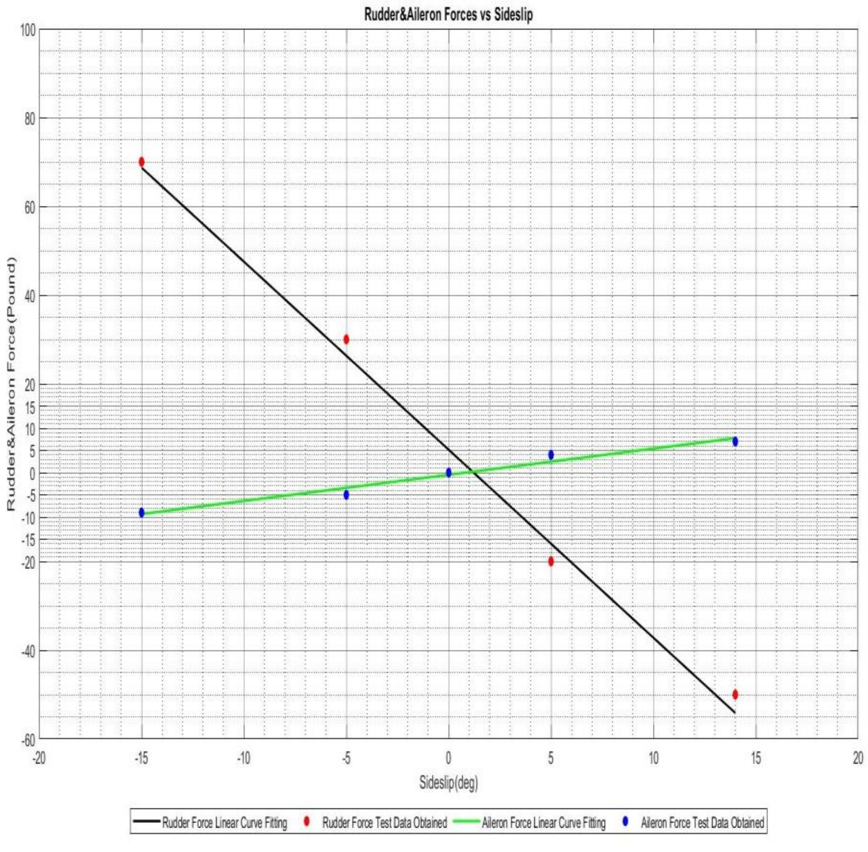
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	12th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	95 KIAS
WEIGHT	6413 lbs	**ALTITUDE**	6060 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Altitude: ±200 ft & Airspeed: ±2 kts & Φ: ±2º
ENGINE SETTINGS (RPM/MAP)	L: 2720/23.1 & R: 2730/23.5	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS UP & LG DOWN	**FLIGHT TEST TECHNIQUE**	WLSS

Figure APPENDIX C.16 WLSS rudder & aileron forces vs sideslip at 95 kias in takeoff configuration without yaw damper



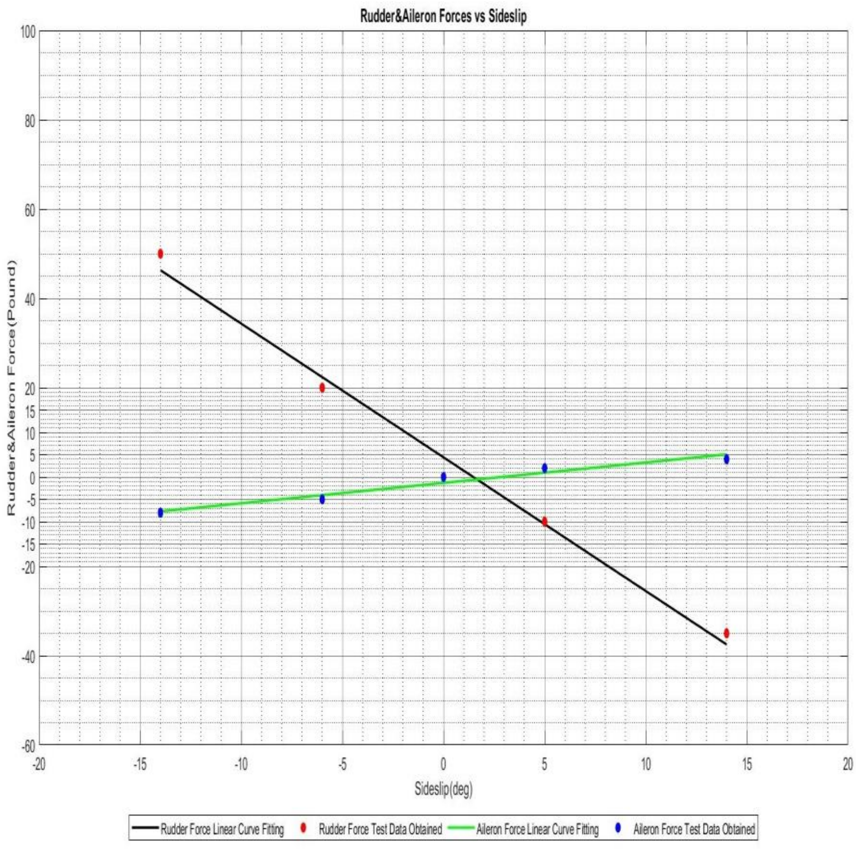
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	12th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	141 KIAS
WEIGHT	6461 lbs	**ALTITUDE**	6700 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Altitude: ±200 ft & Airspeed: ±2 kts & Φ: ±2º
ENGINE SETTINGS (RPM/MAP)	L: 2740/36.5 & R: 2750/36.5	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS UP & LG DOWN	**FLIGHT TEST TECHNIQUE**	WLSS

Figure APPENDIX C.17 WLSS rudder & aileron forces vs sideslip at 141 kias in takeoff configuration without yaw damper



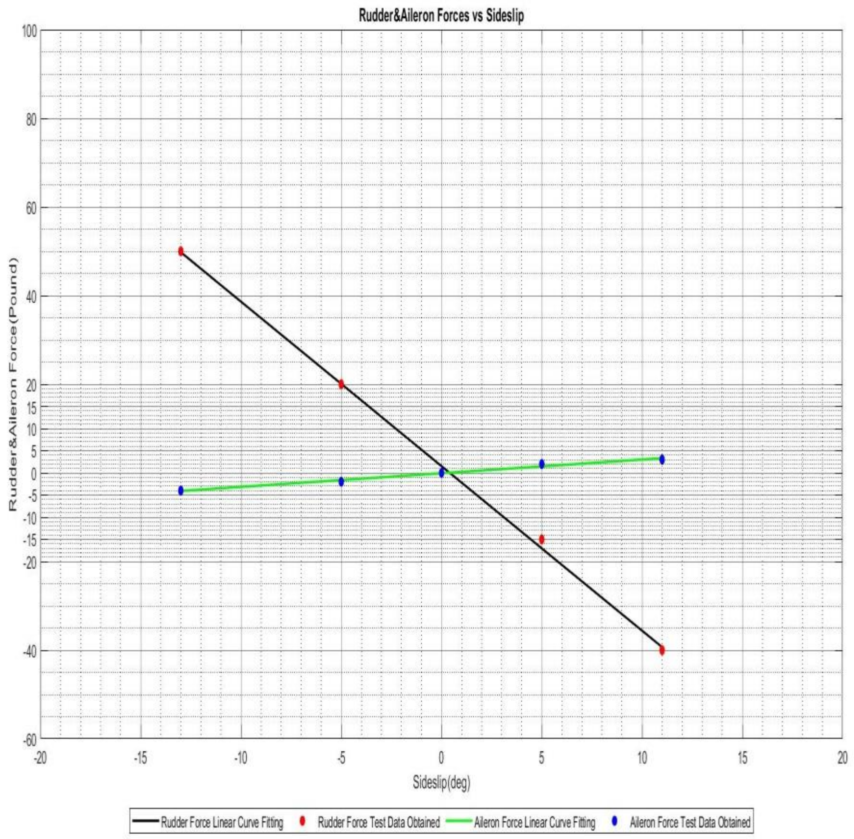
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	12th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	86 KIAS
WEIGHT	6425 lbs	**ALTITUDE**	6820 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Altitude: ±200 ft & Airspeed: ±2 kts & Φ: ±2º
ENGINE SETTINGS (RPM/MAP)	L: 2740/22.9 & R: 2750/23.4	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS 30 & LG DOWN	**FLIGHT TEST TECHNIQUE**	WLSS

Figure APPENDIX C.18 WLSS rudder & aileron forces vs sideslip at 86 kias in landing configuration without yaw damper



