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It was found that the pitch control characteristics dominated the handling qualities. The more easily and precisely pitch could be controlled, the more adverse the control characteristics of the other degrees of freedom the pilot would accept. When precise long-term control of airspeed through pitch modulation was not difficult, the pilots were prepared to tolerate operation well along the backside of the power-required curve. For the typical unaugmented stability characteristics of this class of aircraft, exhibiting small modal separation, the handling qualities were governed by the overall responses to control and disturbance inputs rather than by the location of individual roots of the characteristic equation. This was true even for reasonable short-period characteristics when the stiffness and total damping of the short-term mode was derived to a large extent from the derivative, Z_w. Atmospheric turbulence, wind and wind shear often affected the control task significantly during these steep, low-speed approaches.

This report documents comprehensively the configuration characteristics evaluated and the resulting pilots' comments and ratings. It also presents the statistical characteristics of the pilots' control usage during several landing approaches. Analytical considerations which emphasize those aspects of the handling qualities that proved to be of major concern to the pilots are developed.

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FOREWORD

This report has been prepared for the United States Air Force by the Flight Research Laboratory, National Research Council of Canada, Ottawa, Ontario, under the sponsorship of the Air Force Flight Dynamics Laboratory, Air Force Systems Command, Wright-Patterson Air Force Base, Ohio. The research was conducted under Contract No. F33615-71-C-1722 to the United States Air Force and under Sub Contract No. S 72-3 to CALSPAN Corporation, Buffalo, New York during the period July 1972 to May 1974.

The experimental design was the result of a cooperative venture between CALSPAN and NRC.

The project engineers for each of the participating agencies were T. Neighbor (AFFDL/FGC), D. Key (CALSPAN) and K-H. Doetsch, Jr. (NRC). The assistant project engineer was D.W. Laurie-Lean (NRC). The evaluation pilots were W.S. Hindson (NRC), N.L. Infanti (CALSPAN), D.M. McGregor (NRC) and A.D. Wood (NRC). Digital computer programming was due to D.H. Carter (NRC) and the loan of the TALAR transmitter to G.D. Adams (FAA, NAFEC).

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The report has been reviewed and is approved.

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Flight Control Division

ABSTRACT

A flight investigation was undertaken of the longitudinal handling qualities of the STOL class of aircraft controlled through the modulation of pitch and normal thrust, and flown on steep, instrument landing approaches at low airspeed. Pilots' assessments of the characteristics resulting from independent variations in both short and long term longitudinal dynamics were obtained.

It was found that the pitch control characteristics dominated the handling qualities. The more easily and precisely pitch could be controlled, the more adverse the control characteristics of the other degrees of freedom the pilot would accept. When precise long-term control of airspeed through pitch modulation was not difficult, the pilots were prepared to tolerate operation well along the backside of the power-required curve. For the typical unaugmented stability characteristics of this class of aircraft, exhibiting small modal separation, the handling qualities were governed by the overall responses to control and disturbance inputs rather than by the location of individual roots of the characteristic equation. This was true even for reasonable short-period characteristics when the stiffness and total damping of the short-term mode was derived to a large extent from the derivative, Z_w. Atmospheric turbulence, wind and wind shear often affected the control task significantly during these steep, low-speed approaches.

This report documents comprehensively the configuration characteristics evaluated and the resulting pilots' comments and ratings. It also presents the statistical characteristics of the pilots' control usage during several landing approaches. Analytical considerations which emphasize those aspects of the handling qualities that proved to be of major concern to the pilots are developed.

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The axis system used in the definition of many of the following symbols and that controlled by the autopilot of the simulator is the right-hand principal axis system of the simulator. The control moments and forces which respectively produce positive (clockwise) initial angular accelerations about and positive initial linear accelerations along these axes are positive.

Symbol	Definition	Units
A_x, A_y, A_z	Accelerations along X, Y, Z axes	ft/sec^2
a_x, a_y, a_z	Acceleration perturbations along X, Y, Z axes	ft/sec^2
B	Pitching moment of inertia of simulator	$slug\text{-}ft^2$
C_{L_o}	Lift Coefficient at operating point	
C_{L_α}	Lift curve slope at operating point	
F	General forcing function (Eq. A-4)	
$F_q(s)$, $F_w(s)$	Filter transfer functions for pitch and heave autopilot loops	
$H_u(s)$, $H_v(s)$, $H_w(s)$	Filter transfer functions applied to generate the artificial turbulence components	
$H_{u_{VK}}(s)$, $H_{v_{VK}}(s)$, $H_{w_{VK}}(s)$	Von Karman filter characteristics to describe atmospheric turbulence components	
h_R	Negative of OZ coordinate of main rotor pivot point	ft

LIST OF SYMBOLS (Cont'd)

Symbol	Definition	Units
$\dot{h}$	Rate of change of height	ft/sec
IMC/VMC	Instrument/Visual meteorological conditions	
K	Gain of crosscoupling term from collective to pitch autopilot loop	
K_3	Scale Length relating main rotor pitching moments and X-forces	ft
L	(i) Rolling Acceleration	rad/sec^2/ unit subscript
	(ii) Integral scale length of turbulence	ft
	(iii) As suffix - pilot station effect	
m	Mass of simulator	slugs
ΔM	Pitching Moment perturbation	ft.lb
M	Pitching Acceleration	rad/sec^2/ unit subscript
N	Yawing Acceleration	rad/sec^2/ unit subscript
n	Load factor	g
P, Q, R	Rates of roll, pitch and yaw	rad/sec
p, q, r	Perturbations in rates of roll, pitch and yaw	rad/sec
r.m.s.	Root mean square	
s	Laplace's Transform Variable	1/sec
T	Time interval of sample: Appendix E, Figures 30-35	sec
T_2	Time to double amplitude	sec
t	Time	sec

LIST OF SYMBOLS (Cont'd)