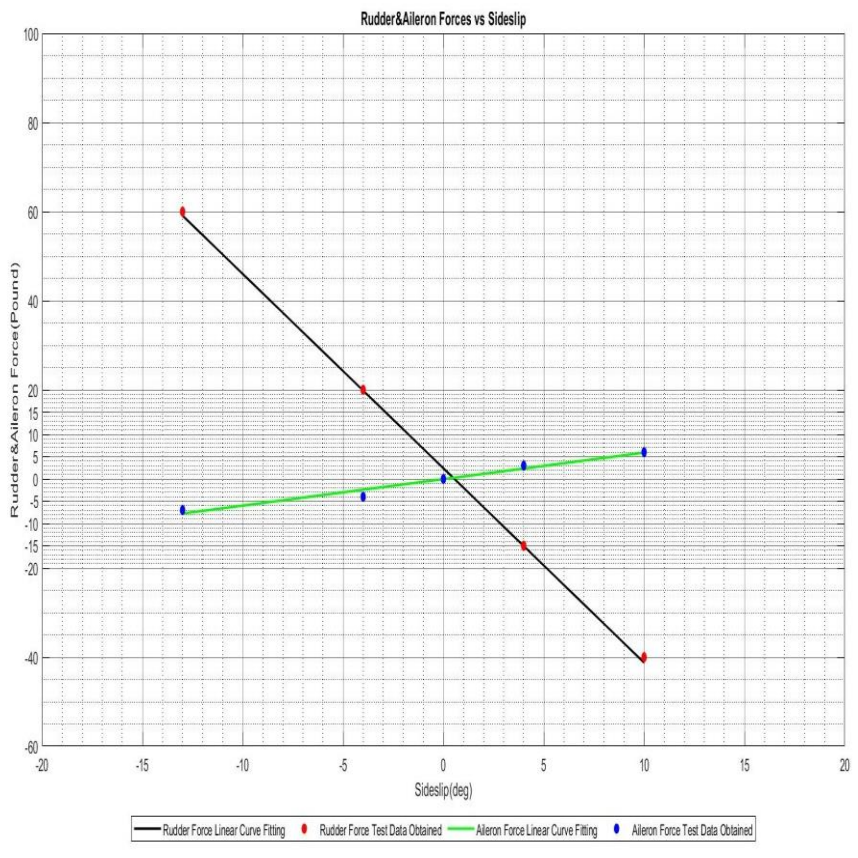
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	12th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	120 KIAS
WEIGHT	6437 lbs	**ALTITUDE**	7400 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Altitude: ±200 ft & Airspeed: ±2 kts & Φ: ±2º
ENGINE SETTINGS (RPM/MAP)	L: 2730/36.5 & R: 2750/36.5	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS 30 & LG DOWN	**FLIGHT TEST TECHNIQUE**	WLSS

Figure APPENDIX C.19 WLSS rudder & aileron forces vs sideslip at 120 kias in landing configuration without yaw damper



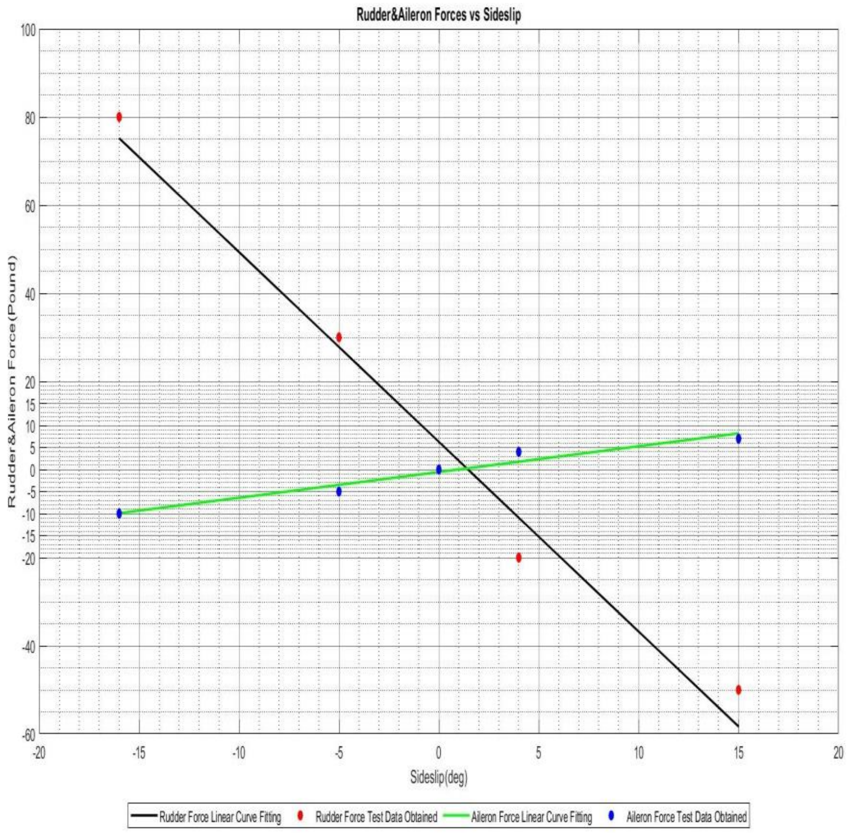
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	19th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	96 KIAS
WEIGHT	6677 lbs	**ALTITUDE**	7280 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Altitude: ±200 ft & Airspeed: ±2 kts & Φ: ±2º
ENGINE SETTINGS (RPM/MAP)	L: 2520/18.2 & R: 2530/19.1	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS UP & LG UP	**FLIGHT TEST TECHNIQUE**	WLSS

Figure APPENDIX C.20 WLSS rudder & aileron forces vs sideslip at 96 kias in cruise configuration with yaw damper



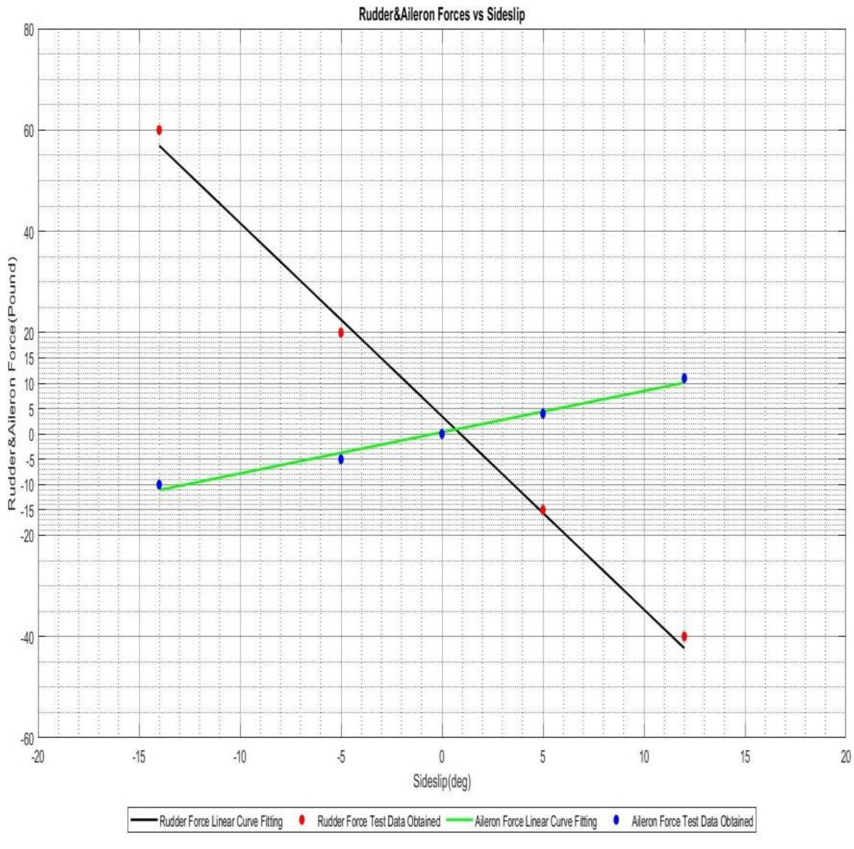
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	19th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	148 KIAS
WEIGHT	6617 lbs	**ALTITUDE**	7400 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Altitude: ±200 ft & Airspeed: ±2 kts & Φ: ±2º
ENGINE SETTINGS (RPM/MAP)	L: 2510/28.3 & R: 2520/27.7	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS UP & LG UP	**FLIGHT TEST TECHNIQUE**	WLSS

Figure APPENDIX C.21 WLSS rudder & aileron forces vs sideslip at 148 kias in cruise configuration with yaw damper



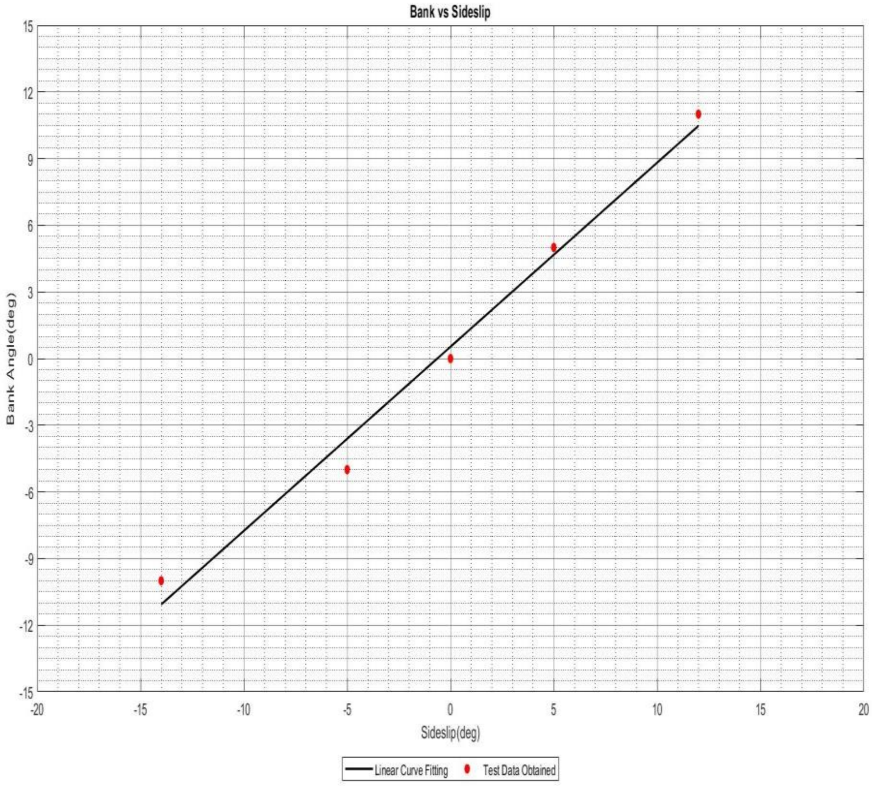
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	12th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	106 KIAS
WEIGHT	6383 lbs	**ALTITUDE**	5840 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Altitude: ±200 ft & Airspeed: ±2 kts
ENGINE SETTINGS (RPM/MAP)	L: 2510/21.2 & R: 2500/21.3	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS UP & LG UP	**FLIGHT TEST TECHNIQUE**	SHSS