Symbol	Definition	Units
U, V, W	Linear velocities along X, Y and Z axes	ft/sec
u, v, w	Perturbations in linear velocities along X, Y and Z axes	ft/sec
X, Y, Z	(i) Principal Axis system (ii) Linear acceleration along axes	 ft/sec^2/ unit subscript
α	Angle of attack	rad
β	Angle of sideslip	rad
γ	Flight path angle - positive for climb	rad
Δ	Characteristic Equation of longitudinal equations of motion	
Δt_o	Average dwell time at zero displacement: Appendix E	sec
δa	Pilot's aileron control displacement	ins
δc	Pilot's collective control displacement	ins
δe	Pilot's elevator control displacement	ins
δr	Pilot's rudder control displacement	ins
δT	Pilot's thrust control displacement	ins
ζ	Damping ratio of a second-order linear system	
$2\zeta\omega$	Total damping of a second-order linear system	1/sec
Θ	Pitch attitude	rad
θ	Pitch attitude perturbation	rad
λ_R	Roll subsidence root of the lateral-directional characteristic equation	1/sec

LIST OF SYMBOLS (Cont'd)

Symbol	Definition	Units
λ_S	Spiral root of the lateral-directional characteristic equation	1/sec
σ	Root mean square value	
Φ	Roll attitude	rad
ϕ	Roll attitude perturbation	rad
$\phi_{ii}(w)$	Input power spectral density	(ft/sec^2)/ rad/sec
$\phi_{oo}(w)$	Output power spectral density	(ft/sec^2)/ rad/sec
$\left\|\frac{\phi}{\beta}\right\|_{DR}$	Modulus of ratio of roll angle to sideslip angle in dutch roll mode	
ω	(i) Frequency (ii) Undamped natural frequency of a second order mode specified by a subscript	rad/sec
ω_a^2	Stiffness characterizing the initial pitch response to elevator	
ω'_{SP}	Equivalent short-period frequency obtained with the assumption $\theta_o = 0$	rad/sec

Prefices

A	Attitude Command Form
R	Rate Command Form

Subscripts

AERO	From Aerodynamic sources
DR	Dutch roll mode
F	Total equivalent fuselage contribution

LIST OF SYMBOLS (Cont'd)

<u>Subscripts</u>

f	Component of fuselage contribution
g	Gust disturbance
H	Basic helicopter
HF	High Frequency
LF	Low Frequency
R	Main Rotor
M	Model
MIX	Composite inertial-air data quantity
PH	Phugoid Mode
p	Pilot's control
s	Control surface
SAS	Contribution from stability augmentation system
SP	Short-period
ss	Steady state
ST	Short-term
o	Fixed operating point condition

1.0 INTRODUCTION

The reduction in approach speeds and the increase in approach glide-slopes that became possible with the advent of the STOL class of aircraft through the use of 'powered' lift to supplement the aerodynamically generated lift, were not attained without accompanying changes in the handling qualities of the aircraft. Many of these changes were, moreover, for the worse and such specifications as those in MIL-F-83300 (Ref. 1) were established to limit the deterioration to levels that remained acceptable to the pilot. Unfortunately, many of the data used in the formulation of these requirements, described in Ref. 2, were, of necessity, derived from the extrapolation of data applicable to CTOL aircraft obtained under quite different operating conditions. This deficiency was recognized from the outset of the formulation of the requirements and, to remedy the resulting weaknesses, the present investigation was undertaken to provide new data of a general nature from in-flight evaluations of typical STOL configurations operating under conditions of instrument approaches at low airspeed and steep approach angle down to weather minimums.

Some of the differences in handling qualities are directly attributable to the change in airspeed. Trajectory control takes on added significance, not only because of changes in the inherent dynamic characteristics resulting from lower approach speeds, but also because the external environment (wind, wind shear and turbulence) has greater influence on the aircraft's trajectory (Ref. 3). Furthermore, at low airspeeds, the separation between the short-period and phugoid modes for aircraft without stability augmentation is often diminished so that classical assumptions used in the calculation of the root locations of these modes may no longer remain valid. This is particularly true when the short-period mode, instead of exhibiting its customary complex form, is composed of widely separated aperiodic roots. The question is then raised of whether, in these circumstances, the characteristic modes of motion remain as sensitive indicators of the ensuing handling qualities.

In order to assess the relative importance of some of these factors experimentally, the various interacting parameters were first decoupled to the greatest extent possible so that pilots' evaluations of single parametric variations in longitudinal dynamic characteristics could be obtained. Interaction between parameters was then allowed so that its influence on the pilot's control task could be ascertained.

Specifically, the following were investigated:

i Short-Period characteristics

ii Speed and Flight Path control characteristics in the presence of good, augmented pitch characteristics

iii Speed and Flight Path control characteristics in the presence of typical unaugmented STOL pitch characteristics

iv Effect of the speed stability derivative M_u

v Effect of $Z_{\delta e}/M_{\delta e}$

vi Effect of $M_{\delta T}/Z_{\delta T}$.

All evaluations were undertaken with an airborne simulator flown at an airspeed of 60 knots under instrument conditions down an 8° glide path to 200 ft A.G.L. prior to visual acquisition of the touch down point. The pilot's instrument display was deliberately rudimentary in keeping with the aims of obtaining basic handling qualities data.

In the following chapters a complete documentation of the experiment and its constraints has been attempted to allow the widespread use of the data in analyses made from different points of view.

2.0 TEST EQUIPMENT AND EVALUATION TASK

2.1 Simulator

The simulator utilized, based on a Bell 47G-3B1 helicopter, is described in some detail in Ref. 4. Since that report was written, several changes of importance to the present investigation have been made, namely:

i The removal of the horizontal stabilizer

ii Changes in the control forms and improvements in the performance of the pitch and heave autopilot loops

iii The incorporation of electro-hydraulic force-feel systems for the evaluation pilot's elevator, aileron and rudder controls

iv The incorporation of a special-purpose on-board computer to allow the calculation with both high fidelity and high signal-to-noise ratio, of the linear motion of the simulator's centre of gravity relative to the long wavelength components of the airmass.

The influence of these changes is considered in detail in the appropriate portions of the text.

In concept, the simulator uses a model-following technique on four of the six degrees of freedom, the rotary motions in pitch, roll and yaw and the linear motion in heave. The fore-and-aft and transverse linear motions cannot be controlled independently and are governed by the inherent characteristics of the simulator as modified by the cross-coupling terms resulting from the closure of the four controlled loops.

Details of the simulation are presented in Appendix A with discussions of the simulator and model equations of motion and of the form of the autopilot loop closures.

2.1.1 Cockpit

The simulator is occupied by two pilots, the safety pilot who sets up the configurations and monitors the safety of the evaluation, and the evaluation pilot who assesses the configurations.

For the present investigation, the evaluation pilot's instrument display, illustrated in Figure 1, was conventional and rudimentary. Available to present him with aircraft state information were, from left to right in this figure:

Top row	Thrust lever position indicator
	Airspeed indicator
	Combined attitude and flight-path indicator
	Altimeter
2nd row	Engine Manifold pressure from 82% to 100%
	Turn and Slip Indicator

Direction Indicator

Vertical Speed Indicator.

A translucent white screen which could be rapidly raised or lowered by the evaluation pilot, served to obliterate all outside visual references when he was flying on instruments.

The evaluation pilot's controls consisted of a central stick and rudder pedals for controlling rotary motions and of a thrust lever, in a conventional left-hand throttle-quadrant format, to control the normal thrust of the configuration. The simulator's engine speed was governed to maintain constant rotor rpm. The evaluation pilot's controls, through an onboard computer, commanded the appropriate motion of the simulator for the configuration being evaluated.

Electro-hydraulic force-feel systems for the pilot's stick and rudder controls allowed desirable force-displacement characteristics to be presented to the pilot. The characteristics chosen are described in Appendix B and tabulated in Figure 2.

2.1.2 Motion Sensing System

To define the motion of the simulator, measurements were made of rotary rates, attitudes, linear accelerations and linear velocities, the latter relative to the airmass. All measurements were referred to the principal axes of the simulator. The linear velocities, which were required either as feedback in the model equations of motion or in the heave autopilot loop, are normally subject to fluctuations arising from external turbulence or from wind shear. Both the pitot-static system and the α and β-vanes used in the experiment as prime velocity sensors responded to these external disturbances and, in order that the effects of the latter's shorter wavelength components on the simulator's motion could be alleviated, a complementary filter arrangement which mixed inertial data with air data was utilized. The ensuing velocity data may be considered as aircraft inertial data washed out at low frequency to airmass reference frame data. The major advantage of the system was that the influence of short-wavelength external disturbances or position errors on the velocity data was filtered out, thereby allowing a much improved signal-to-noise ratio, whilst the aircraft still responded to the long wavelength changes in the airmass frame of reference relative to the ground. This latter condition is necessary when it is not possible, as in the present experiment, to control all the linear-motion degrees of freedom and when engine power limitations are such that complete alleviation of long wavelength components of large amplitude is not feasible along the controlled degree of freedom. Further details of the air data sensing system, as it affected the heave autopilot loop, are given in Appendix A.

The inertial data were sensed by a strap-down system of attitude and rate gyros and linear accelerometers.

2.1.3 Parameters Recorded

Recorded continuously on magnetic tape during evaluations were the following quantities:

- i Pilot's comments
- ii Glide slope tracking error
- iii Localizer tracking error
- iv Longitudinal velocity, U_H
- v Normal velocity, w_H
- vi Normal acceleration, a_{z_H}
- vii Pitch attitude, θ_H
- viii Pitch rate, q_H
- ix Commanded normal velocity, w_M
- x Commanded pitch rate, q_M
- xi Evaluation pilot's elevator input, δe
- xii Evaluation pilot's thrust lever input, δT
- xiii Longitudinal component of artificial turbulence, u_g
- xiv Normal component of artificial turbulence, w_g.

2.1.4 Artificial Turbulence Generation

In efforts to define better the disturbing influences on the simulator, evaluations were made in conditions characterized by both low external turbulence and mean winds. Typical turbulence disturbance levels were then artificially created through the excitation of the model equations of motion with the output of three independent, on-board turbulence generators producing gust components with the Von Karman spectral shape and a normal distribution. The form of the implementation is discussed in Appendix C.

No artificial mean winds or wind shears were simulated.

2.1.5 Simulator Performance

A discussion of the ability of the autopilot loops in pitch and heave to ensure that the simulator followed the motions commanded by the model equations of motion is presented in Appendix A.

The remaining question to be resolved is whether the estimates of fuselage X-forces were adequate to obtain the predicted modal motion. An attempt to verify this point was made by exciting a ground-based simulation of the model with the pilot's inputs recorded in flight during the evaluation of the same configuration. This technique is not entirely satisfactory for the class of configurations evaluated, characterized as they are by low total stiffness, because very small biases or the pilot's inputs to counteract the influence of unrecorded external disturbances or lateral-directional inputs, can result in large long-term responses.

The comparisons are presented in Figures 4 to 7 for four configurations, the first with no longitudinal velocity feedback to the equations of motion and the others with differing degrees of feedback. It is seen that, even with the above mentioned proviso, good motion following was obtained. Further discussion of these comparisons is presented in Appendix D.

2.2 Ground Guidance Aid

To provide guidance during the base and final legs of the approach phase a High-Angle TALAR Transmitter, Model IV, was utilized. Calibration against a theodolite indicated that when set to the 8° glide slope of the experiment, the narrow-beam width limits were given by

Glide Slope	+3°, -2.5°
Localizer	±3°.

The full scale deflections of the aircraft's receiver corresponded to these angular deviations from the centre of the guidance beam.

The specifications for the transmitter indicate a localizer coverage at 2 n.m. of ±55° when on glide path.

2.3 The Pilots

Four pilots participated in the evaluations:

A	D.M. McGregor	NRC
B	W.S. Hindson	NRC
C	A.D. Wood	NRC
D	N.L. Infanti	CALSPAN

Each pilot has accumulated considerable experience relevant to evaluating the class of aircraft being investigated, both in aircraft and airborne simulators.

The pilots were allowed as much preliminary flying as they felt necessary to familiarize themselves with the task and instrument crosscheck. About four hours (12 complete circuits) were opted for. In retrospect, it was felt that the learning process probably required longer than this period, a figure of 10 hours being suggested as appropriate by one pilot. It was also important for the pilots to remain current on the task, a refamiliarization flight being required after their not having flown the task for a period of about three weeks.

Three evaluations per flight hour could normally be undertaken and the workload was such that the pilots generally reached their saturation point after six evaluations in any one day.

2.4 Configuration Evaluation Task

The task, detailed in Figure 8, consisted essentially of a VMC circuit and an IMC approach down from 1900 feet using a TALAR, microwave approach-aid set up for a nominal approach angle of 8 degrees. The evaluation pilot "broke-out" to VMC conditions at a height of 200 feet and performed a transition manoeuvre into horizontal flight at 10 feet above a marked touchdown point and at an airspeed of 60 knots. The touchdown point was situated 200 feet upwind of the TALAR transmitter.