Figure APPENDIX C.22 SHSS rudder & aileron forces vs sideslip at 106 kias in cruise configuration without yaw damper



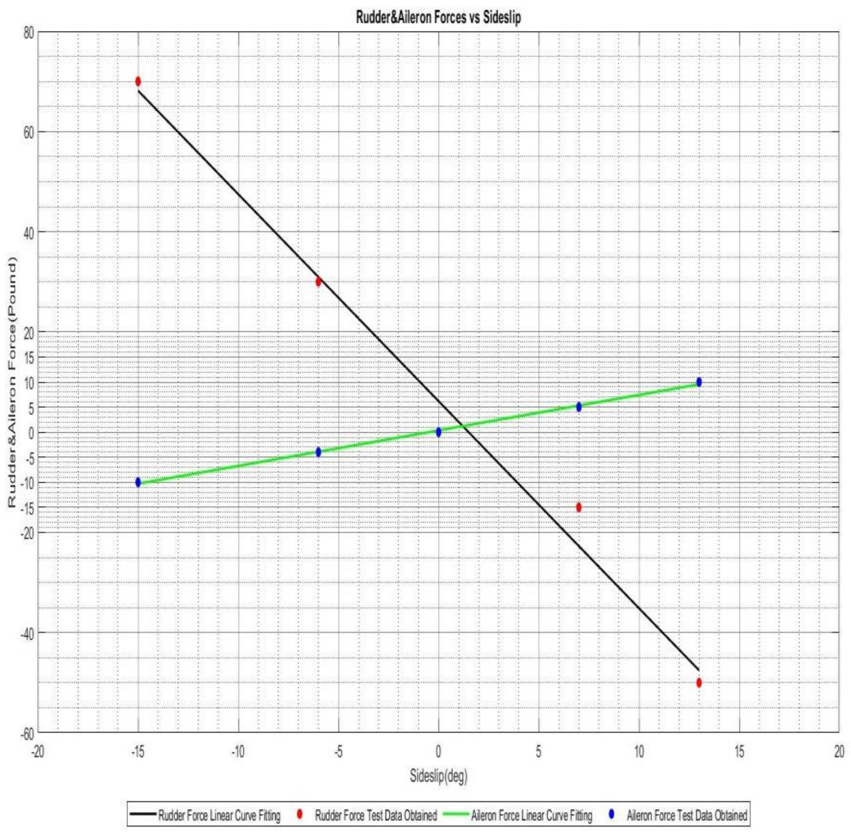
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	12th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	106 KIAS
WEIGHT	6383 lbs	**ALTITUDE**	5840 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Altitude: ±200 ft & Airspeed: ±2 kts
ENGINE SETTINGS (RPM/MAP)	L: 2510/21.2 & R: 2500/21.3	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS UP & LG UP	**FLIGHT TEST TECHNIQUE**	SHSS

Figure APPENDIX C.23 SHSS bank angle vs sideslip at 106 kias in cruise configuration without yaw damper



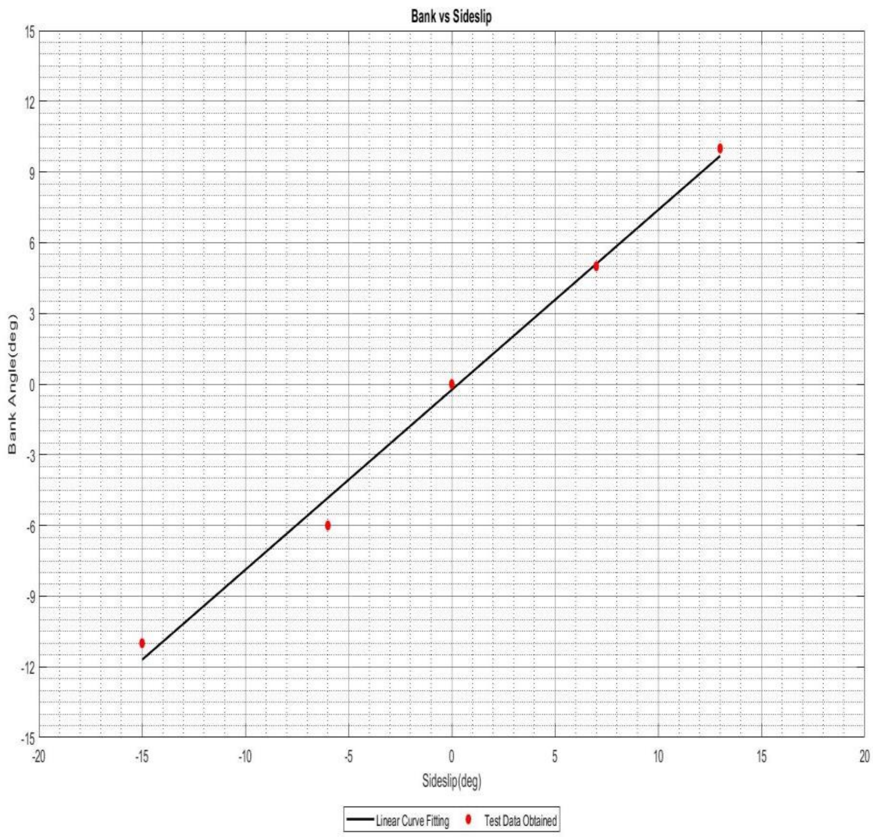
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	12^{th} August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	155 KIAS
WEIGHT	6371 lbs	**ALTITUDE**	5900 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Altitude: ±200 ft & Airspeed: ±2 kts
ENGINE SETTINGS (RPM/MAP)	L: 2490/30.0 & R: 2510/30.0	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS UP & LG UP	**FLIGHT TEST TECHNIQUE**	SHSS

Figure APPENDIX C.24 SHSS rudder & aileron forces vs sideslip at 155 kias in cruise configuration without yaw damper



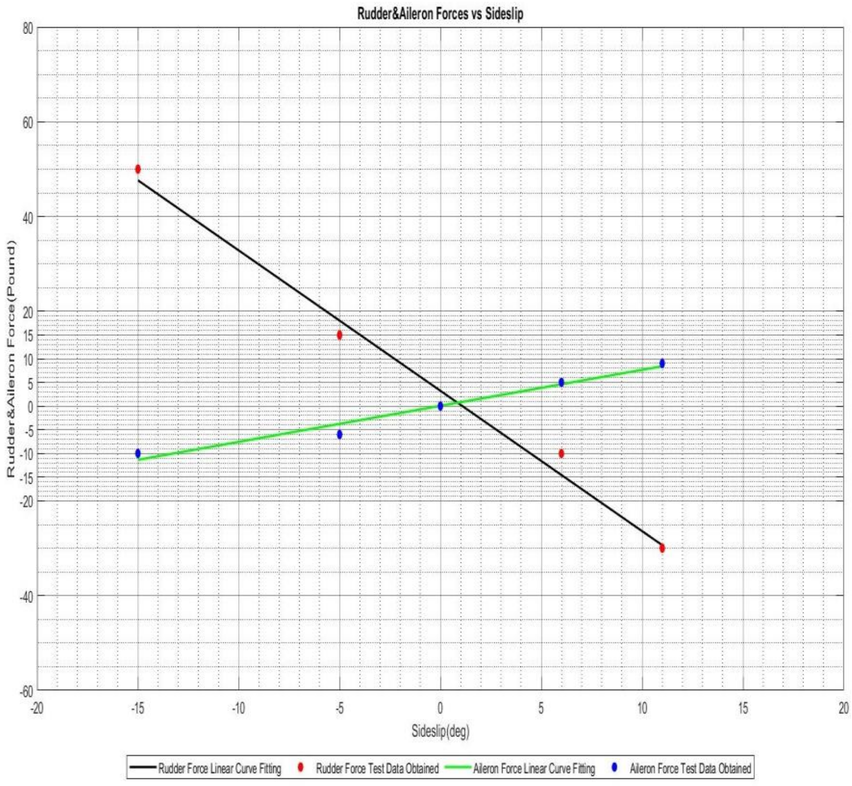
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	12th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	155 KIAS
WEIGHT	6371 lbs	**ALTITUDE**	5900 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Altitude: ±200 ft & Airspeed: ±2 kts
ENGINE SETTINGS (RPM/MAP)	L: 2490/30.0 & R: 2510/30.0	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS UP & LG UP	**FLIGHT TEST TECHNIQUE**	SHSS

Figure APPENDIX C.25 SHSS bank angle vs sideslip at 155 kias in cruise configuration without yaw damper