The purpose of the VMC portion of the task was primarily to position the simulator for the IMC approach task and to enable the evaluation pilot to learn something of the characteristics of the configuration being simulated.

The sequence of events in an evaluation flight was as follows:

VMC - Turbulence Out

(1) The safety pilot adjusted the cockpit potentiometers and function switches that determined the magnitude and sign of the stability derivatives for the configuration being simulated.

(2) With the aircraft still on the ground the safety pilot excited the simulation model with sequential, artifically produced, electrical elevator and thrust control doublets. The recorded model responses were later compared with ones obtained in a laboratory ground-simulation in order to determine whether the model had been set correctly.

(3) The previous model of the flight was identified for the record on magnetic tape and on the evaluation pilot's comment sheet. This was the first time that the evaluation pilot was informed of the identity of the model he had previously evaluated.

(4) The safety pilot flew the simulator to a height of 500 feet above the ground and established an airspeed of 60 knots in level flight. The autopilot was engaged and the analogue computer was switched to the "operate" mode. At this point, the evaluation pilot assumed full control of the

aircraft under visual conditions with the artificial turbulence switched out.

(5) The evaluation pilot flew the aircraft straight ahead at 50 knots up to an altitude of 2000 feet, made a left turn onto the crosswind leg and continued to climb to the downwind leg.

(6) A left turn was made onto the downwind leg and, at 2300 feet, the aircraft was levelled off and its airspeed increased to 60 knots.

(7) When steady conditions were established, a descent was made to 1900 feet at 500 fpm and at an airspeed of 60 knots. This manoeuvre enabled the evaluation pilot to assess the ease of establishing and maintaining desired vertical and longitudinal velocities.

(8) Back in level flight at 1900 feet, the evaluation pilot undertook a series of linked turns through heading changes of 60 degrees, -120 degrees, 120 degrees and -60 degrees back onto the downwind leg. The bank angle in the turns was no greater than 20 degrees. The purpose of the turns was to permit the pilot to assess the thrust requirements of the configuration in turning flight.

IMC - Turbulence Out

(9) As he drew level with the TALAR transmitter, the evaluation pilot pulled up the screen on top of the instrument panel to remove all external visual cues, and commenced flight under instrument conditions. When he had stabilized

the aircraft, he increased the airspeed to 70 knots.

IMC - Turbulence In

(10) The safety pilot provided information as to when to commence the turn onto the base-leg, which allowed a suitable 90° track to the approach to be followed. He also switched in the artificial turbulence at that point.

(11) The turn onto the base-leg was made with a maximum bank angle of 20 degrees and the speed was reduced to 60 knots in the turn. Subsequent guidance to the breakout height of 200 feet was provided by the TALAR unit.

VMC - Turbulence In

(12) At 200 feet, the evaluation pilot lowered the cockpit screen and returned to visual flight conditions. He then performed a transition manoeuvre from the glide-path to arrive at 10 feet over the marked touchdown point, at 60 knots in level flight.

(13) The safety pilot took control and landed the simulator. While the safety pilot set up the next configuration, the evaluation pilot documented his comments concerning the configuration characteristics on the pilot's comment sheet, shown in Figure 9, and gave a subjective rating according to the Cooper-Harper scale shown in Figure 10.

In addition to the above mentioned ratings of handling qualities, Pilot B also gave a subjective rating of the influence of turbulence according to the scale presented in Figure 11 (source: CALSPAN). This rating follows his numerical rating of the configuration in Table III.

3.0 CONTROLLED AND UNCONTROLLED CONSTRAINTS ON THE SIMULATOR MOTION

The following chapter is concerned both with those aspects of simulator motion which could be directly controlled and with those which were uncontrollable because of either simulator limitations or influences of the external environment.

3.1 Equations of Motion

The equations governing the simulator motion and the implementation of the model equations of motion are described in detail in Appendix A.

3.1.1 Controlled Degrees of Freedom

Two of the three degrees of freedom of importance to the longitudinal dynamics (heave and pitch) could be controlled independently whereas that of the fore-and-aft motion was dependent on the motion in the other degrees of freedom and on external atmospheric conditions.

The desired variations in pitching motion were obtained through the response derivatives,

$$M_u,\ M_w,\ M_{\dot{w}},\ M_q,\ M_\theta,$$

and the pilot's control derivatives, $M_{\delta e}$ and $M_{\delta T}$.

In the heave equation of motion, variations were made through the response derivatives,

$$Z_u,\ Z_w,\ Z_q \text{ and } Z_\theta,$$

and the pilot's control derivatives, $Z_{\delta T}$ and $Z_{\delta e}$.

No physically unrealistic values for derivatives were allowed and this resulted in the imposition of the following additional constraints:

$$M_q < 0$$

$$\frac{UM_{\dot{w}}}{M_q} < 1.0$$

$$\frac{Z_u}{Z_w} \leq 1.2$$

$$Z_u \leq 0$$

$$Z_{\delta e} \geq 0.$$

The evaluation pilot's control sensitivities, $M_{\delta e}$ and $Z_{\delta T}$, were established initially on the basis of the magnitude of $M_q + M_{\dot{\alpha}}$ and Z_w respectively. The sensitivities so obtained were subsequently adjusted on the basis of pertinent pilots' comments made during the first few evaluations. If the ensuing preset levels still did not coincide with his desires, the pilot was free to alter the sensitivities at any time during an evaluation. The pilots made little use of this option as, quite often, if the response to controls was of concern, it was because the aircraft's dynamic characteristics were such that a compromise gearing between satisfactory initial and final responses to control inputs needed to be selected. The optimum sensitivity in these circumstances was not well defined.

The control sensitivities selected or accepted by the pilots are documented with their comments in Table III, along with any changes made by the pilot from the original setting.

3.1.2 The Dependent Fore-and-Aft Degree of Freedom

No means existed, in the simulator utilized, of varying the longitudinal force characteristics independently. The closed-loop response in this degree of freedom could, however, be formulated in terms of the demanded pitching motion and of the fuselage contributions to the longitudinal forces, as is shown in Appendix A.