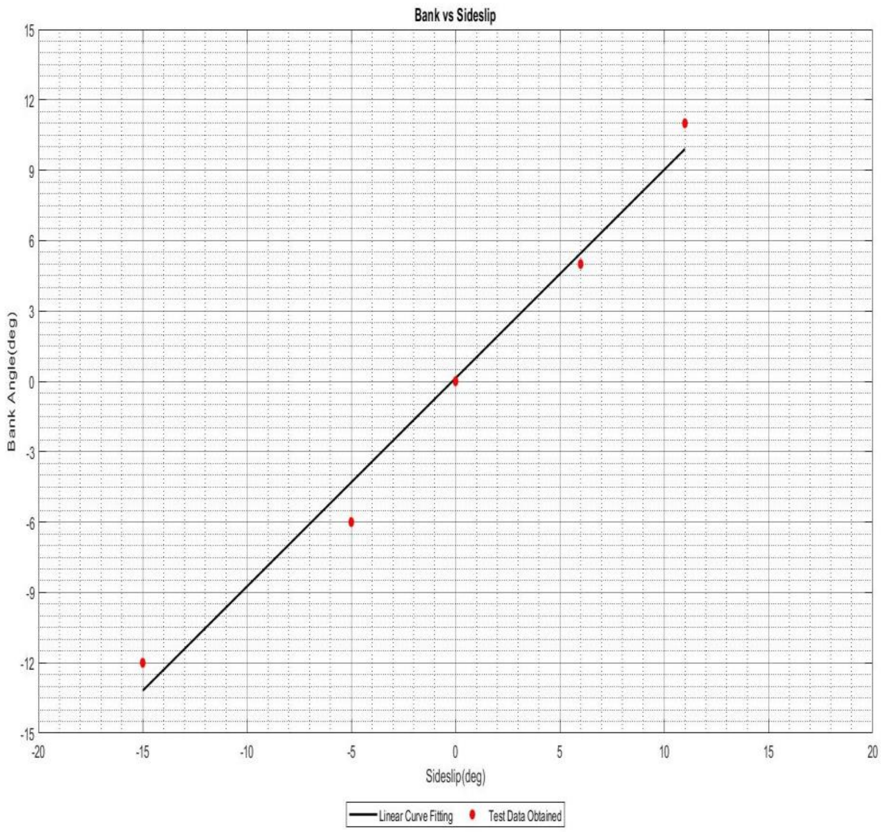
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	12th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	96 KIAS
WEIGHT	6401 lbs	**ALTITUDE**	5800 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Altitude: ±200 ft & Airspeed: ±2 kts
ENGINE SETTINGS (RPM/MAP)	L: 2730/23.2 & R: 2750/23.4	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS UP & LG DOWN	**FLIGHT TEST TECHNIQUE**	SHSS

Figure APPENDIX C.26 SHSS rudder & aileron forces vs sideslip at 96 kias in takeoff configuration without yaw damper



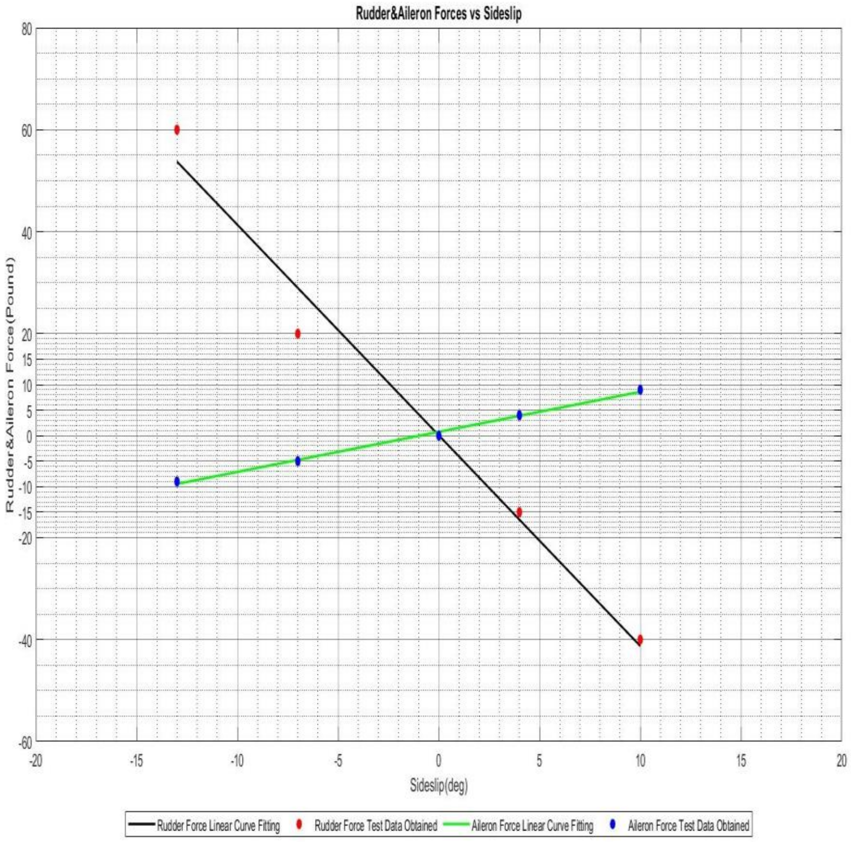
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	12th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	96 KIAS
WEIGHT	6401 lbs	**ALTITUDE**	5800 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Altitude: ±200 ft & Airspeed: ±2 kts
ENGINE SETTINGS (RPM/MAP)	L: 2730/23.2 & R: 2750/23.4	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS UP & LG DOWN	**FLIGHT TEST TECHNIQUE**	SHSS

Figure APPENDIX C.27 SHSS bank angle vs sideslip at 96 kias in takeoff configuration without yaw damper



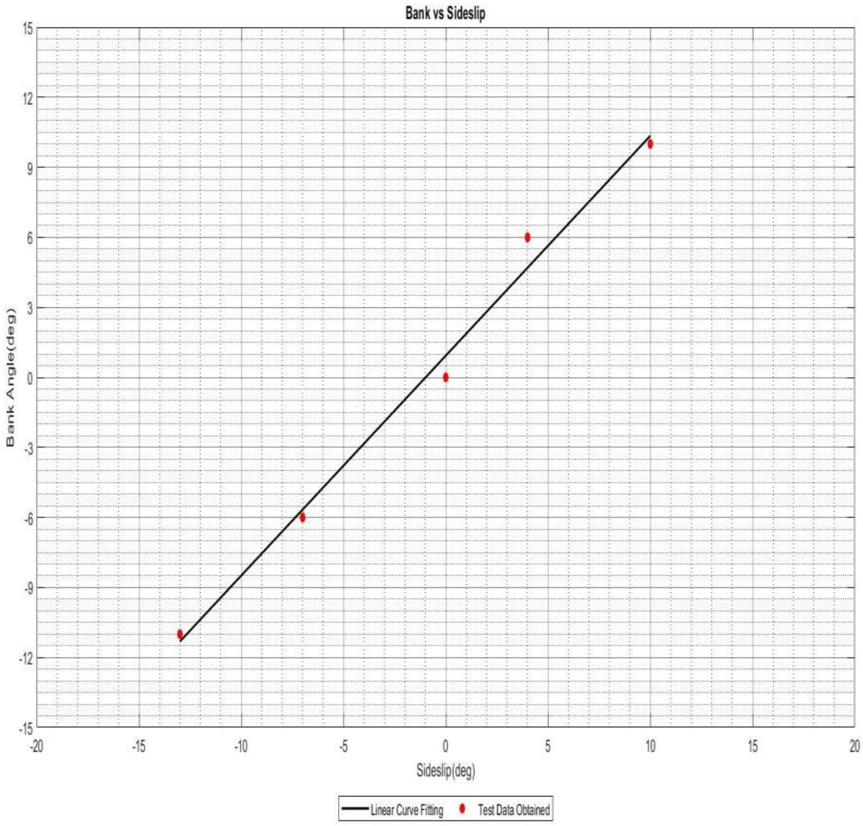
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	12th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	123 KIAS
WEIGHT	6347 lbs	**ALTITUDE**	6300 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Altitude: ±200 ft & Airspeed: ±2 kts
ENGINE SETTINGS (RPM/MAP)	L: 2490/30.0 & R: 2510/30.0	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS UP & LG DOWN	**FLIGHT TEST TECHNIQUE**	SHSS

Figure APPENDIX C.28 SHSS rudder & aileron forces vs sideslip at 123 kias in takeoff configuration without yaw damper



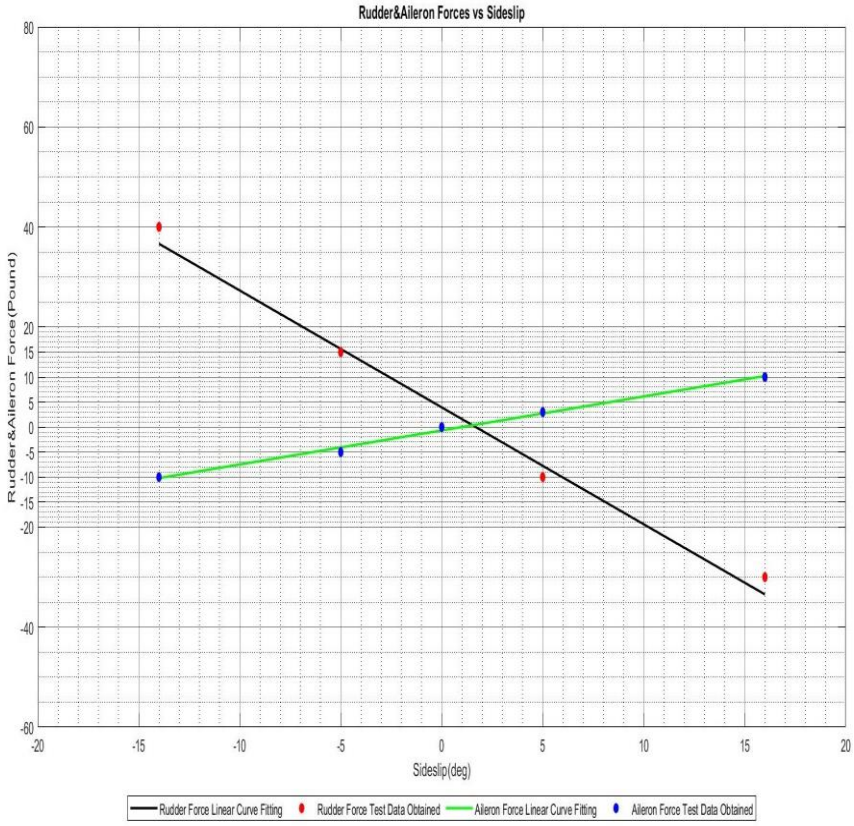
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	12th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	123 KIAS
WEIGHT	6347 lbs	**ALTITUDE**	6300 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Altitude: ±200 ft & Airspeed: ±2 kts
ENGINE SETTINGS (RPM/MAP)	L: 2490/30.0 & R: 2510/30.0	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS UP & LG DOWN	**FLIGHT TEST TECHNIQUE**	SHSS