With the modulation of the thrust vector by the autopilot in the longitudinal plane to produce the desired pitch and heave motions, the only suitable means available to the pilot of controlling long-term airspeed variations of the simulator was through pitch modulation. The geometric and inertial characteristics of the simulator were such that the force component at the rotor hub, required to produce the desired pitching accelerations, did not have a significant influence on the long-term variations in airspeed when compared with that due to the gravitational component $mg\theta$. The aerodynamic reaction forces significant to the long-term control of airspeed all originated from the fuselage longitudinal force and pitching moment derivatives and resulted in rather low closed-loop drag characteristics for the class of aircraft being simulated.

As far as the pilot was concerned, when he was flying configurations with reasonable flight-path control characteristics, the influence of the drag characteristics was most apparent in the sensitivity of trim speed to attitude changes and in the time constant associated with attaining these speed changes. For pitch modulation at constant angle of attack with the simulator in question, the steady state speed variation was about 8 knots per degree and the associated time constant was approximately 25 seconds. Comments were made by the pilots about this high sensitivity of trim speed to pitch attitude, particularly when precise control of long-term pitch variations was difficult.

The quantitative effect of the harmony between speed and attitude on the pilot's assessments of handling qualities will have to await further experimental investigation in simulators capable of producing more significant drag forces. However, it is to be noted that even with the existing harmony, many pilots' ratings of 3 were attained in this programme when easily controlled pitching characteristics prevailed and when the control task was not complicated by operation on the 'backside' of the power-required curve.

3.1.3 The Effect of the Steady-State Pitch Attitude of the Simulator

The steady-state pitch attitude of the principal axis system being controlled can have a significant influence on the longitudinal characteristic modes when the overall stiffness becomes low. (For the loading condition of the simulator, the pitch attitude in straight and level flight at 60 knots was -7°.) Its influence is seen clearly in the root loci as $-M_w$ is reduced. When the resulting stiffness thereby becomes low, the singularity at the origin for zero θ_o (and for $M_u = Z_u = 0$) moves away from the origin when θ_o is varied. Coupled with this movement one finds complementary movements in the short-period roots which indicate that variations in θ_o primarily result in a redistribution of the damping between the modes. In these circumstances, and when the characteristic equation is composed of four aperiodic roots (one of these, associated with the phugoid mode, remains at X_u for $M_u = Z_u = 0$), it no longer remains obvious which combination of two of the remaining three aperiodic roots should be used to generate an equivalent overdamped second order pair to define the short-term mode. Possible ambiguity could thereby result in configuration classification.

Current requirements necessitate a separation of the modes into long and short-term pairs to establish conformity. Difficulty is foreseen in uniquely demonstrating compliance with the requirements in these circumstances.

To help assess the influence of non-zero θ_o on handling qualities, it is noted that the movement from the origin of one characteristic root through θ_o variations is complemented by movement in the opposite direction by another. The total damping of these roots remains much the same and the effect on handling qualities is probably not significant for moderate values of θ_o. This premise is made on the basis of the effect of a similar and marked sensitivity of the root loci to M_u variations for these configurations with low short-term stiffness. In evaluations of such configurations differing only in their values of M_u, the pilot was able to redistribute the damping between the modes without discernible effect on his assessments of the ensuing handling qualities.

3.1.4 Thrust Control Direction

The autopilot loops used for controlling the motion of the simulator ensure that the thrust vector over which the evaluation pilot has control, acts along the normal axis of the aircraft when neither pitching nor rolling accelerations are demanded. For the conditions of the experiment, this meant that the thrust vector remained essentially normal to the flight path of the aircraft.

STOL aircraft are typified by resultant thrust vector inclinations that lie somewhere between this direction and that along the flight path, and consideration thus needs to be given to the constraint imposed by the thrust inclination of this experiment.

The influence of thrust vector inclination depends primarily on three factors, namely on the velocity component (airspeed or rate of change of height) being controlled by thrust modulation, on the availability to the pilot of independent control over both thrust magnitude and inclination, and on the ease and precision with which undesired velocity responses to thrust vector variations may be compensated for through pitch modulation. Details are presented in Ref. 3 of the pitch modulation necessary to constrain one velocity component to the desired constant level while the other is being changed by variations in the thrust vector. Under these conditions, it is shown that the time constant associated with attaining a change in the velocity component controlled by thrust is independent of the thrust inclination. However, the pitch compensation demanded is dependent on thrust inclination and, not surprisingly, a near normal thrust vector reduces the necessary pitch modulation when thrust controls rate of change of height, whereas a near longitudinal one does so when thrust controls longitudinal velocity.

If pitch attitude can be easily and precisely controlled, the modulation required to compensate for undesired changes in trim condition caused by thrust variations probably does not play an important role in the ensuing handling qualities. However, as control of pitch becomes more difficult, the need to compensate continually for thrust changes may add significantly to the pilot's workload and lead to a deterioration in his performance.

3.1.5 Pilot-Station Effects (Configurations denoted by L)

It is likely that the pilots of STOL aircraft will be seated further forward of the centre of gravity of the aircraft than in the simulator used in this experiment.

In order to assess the influence of motion cues resulting from a forward pilot's station, the effect of being 25 ft in front of the centre of gravity (designated by L in configuration identifiers) was simulated during many evaluations. In general, the differences in ratings and commentaries resulting for the same configuration with either the simulated station of 25 ft or the actual station of 3 ft ahead of the centre of gravity were insignificant.

The lateral forces arising from a forward pilot's station could not be simulated as no means of independently varying the side-force characteristics of the simulator existed.

3.1.6 Effect of Turning

The most significant long-term forcing function of the longitudinal equations of motion from the lateral-directional planes probably results during turning manoeuvres and, for this reason, deliberate turning manoeuvres were incorporated into the task. With airspeed maintained through control of pitch attitude, the additional thrust required in turns to maintain height is primarily a function of bank angle. If no thrust inputs are made, however, the steady rate of descent, for small X_w and a given bank angle, becomes inversely proportional to $-Z_w$. Quite significant descent rates can result for small $-Z_w$ and moderate bank angles if no compensating thrust is applied, for example, 500 fpm for a bank angle of 20° and Z_w of -0.25.