Figure APPENDIX C.29 SHSS bank angle vs sideslip at 123 kias in takeoff configuration without yaw damper



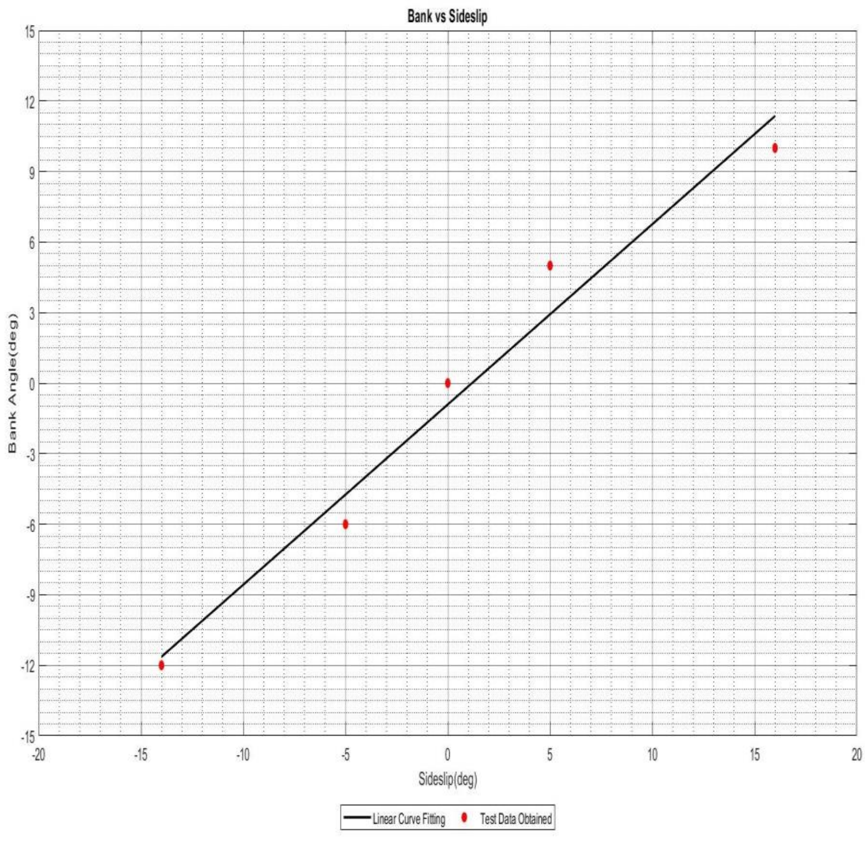
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	12th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	92 KIAS
WEIGHT	6293 lbs	**ALTITUDE**	7600 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Altitude: ±200 ft & Airspeed: ±2 kts
ENGINE SETTINGS (RPM/MAP)	L: 2730/18.2 & R: 2750/18.1	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS 30 & LG DOWN	**FLIGHT TEST TECHNIQUE**	SHSS

Figure APPENDIX C.30 SHSS rudder & aileron forces vs sideslip at 92 kias in landing configuration without yaw damper



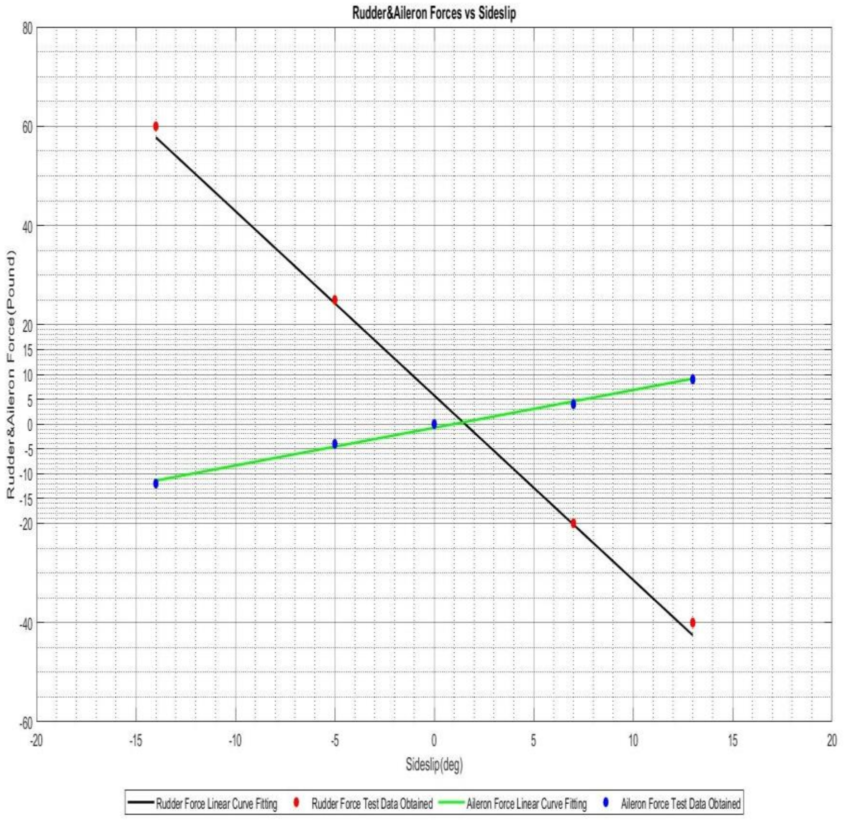
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	12th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	92 KIAS
WEIGHT	6293 lbs	**ALTITUDE**	7600 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Altitude: ±200 ft & Airspeed: ±2 kts
ENGINE SETTINGS (RPM/MAP)	L: 2730/18.2 & R: 2750/18.1	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS 30 & LG DOWN	**FLIGHT TEST TECHNIQUE**	SHSS

Figure APPENDIX C.31 SHSS bank angle vs sideslip at 92 kias in landing configuration without yaw damper



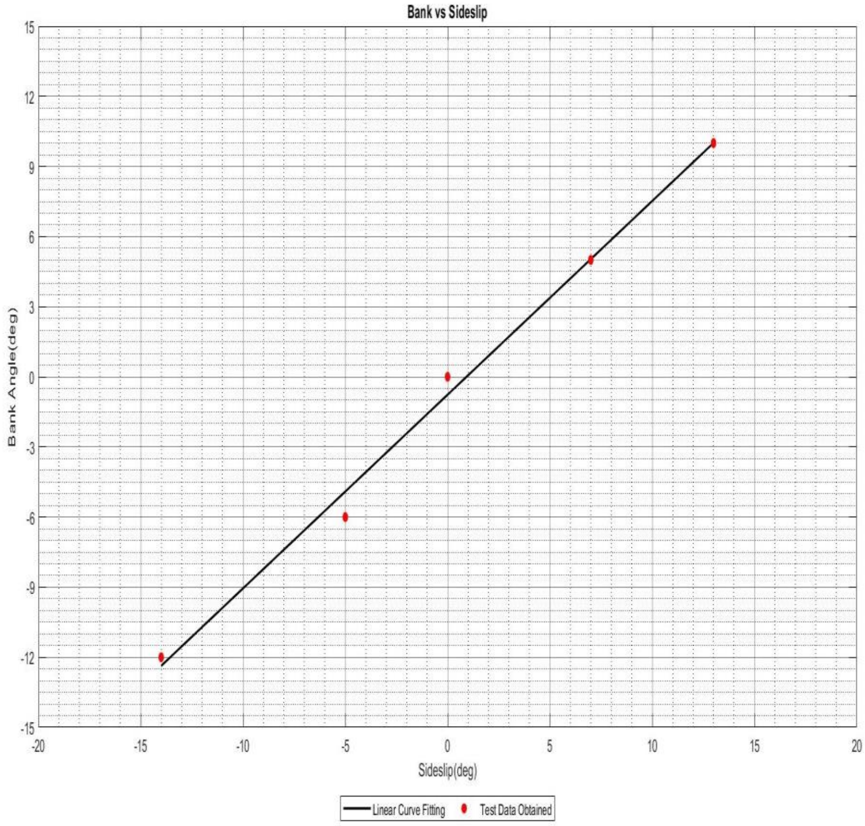
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	12th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	127 KIAS
WEIGHT	6305 lbs	**ALTITUDE**	7800 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Altitude: ±200 ft & Airspeed: ±2 kts
ENGINE SETTINGS (RPM/MAP)	L: 2740/31.2 & R: 2750/31.1	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS 30 & LG DOWN	**FLIGHT TEST TECHNIQUE**	SHSS

Figure APPENDIX C.32 SHSS rudder & aileron forces vs sideslip at 127 kias in landing configuration without yaw damper



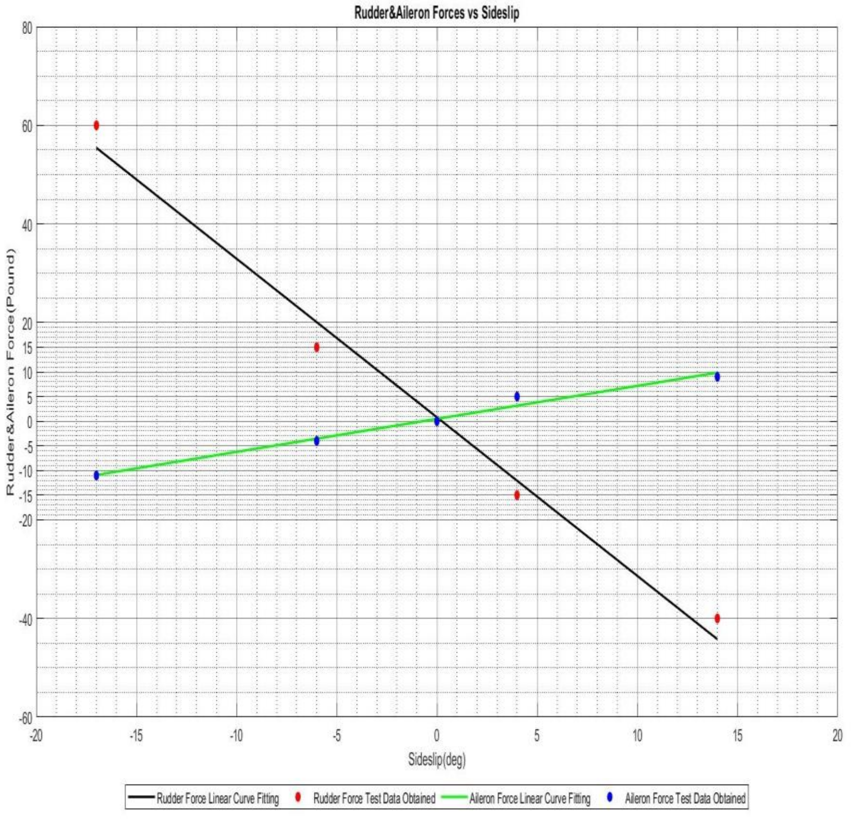
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	12th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	127 KIAS
WEIGHT	6305 lbs	**ALTITUDE**	7800 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Altitude: ±200 ft & Airspeed: ±2 kts
ENGINE SETTINGS (RPM/MAP)	L: 2740/31.2 & R: 2750/31.1	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS 30 & LG DOWN	**FLIGHT TEST TECHNIQUE**	SHSS

Figure APPENDIX C.33 SHSS bank angle vs sideslip at 127 kias in landing configuration without yaw damper



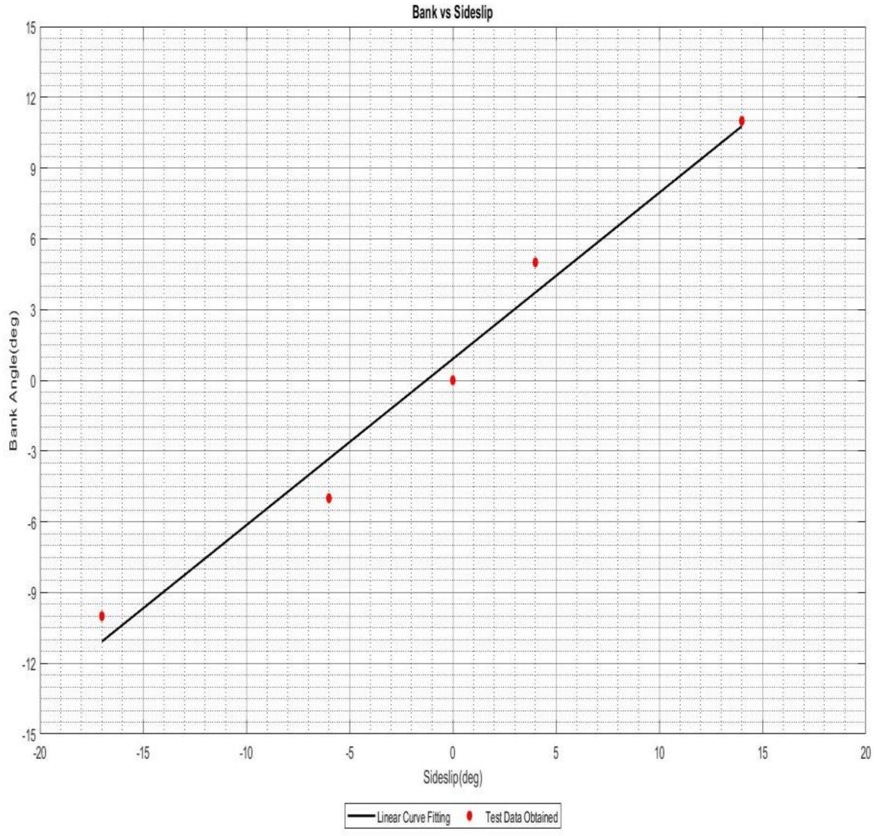
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	19th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	105 KIAS
WEIGHT	6521 lbs	**ALTITUDE**	6900 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Altitude: ±200 ft & Airspeed: ±2 kts
ENGINE SETTINGS (RPM/MAP)	L: 2520/19.3 & R: 2530/19.6	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS UP & LG UP	**FLIGHT TEST TECHNIQUE**	SHSS

Figure APPENDIX C.34 SHSS rudder & aileron forces vs sideslip at 105 kias in cruise configuration with yaw damper



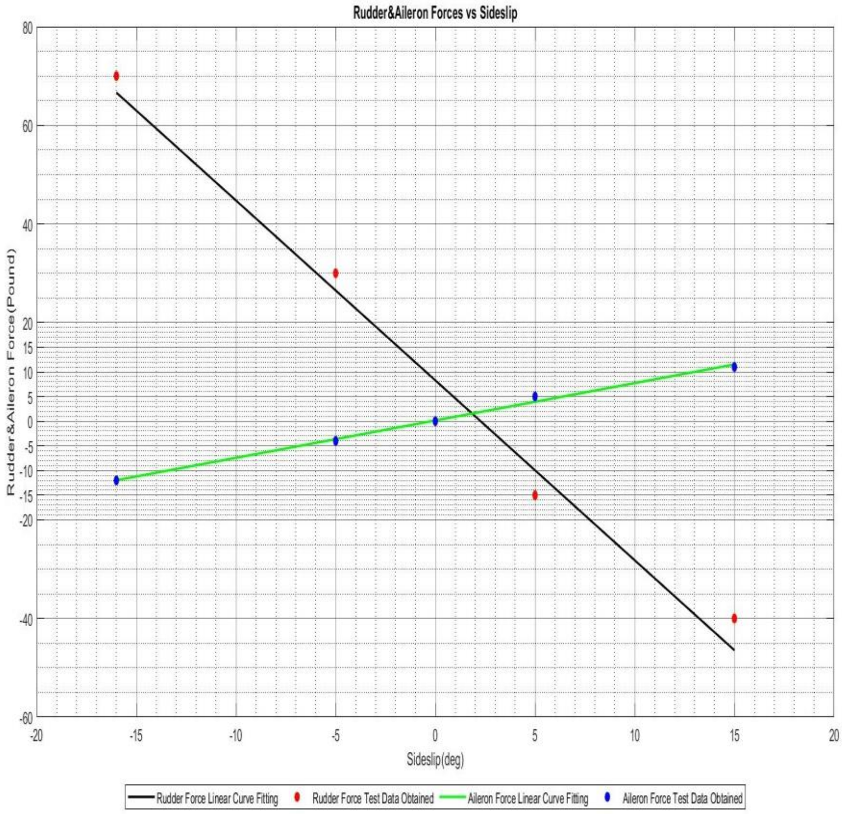
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	19th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	105 KIAS
WEIGHT	6521 lbs	**ALTITUDE**	6900 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Altitude: ±200 ft & Airspeed: ±2 kts
ENGINE SETTINGS (RPM/MAP)	L: 2520/19.3 & R: 2530/19.6	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS UP & LG UP	**FLIGHT TEST TECHNIQUE**	SHSS

Figure APPENDIX C.35 SHSS bank angle vs sideslip at 105 kias in cruise configuration with yaw damper



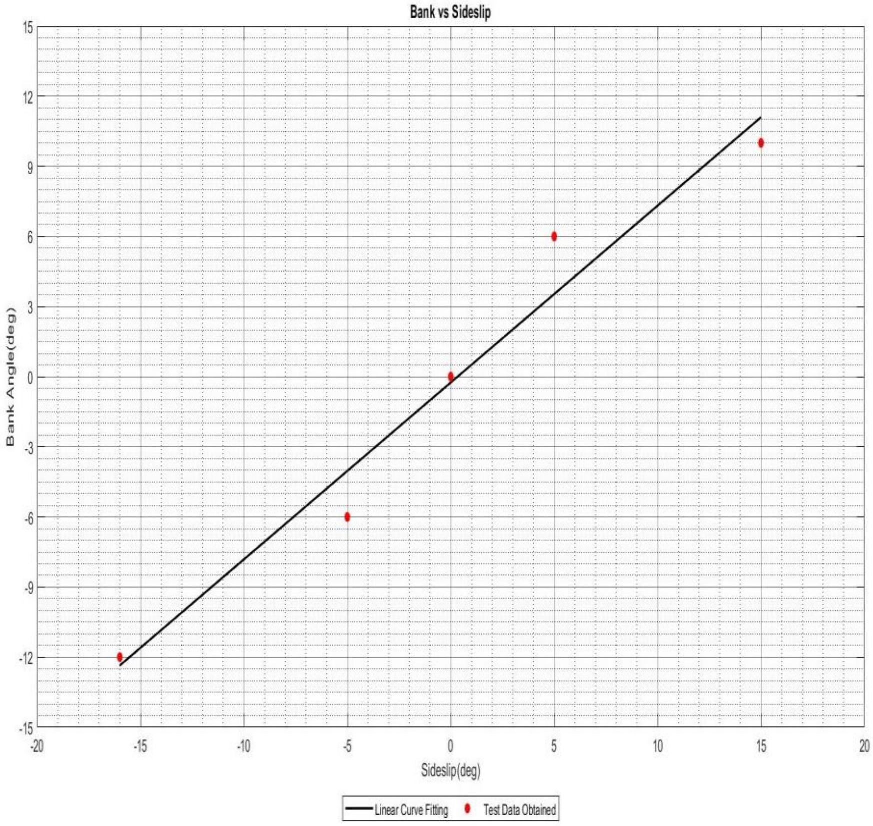
COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	19th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	148 KIAS
WEIGHT	6497 lbs	**ALTITUDE**	6900 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Altitude: ±200 ft & Airspeed: ±2 kts
ENGINE SETTINGS (RPM/MAP)	L: 2510/30.0 & R: 2530/30.0	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS UP & LG UP	**FLIGHT TEST TECHNIQUE**	SHSS