3.1.7 Lateral-Directional Characteristics

It was intended that the pilot be presented with lateral-directional characteristics which were representative of the class of aircraft being investigated but which were, in addition, unobtrusive in order that attention could be focussed on the longitudinal characteristics. For this reason, one of the better configurations of a previous investigation (LH 100+30+30, Ref. 5) was selected for the entire programme.

The characteristic roots were

$$\lambda_R = -4 \frac{1}{\text{sec}} ,$$

$$\lambda_S = 0 ,$$

$$\omega_{DR} = 1.0 \text{ rad/sec} ,$$

$$\zeta_{DR} = 0.3 ,$$

$$\left|\frac{\phi}{\beta}\right|_{DR} = 0.2 .$$

The dutch roll mode was not excited by application of aileron control.

The non-zero derivatives used to obtain these characteristics were

$$\frac{N_{\delta a}}{L_{\delta a}} = 0.2 , \quad N_r = -.63 , \quad N_p = 1.06 , \quad N_\beta = 1.14$$

$$L_r = .41 , \quad L_p = -3.9 , \quad L_\beta = -.75$$

$$Y_r = .95 , \quad Y_p = -4.34 , \quad Y_\beta = -5.48$$

Finally, the pilot's control sensitivities were

$L_{\delta a} = 0.5$,

$N_{\delta r} = 0.6$ to Fl. No. 102 ,

$= 0.4$ after Fl. No. 102 .

The change in rudder control sensitivity was made because Pilot A felt that control harmony would thereby be improved. The long-term responses were considered by him to be somewhat too great at the higher sensitivity level.

3.2 External Environment

As the simulator is flown in the real environment, the influence of atmospheric conditions on evaluations needs to be discussed.

3.2.1 Mean Winds and Wind Shear

The ground approach aid presents data to the pilot in an earth-fixed frame of reference whereas he is required to fly the aircraft at a prescribed airspeed. With the decreased approach speeds typifying STOL aircraft, the normal wind fluctuations encountered in the lower atmosphere take on added significance through their influence on the control of the final approach phase. The major effects are seen in the need to correct for airspeed changes and in the requirement to change the rate of descent and heading in order to maintain the earth-fixed trajectory whenever variations in wind that are a significant proportion of airspeed occur.

To limit these influences, evaluations were in general not undertaken in surface winds greater than 10-15 knots. Even with this restriction, rates of descent over extended periods of between 400 fpm and 1500 fpm about a nominal zero-wind value of 850 fpm were reported by the pilots to result from wind and wind shear. In view of these variations, it was decided that the effect of limiting the maximum descent angle could not be investigated satisfactorily in this experiment.

The lateral wind shear encountered by the pilots was also cause for frequent comment and the attention required to counteract its effects on ground track could contribute significantly to the difficulty of controlling configurations with undesirable longitudinal handling qualities.

3.2.2 External Turbulence

In order to alleviate the influence of external turbulence on the motion of the simulator, velocity feedback signals to the autopilot or model equations of motion were composite mixed inertial-air data signals as described in Section 2.1. Despite the attributes of this system, engine power limitations did impose a constraint on evaluations whenever large scale convective instabilities predominated.

Estimates of the magnitude of surface wind, wind shear and external turbulence were made by the pilots for each evaluation and recorded with their comments.

4.0 CONFIGURATION MATRIX EVALUATED

For the purposes of classification, the evaluations undertaken have been grouped so as to illustrate the influence of certain parametric variations of known importance to longitudinal handling qualities. In general, the variations were made first to illustrate the influence of given parameters when the others of known significance were held to unobtrusive levels and then, in order to assess the influence of parametric interactions, these secondary parameters were allowed to take on added significance whilst variations in the primary parameters were made.

The configuration matrix which evolved is illustrated in Figure 12, the derivatives in Table I and the primary modal characteristics in Table II.

A brief discussion of the resulting grouping is given in the following section, and a more detailed appraisal is given in Section 5 prior to the assessment of the pilots' comments for each group of parametric variations.

GROUP I Short-Period Characteristics

The effect of varying the stiffness and total damping of the short-period mode for various levels of Z_w was investigated. For this group the phugoid roots were maintained nearly constant through $Z_u = M_u = 0$ as may be seen from Table II. The configurations were all operated on the 'frontside' of the power-required curve.

GROUP II Variations of Flight-Path Characteristics in the Presence of Good Pitch Control Characteristics

Several of the configurations of Group I were stabilized through a simple pitch stability augmentation system to ease the pilot's pitch control task. Variations were made in the force characteristics through Z_u and Z_w in order to investigate operation on the 'backside' of the power-required curve. Both pitch attitude and rate command forms were investigated.

GROUP III Simultaneous Variations in Both Short and Long-Term Characteristics through Z_u

The pitch stability augmentation of Group II was removed and an investigation of configurations exhibiting both the resulting poor (low stiffness and/or damping) pitch characteristics and 'backside' operation was undertaken.

GROUP IV Simultaneous Variations in Both Short and Long-Term Characteristics through M_u

The influence of the speed stability derivative on the configurations of Group III was assessed.

GROUP V Effect of non-zero $Z_{\delta e}/M_{\delta e}$ on Selected Configurations

The effect of realistic changes in lift expected with pitching moment production was investigated on configurations both with and without pitch stability augmentation.

GROUP VI Effect of Non-Zero $M_{\delta T}/Z_{\delta T}$ on Configuration 2-2

One basic configuration was chosen to investigate typical variations in the thrust offset effect on the pilot's assessment of handling qualities.

5.0 ANALYTICAL CONSIDERATIONS AND PILOTS' ASSESSMENTS OF CONFIGURATION CHARACTERISTICS

Each of the groups of configurations detailed in the previous section is considered from an analytical point of view. The analytical results are then compared with the pilots' assessments of the appropriate handling qualities.

The pilot's elevator control usage during evaluations of representative configurations was also analyzed statistically to provide an indication of the sensitivity of the power spectral density and amplitude distributions to such changes in handling qualities that demanded different levels of compensation from the pilot. A discussion of this aspect is presented in Section 5.7 and Appendix E.

With regard to the terminology used in subsequent sections of the report, the short-term mode is, as in Ref. 2, considered to be the second-order mode that primarily determines the short-term response of angle of attack to an abrupt elevator input. The short-period approximation t this mode is the second-order solution which would result if the influence of longitudinal velocity perturbations on the short-term mode were negligible.