Figure APPENDIX C.36 SHSS rudder & aileron forces vs sideslip at 148 kias in cruise configuration with yaw damper



COMMON DATA			
AIRCRAFT	B60 DUKE	**DATE OF TEST**	19th August 2022
TAIL NUMBER	C-FYWQ	**AIRSPEED**	148 KIAS
WEIGHT	6497 lbs	**ALTITUDE**	6900 ft MSL (local QNH was used)
C.G	29.0%	**DATA TOLERANCE**	Altitude: ±200 ft & Airspeed: ±2 kts
ENGINE SETTINGS (RPM/MAP)	L: 2510/30.0 & R: 2530/30.0	**TEST CREW**	TP: HAL – FTE:BAT&HAS
AIRCRAFT CONFIGURATION	FLAPS UP & LG UP	**FLIGHT TEST TECHNIQUE**	SHSS

Figure APPENDIX C.37 SHSS bank angle vs sideslip at 148 kias in cruise configuration with yaw damper



APPENDIX D SPECIFICATION COMPLIANCE

Table D.1. Specification Compliance

LONGITUDINAL STATIC STABILITY			
Paragraph	**Title**	**Description**	**Compliance**
CS 23.173(a)	Static longitudinal stability	A pull must be required to obtain and maintain speeds below the specified trim speed and a push required to obtain and maintain speeds above the specified trim speed. This must be shown at any speed that can be obtained, except that speeds requiring a control force in excess of 178 N (40 lbf) or speeds above the maximum allowable speed or below the minimum speed for steady unstalled flight, need not be considered.	MET
CS 23.173(b)(1)		The airspeed must return to within the tolerances specified when the control force is slowly released at any speed within the speed range specified in sub-paragraph (a). The applicable tolerances are – For all aeroplanes, plus or minus 10% of the original trim airspeed;	MET
CS 23.173(b)(2)		The airspeed must return to within the tolerances specified when the control force is slowly released at any speed within the speed range specified in sub-paragraph (a). The applicable tolerances are – For commuter category aeroplanes, plus or minus 7.5% of the original trim airspeed for the cruising conditions specified in CS 23.175(b).	MET
CS 23.173(c)		The stick force must vary with speed so that any substantial speed change results in a stick force clearly perceptible to the pilot.	MET
CS 23.175(a)	Demonstration of static longitudinal stability	(a) Climb. The stick force curve must have a stable slope, at speeds between 85% and 115% of the trim speed, with – (1) Flaps retracted; (2) Landing gear retracted; (3) Maximum continuous power; and (4) The aeroplane trimmed at the speed used in determining the climb performance required by CS 23.69 (a).	MET
CS 23.175(b)		Cruise. With flaps and landing gear retracted and the aeroplane in trim with power for level flight at representative cruising speeds at high and low altitudes, including speeds up to VNO or VMO/MMO as appropriate, except that the speed need not exceed VH – (2) For commuter category aeroplanes, the stick force curve must have a stable slope at all speeds within a range of 93 km/h (50 knots) plus the resulting free return speed range, above and below the trim speed, except that the slope need not be stable – (i) At speeds less than 1.4 VSI; or (ii) At speeds greater than VFC/MFC; or (iii) At speeds that require a stick force greater than 222 N (50 lbf).	MET
CS 23.175(c)		Landing. The stick force curve must have a stable slope at speeds between 1·1 VS1 and 1·8 VS1 with – (1) Flaps in the landing position; (2) Landing gear extended; and (3) The aeroplane trimmed at – (i) VREF, or the minimum trim speed if higher, with power off; and (ii) VREF with enough power	MET

<table>
<tr><th colspan="4">LONGITUDINAL MANEUVER STABILITY</th></tr>
<tr><th>Paragraph</th><th>Title</th><th>Description</th><th>Compliance</th></tr>
<tr><td>CS 23.155(a)(1)</td><td rowspan="4">Elevator control force in manoeuvres</td><td>The elevator control force needed to achieve the positive limit manoeuvring load factor may not be less than –
(1) For wheel controls, W/10N (where W is the maximum weight in kg) (W/100 lbf (where W is the maximum weight in lb)) or 89 N (20 lbf), whichever is greater, except that it need not be greater than 222 N (50 lbf);</td><td>NOT TESTED</td></tr>
<tr><td>CS 23.155(b)(1)</td><td>The requirement of sub-paragraph (a) must be met with wing flaps and landing gear retracted under each of the following conditions –
(1) At 75% of maximum continuous power for reciprocating engines or maximum continuous power for turbine engines.</td><td>NOT TESTED</td></tr>
<tr><td>CS 23.155(b)(2)</td><td>The requirement of sub-paragraph (a) must be met with wing flaps and landing gear retracted under each of the following conditions –
(2) In a turn, after the aeroplane is trimmed with wings level, at the minimum speed at which the required normal acceleration can be achieved without stalling, and at the maximum level flight trim speed except that the speed may not exceed VNE or VMO/MMO, whichever is appropriate.</td><td>MET</td></tr>
<tr><td>CS 23.155(c)</td><td>There must be no excessive decrease in the gradient of the curve of stick force versus manoeuvring load factor with increasing load factor.</td><td>MET</td></tr>
<tr><td>MIL-F-8785C
3.2.2.2.1</td><td rowspan="2">Control Forces in Manoeuvring Flight</td><td>At constant speed in steady turning flight, pullups and pushovers, the variation in pitch controller force with steady state normal acceleration shall have no objectionable non-linearities within the following load factor ranges:
<table><tr><th>Class</th><th>Min.</th><th>Max.</th></tr><tr><td>I, II, & III
IV</td><td>.5
0</td><td>.5 [$n_o(+) + 1$] or 3
whichever is less</td></tr></table>
Outside this range, a departure from linearity resulting in a local gradient which differs from the average gradient for the manoeuvre by more than 50 percent is considered excessive, except those larger increases in force gradient are permissible at load factors greater than 0.85nL. All local force gradients shall be within the limits of table V. In addition, Fδ/nz should be near the Level 1 upper boundaries of Table V for combinations of high frequency and low damping. The term gradient does not include that portion of the force versus nZ curve within the breakout force.
Since the range of acceptable force gradients for side stick controllers varies within the control deflection gradient and the task to be performed, the contractor shall show that the control force gradients will produce suitable flying qualities.</td><td rowspan="2">LEVEL 1
MET</td></tr>
<tr><td>MIL-F-8785C
3.2.2.2.1
Table V</td><td>Wheel Controllers
<table><tr><th>Level</th><th>Maximum Gradient, $(F_s/n)_{max}$, pounds per g</th><th>Minimum Gradient $(F_s/n)_{min}$, pounds per g</th></tr><tr><td>1</td><td>$\frac{500}{n/\alpha}$
but not more than 120.0
nor less than $\frac{120}{n_L - 1}$</td><td>The higher of
$\frac{35}{n_L - 1}$
and 6.0</td></tr><tr><td>2</td><td>$\frac{775}{n/\alpha}$
but not more than 182.0
nor less than $\frac{182}{n_L - 1}$</td><td>The higher of
$\frac{18}{n_L - 1}$
and 3.0</td></tr><tr><td>3</td><td>240.0</td><td>5.0</td></tr></table></td></tr>
</table>

LONGITUDINAL DYNAMIC STABILITY			
Paragraph	**Title**	**Description**	**Compliance**
CS 23.181(a)	Dynamic stability	(a) Any short period oscillation not including combined lateral-directional oscillations occurring between the stalling speed and the maximum allowable speed appropriate to the configuration of the aeroplane must be heavily damped with the primary controls – (1) Free; and (2) In a fixed position, except when compliance with CS 23.672 is shown.	MET
CS 23.181(c)		Any long-period oscillation of the flight path (phugoid) must not be so unstable as to cause an unacceptable increase in pilot workload or otherwise endanger the aeroplane. When, in the conditions of CS 23.175, the longitudinal control force required to maintain speeds differing from the trimmed speed by at least plus or minus 15% is suddenly released, the response of the aeroplane must not exhibit any dangerous characteristics nor be excessive in relation to the magnitude of the control force released.	MET
MIL-F-8785C 3.2.1.2	Phugoid Stability	The long-period oscillations which occur when the airplane seeks a stabilized airspeed following a disturbance shall meet the following requirements: a. Level 1 ----- zp at least 0.04 b. Level 2 ----- zp at least 0 c. Level 3 ----- T2 at least 55 seconds These requirements apply with the pitch control free and also with it fixed. They need not be met transonically in cases where 3.2.1.1.1 permits relaxation of the static stability requirement.	LEVEL 1 MET