5.1 GROUP I Short-Period Characteristics

The short-term characteristics to be evaluated in this group were established by constraining the total damping of the characteristic modes to the desired level for different values of Z_w and by then obtaining the appropriate short-period stiffness through variations in M_w.

In order to achieve decoupling between the longitudinal velocity perturbations and the pitching moments and normal forces, M_u and Z_u were held at zero (this makes the short-period and short-term modes identical). The influence of the coupling derivatives M_u and Z_u was subsequently assessed to determine their effect on speed and flight path control, and is discussed in following sections of the report. The level of $M_{\dot{w}}$, which can have an important effect on the aircraft responses, was fixed at realistic values of either $UM_{\dot{w}} = 0.76\ M_q$ or $UM_{\dot{w}} = 0.5\ M_q$.

The non-zero θ_o which, in the simulator used, could not be inaependently varied, establishes a non-zero root in the characteristic equations for this group of configurations. For the configurations with low stiffness, this results in the possibility of multiple choices for the grouping of two of three aperiodic roots to be combined to define the short-term stiffness. In these circumstances the concept of short-term stiffness in itself is somewhat artificial and, in order to provide a consistent measure which merges smoothly into the unique values resulting in the presence of complex roots well separated from the phugoid roots, the value to be used for short-period stiffness is here further restricted through the definition

$$\omega_{SP}'^2 = \omega_{SP}^2\Big|_{\theta_o = 0} .$$

For Group I, the constraints $M_u = Z_u = \theta_o = 0$ result in a real root at the origin and a real root at - .04 for all configurations. These two roots are identified as the phugoid or low frequency pair.

5.1.1 Analytical Considerations

It becomes apparent from a study of the pilots' comments that the prime concern of a pilot when faced with low short-term stiffness is the control of pitch attitude with elevator. The θ/δ_e (s) transfer function should thus provide a sensitive indication of the source of the pilot's difficulty. For $M_u = Z_u = M_\theta = Z_{\delta e} = 0$ and $\theta_o = 0$ (applied for consistency with the assumption used in the definition of the stiffness), one obtains the following well known short-period approximation:

$$\frac{q}{M_{\delta e}\delta e}(s) = \frac{s - Z_w}{s^2 - (M_q + UM_{\dot{w}} + Z_w)s - (UM_w - M_q Z_w)} \tag{1}$$

$$= \frac{s - Z_w}{s^2 + 2\zeta_{SP}\,\omega'_{SP}\,s + \omega'^{2}_{SP}} \tag{2}$$

In order to obtain a better understanding of the terms influencing the initial pitch response to elevator inputs, Equation 2 is expanded about the zero location to give (Ref. 3),

$$\frac{q}{M_{\delta e}\delta e}(s) = \frac{1}{s^2 + 2\zeta_A\,\omega_A\,s + \omega_A^2}\left[s - \frac{Z_w\,\omega_A^2}{s^2 + 2\zeta_{SP}\,\omega'_{SP}\,s + \omega'^{2}_{SP}}\right], \tag{3}$$

where $2\zeta_A \omega_A = 2\zeta_{SP} \omega'_{SP} + Z_w$ (4)

$$= -(M_q + UM_{\dot{w}})$$

and $\omega_A^2 = \omega'^2_{SP} + 2\zeta_A \omega_A Z_w$ (5)

$$= -U(M_w + M_{\dot{w}} Z_w)$$

If the high-frequency pitch response is approximated by

$$\frac{q_{HF}}{M_{\delta e}\delta e}(s) = \frac{s}{s^2 + 2\zeta_A \omega_A s + \omega_A^2}, \tag{6}$$

then the ratio between this approximate solution and the response due to the short-period approximation is

$$\frac{q_{HF}}{q_{SP}}(s) = \frac{s(s^2 + 2\zeta_{SP} \omega'_{SP} + \omega'^2_{SP})}{s(s^2 + 2\zeta_{SP} \omega'_{SP} + \omega'^2_{SP}) - Z_w \omega_A^2} \tag{7}$$

The short-term pitch response to elevator inputs is well represented by Equation 6 provided that $|Z_w \omega_A^2|$ remains small in comparison with the modulus of $s(s^2 + 2\zeta_{SP} \omega'_{SP} s + \omega'^2_{SP})$ in the frequency range of interest to the pilot in his short-term control of pitch attitude. Reference 3 presents examples of comparisons between the pitch responses given by Equations 2 and 6 respectively to elevator inputs for a variety of configurations evaluated in Group I of this investigation. Little deviation between the solutions occurs in the first two or three seconds following a step elevator input.

The low frequency or long-term pitch response to elevator inputs is, in general, not adquately represented by Equation 6 and, for the low stiffness configurations being considered in this group, this portion of the response is better represented by

$$\frac{q_{LF}}{M_{\delta e}\delta e}(s) \approx \frac{-Z_w}{2\zeta_{SP}\,\omega'_{SP}\,s + \omega'^2_{SP}} \,. \qquad (8)$$

When formulated in terms of the unaugmented short-period approximation of Equation 1, Equation 6 becomes

$$\frac{q_{HF}}{M_{\delta e}\delta e}(s) \approx \frac{s}{s^2 - (M_q + UM_{\dot{w}})s - U(M_w + M_{\dot{w}}\,Z_w)} \qquad (9)$$

It is seen that the high frequency response is characterized by a second-order system with a total damping less than that given by $2\zeta_{SP}\,\omega'_{SP}$ and a stiffness which becomes negative when $-M_w < M_{\dot{w}}\,Z_w$.

The special case of pole-zero cancellation for $M_w + M_{\dot{w}}\,Z_w = 0$ (or $\omega_A^2 = 0$) is readily obtained from Equation 3 and the resulting response is given by

$$\frac{q}{M_{\delta e}\delta e}(s) = \frac{1}{s - (M_q + UM_{\dot{w}})} \qquad (10)$$

$$= \frac{1}{s + (2\zeta_{SP}\,\omega'_{SP} + Z_w)} \qquad (11)$$

This condition, quite apart from the first-order pitch response to elevator inputs (the form of this, in the time scales of interest, is essentially retained even for non-zero θ_o), also results in a first order pitch response to normal thrust inputs and in minimum pitch response to normal gusts. Because of these attributes this configuration will be designated as basic in the considerations of the effects of

M_w and Z_w that follow.