LATERAL DIRECTIONAL STATIC STABILITY			
Paragraph	**Title**	**Description**	**Compliance**
CS 23.177(a)	Static directional and lateral stability	The static directional stability, as shown by the tendency to recover from a wings level sideslip with the rudder free, must be positive for any landing gear and flap position appropriate to the take-off, climb, cruise, approach and landing configurations. This must be shown with symmetrical power up to maximum continuous power and at speeds from 1.2 VS1 up to maximum allowable speed for the condition being investigated. The angle of sideslip for these tests must be appropriate to the type of aeroplane. At larger angles of sideslip up to that at which full rudder is used or a control force limit in CS 23.143 is reached, whichever occurs first, and at speeds from 1.2 VS1 to Vo the rudder pedal force must not reverse.	MET
CS 23.177(b)		The static lateral stability, as shown by the tendency to raise the low wing in a sideslip, must be positive for all landing gear and flap positions. This must be shown with symmetrical power up to 75% of maximum continuous power at speeds above 1.2 VS1 in the take-off configuration(s) and at speeds above 1.3 VS1 in other configurations, up to the maximum allowable speed for the configuration being investigated, in the take-off, climb, cruise and approach configurations. For the landing configuration, the power must be up to that necessary to maintain a 3° angle of descent in co-ordinated flight. The static lateral stability must not be negative at 1.2 VS1 in the take-off configuration, or at 1.3 VS1 in other configurations. The angle of sideslip for these tests must be appropriate to the type of aeroplane but in no case may the constant heading sideslip angle be less than that obtainable with 10° bank, or if less, the maximum bank angle obtainable with full rudder deflection or 667 N (150 lbf) rudder force.	MET
CS 23.177(d)		In straight, steady sideslips at 1.2 VS1 for any landing gear and flap positions and for any symmetrical power conditions up to 50% of maximum continuous power, the aileron and rudder control movements and forces must increase steadily (but not necessarily in constant proportion) as the angle of sideslip is increased up to the maximum appropriate to the type of aeroplane. At larger sideslip angles up to the angle at which full rudder or aileron control is used or a control force limit contained in CS 23.143 is reached, the aileron and rudder control movements and forces must not reverse as the angle of sideslip is increased. Rapid entry into, or recovery from, a maximum sideslip considered appropriate for the aeroplane must not result in uncontrollable flight characteristics.	MET
MIL-F-8785C 3.3.6.1	Yawing moments in steady sideslips	For sideslips specified in 3.3.6, right yaw-control-pedal deflection and force shall produce left sideslips and left yaw-control-pedal deflection and forces shall produce right sideslips. For Levels 1 and 2 the following requirements shall apply. The variation of sideslip angle with yaw-control-pedal deflection shall be essentially linear for sideslip angles between +15 degrees and - 15 degrees. For larger sideslip angles, an increase in yaw-control-pedal deflection shall always be required for an increase in sideslip. The variation of sideslip angle with yaw-control-pedal force shall be essentially linear for sideslip angles between +10 degrees and -10 degrees. Although a lightening of pedal force is acceptable for sideslip angles outside this range, the pedal force shall never reduce to zero.	LEVEL 1 MET
MIL-F-8785C 3.3.6.2	Side forces in steady sideslips	For the sideslips of 3.3.6, and increase in right bank angle shall accompany an increase in right sideslip, and an increase in left bank angle shall accompany an increase in left sideslip.	MET
MIL-F-8785C 3.3.6.3	Rolling moments in steady sideslips	For the sideslips of 3.3.6, left roll-control deflection and force shall accompany left sideslips, and right roll-control deflection and force shall accompany right sideslips. For Levels 1 and 2, the variation of roll-control deflection and force with sideslip angles shall be essentially linear.	MET

<table>
<tr><th colspan="4">LATERAL DIRECTIONAL DYNAMIC STABILITY</th></tr>
<tr><th>Paragraph</th><th>Title</th><th>Description</th><th>Compliance</th></tr>
<tr><td>CS 23.157(a)(2)</td><td rowspan="4">Rate of Roll</td><td>Take–off. It must be possible, using a favourable combination of controls, to roll the aeroplane from a steady 30° banked turn through an angle of 60°, so as to reverse the direction of the turn within –
For aeroplanes of over 2 722 kg (6 000 lb) maximum weight,
$\frac{W+200}{590}$ but not more than 10 seconds, where W is the weight in kg,
($\frac{W+500}{1\,300}$ but not more than 10 seconds, where W is the weight in lb.)</td><td>MET (for maximum weight of 7000 lbs less than 5.8 sec)</td></tr>
<tr><td>CS 23.157(b)</td><td>The requirement of sub-paragraph (a) must be met when rolling the aeroplane in each direction in the following conditions –
(1) Flaps in the take-off position;
(2) Landing gear retracted;
(3) For a single-engined aeroplane, at maximum take-off power and for a twinengined aeroplane, with the critical engine inoperative, the propeller in the minimum drag position and the remaining engine at maximum take-off power; and
(4) The aeroplane trimmed at a speed equal to the greater of 1.2 VS1 or 1.1 VMC or as nearly as possible in trim for straight flight.</td><td>MET</td></tr>
<tr><td>CS 23.157(c)(2)</td><td>Approach. It must be possible using a favourable combination of controls, to roll the aeroplane from a steady 30° banked turn through an angle of 60°, so as to reverse the direction of the turn within –
For and aeroplane of over 2 722 kg (6 000 lb) maximum weight,
$\frac{W+1\,300}{1\,000}$ but not more than 7 seconds where W is weight in kg.
($\frac{W+2\,800}{2\,200}$ but not more than 7 seconds where W is weight in lb.)</td><td>MET (for maximum weight of 7000 lbs less than 4.5 sec)</td></tr>
<tr><td>CS 23.157(d)</td><td>The requirement of sub-paragraph (c) must be met when rolling the aeroplane in each direction in the following conditions –
(1) Flaps in the landing position(s);
(2) Landing gear extended;
(3) All engines operating at the power for a 3° approach; and
(4) The aeroplane trimmed at VREF.</td><td>MET</td></tr>
<tr><td>CS 23.181(b)</td><td>Dynamic stability</td><td>Any combined lateral–directional oscillations (“Dutch roll”) occurring between the stalling speed and the maximum allowable speed appropriate to the configuration of the aeroplane must be damped to 1/10 amplitude in 7 cycles with the primary controls –
(1) Free; and
(2) In a fixed position, except when compliance with CS 23.672 is shown.</td><td>MET</td></tr>
<tr><td>MIL-F-8785C 3.3.1.1</td><td>Lateral-directional oscillations (Dutch roll)</td><td>The frequency, wnd, and damping ratio, zd, of the lateral-directional oscillations following a yaw disturbance input shall exceed the minimum values in table VI. The requirements shall be met in trimmed and in maneuvering flight with cockpit controls fixed and with them free, in oscillations of any magnitude that might be experienced in operational use. If the oscillation is nonlinear with amplitude, the requirement shall apply to each cycle of the oscillation. In calm air residual oscillations may be tolerated only if the amplitude is sufficiently small that the motions are not objectionable and do not impair mission performance. For Category A Flight Phases, angular deviations shall be less than ±3 mils.
TABLE VI. Minimum Dutch roll frequency and damping.
<table>
<tr><th>Level</th><th>Flight Phase Category</th><th>Class</th><th>Min ζ_d*</th><th>Min $\zeta_d\omega_{nd}$* rad/sec.</th><th>Min ω_{nd} rad/sec.</th></tr>
<tr><td rowspan="6">1</td><td>A (CO and GA)</td><td>IV</td><td>0.4</td><td>-</td><td>1.0</td></tr>
<tr><td rowspan="2">A</td><td>I, IV</td><td>0.19</td><td>0.35</td><td>1.0</td></tr>
<tr><td>II, III</td><td>0.19</td><td>0.35</td><td>0.4**</td></tr>
<tr><td>B</td><td>All</td><td>0.08</td><td>0.15</td><td>0.4**</td></tr>
<tr><td rowspan="2">C</td><td>I, II-C, IV</td><td>0.08</td><td>0.15</td><td>1.0</td></tr>
<tr><td>II-L, III</td><td>0.08</td><td>0.10</td><td>0.4**</td></tr>
<tr><td>2</td><td>All</td><td>All</td><td>0.02</td><td>0.05</td><td>0.4**</td></tr>
<tr><td>3</td><td>All</td><td>All</td><td>0</td><td>0</td><td>0.4**</td></tr>
</table>
* The governing damping requirement is that yielding the larger value of ζ_d, except that ζ_d of 0.7 is the maximum required for Class III.
** Class III airplanes may be excepted from the minimum ω_{nd} requirement, subject to approval by the procuring activity, if the requirements of 3.3.2 through 3.3.2.4.1, 3.3.5 and 3.3.9.4 are met.
When $\omega_{nd}^2 \lvert \phi/\beta \rvert_d$ is greater than 20 (rad/sec)^2, the minimum $\zeta_d\omega_{nd}$ shall be increased above the $\zeta_d\omega_{nd}$ minimums listed above by:
Level 1 - $\Delta\zeta_d\omega_{nd} = .014(\omega_{nd}^2 \lvert \phi/\beta \rvert_d - 20)$
Level 2 - $\Delta\zeta_d\omega_{nd} = .009(\omega_{nd}^2 \lvert \phi/\beta \rvert_d - 20)$
Level 3 - $\Delta\zeta_d\omega_{nd} = .004(\omega_{nd}^2 \lvert \phi/\beta \rvert_d - 20)$
with ω_{nd} in rad/sec.</td><td>LEVEL 1
MET</td></tr>
<tr><td>MIL-F-8785C 3.3.1.3</td><td>Spiral stability</td><td>The combined effects of spiral stability, flight-control-system characteristics and rolling moment change with speed shall be such that following a disturbance in bank of up to 20 degrees, the time for the bank angle to double shall be greater than the values in table VIII. This requirement shall be met with the airplane trimmed for wings-level, zero-yawrate flight with the cockpit controls free.
TABLE VIII. Spiral stability - minimum time to double amplitude.
<table>
<tr><th>Flight Phase Category</th><th>Level 1</th><th>Level 2</th><th>Level 3</th></tr>
<tr><td>A & C</td><td>12 sec</td><td>8 sec</td><td>4 sec</td></tr>
<tr><td>B</td><td>20 sec</td><td>8 sec</td><td>4 sec</td></tr>
</table></td><td>LEVEL 1
MET</td></tr>
</table>