5.1.1.1 Effect of M_w

Variations in M_w do not affect the total damping of the longitudinal modes of motion but they do have a significant effect on the total stiffness, that is, for complex roots, on the stiffness of the short-period mode and, for aperiodic modes, on the distribution of the total damping between the roots.

Attention is again directed at the short-period pitch response to elevator inputs. In order to emphasize the changes in harmony between the initial and final pitch responses to elevator inputs when the short-period characteristics are changed through M_w, the steady-state pitch rate response to step inputs is used for normalizing purposes. This implies that the elevator displacement appropriate to the attainment of a given change in the steady state pitch rate is applied by the pilot in one step. (This form of normalizing is only possible for stable short-term pitch responses to elevator.) When comparisons are then made between the pitch responses of the basic configuration with $-M_w = M_{\dot{w}} Z_w$ and those with $-M_w > M_{\dot{w}} Z_w$, it is found that the initial response of the latter group is quickened relative to the basic first-order response by the stiffness formulated in Equation 6 and, indeed, can appear to be underdamped for complex roots. However, when $-M_w < M_{\dot{w}} Z_w$, the response is more sluggish than the first-order response and can, in the short term, create the impression of the existence of an aperiodic instability. The loci, due to variations in M_w, of both the short-period roots and the roots of the approximation to the high frequency pitch response to elevator inputs are presented in Figure 13a to illustrate these regions of operation.

Turning to other transfer functions relevant to the pitch response, it is found that moving $-M_w$ from $M_{\dot{w}} Z_w$ results in increasing response to both normal gusts and normal thrust inputs.

5.1.1.2 Effect of Z_w

The level of Z_w can affect significantly the pitch control characteristics even of configurations with identical short-period roots.

It is seen from Equations 1 and 9 and from the root loci plots in Figure 13b that, although the short-period stiffness and damping are both increased with increases in $-Z_w$, the short-term pitch stiffness to elevator inputs is decreased in the presence of the normally negative values of $M_{\dot{w}}$, whereas the short-term pitch damping remains unchanged. Thus, despite the movement away from the origin of the short-period roots which can be achieved through increases in $-Z_w$, the short-term control of pitch through elevator is characterized by an apparently reduced high frequency stiffness at constant damping as $- Z_w$ is increased. When comparisons are made between configurations with the same short-period characteristic roots but with different values for Z_w, it is generally true that both the apparent total damping and stiffness of the pitch response to elevator inputs at high frequencies are reduced at higher levels of $- Z_w$. This can lead to sluggish pitch control characteristics and to poor control over the trim values of pitch attitude for configurations whose short-period stiffness and damping are derived to a large extent from the contribution of Z_w.

Other effects of Z_w are seen in the normal acceleration response to vertical gusts which increases with increasing $- Z_w$, and in the time constant associated with the control of normal-velocity related quantities which decreases with increasing $- Z_w$. As $- Z_w$ is increased, the height control task should thus be eased through the quickened response to normal thrust inputs, whereas the ride and control of pitch will be worsened at a given level of short-period stiffness and total damping.

5.1.2 Configuration Characteristics Evaluated

The significant characteristics are listed in Tables I and II and illustrated in Figure 12. Common to all configurations in this group were the steady-state flight path response to elevator given by

$$\left.\frac{\dot{h}}{u}\right|_{\delta e_{ss}} = -.23 ,$$

and that Z_u and M_u were set to zero.

The short-period stiffness was varied through M_w for the following values of total damping and Z_w:

CONFIGURATIONS	Z_w	$2\zeta_{SP}\ \omega'_{SP}$
1 - 5	- .5	1.75
6 - 9	- .25	1.75
10 - 15	- 1.0	1.75
16 - 17	- .5	1.4
18 - 20	- .5	1.0

5.1.3 Pilots' Assessments of Handling Qualities

As a general observation to preface the discussion of pilots' comments and ratings, it should be noted that on occasion considerable variations in ratings were obtained for different evaluations of the same configurations. Only a study of the pilots' comments will indicate the actual cause for this spread but it can often be attributed to the difficulty that the pilot has in assigning an overall rating to a configuration exhibiting several mediocre to poor characteristics, any one of which may or may not be disturbed sufficiently to cause him anxiety during an evaluation. Although all the comments have been studied in detail, the main concern in the text is to extract trends in the changes in handling qualities that result from parametric variations. The comments pertaining to individual evaluations are presented in full in Table III to allow the reader to study the causes for anomalous behaviour.

For the first group in question, the influence on pilots' ratings of variations in M_w at different Z_w for $2\zeta_{SP}\omega'_{SP} = 1.75$ is presented in Figure 14 whereas that at different damping levels for $Z_w = -0.5$ is presented in Figure 15.

The comments regarding the difficulty experienced and the precision attained in each flight phase are also presented in a statistical manner in Figures 26 and 27 for two of the parametric variations discussed in this group. Shown are the extreme and mean adjectives and their standard deviation as used by the pilots to describe the various flight phases in each of the evaluations of the configuration. To attain these statistical properties on the basis of the prescribed adjectives, it has been assumed that the pilots used the adjectives according to a linear scale. The aim of the presentation is to indicate the mean trends as well as the likely deviations which may occur.

5.1.3.1 Configurations 1-5, $Z_w = -.5$, $2\zeta_{SP}\ \omega'_{SP} = 1.75$

The above mentioned statistical properties of the pilots' comments are summarized in Figure 27 and those of Pilot A's control usage for Configurations 1, 2 and 5 are presented in Figure 30.

The basic configuration of the group (#2) with $\frac{q}{M_{\delta e}\delta e}(s) \simeq \frac{1}{s + 1.25}$ exhibited good pitch characteristics with no oscillatory tendencies. Speed control (both longitudinal and normal) caused at worst only slight difficulty and the insensitivity to turbulence was favourably commented upon. Any slight difficulty during glideslope and localizer tracking was attributed to the wind shear encountered. In the flare, rate of descent could easily be arrested with fair to good precision.

As $-M_w$ was increased, the crosscoupling effects from the heave motion to the pitching motion became nuisance factors but, at the level of M_w investigated, did not degrade the rating. Turbulence response and the effects of thrust changes on the pitching moment equation elicited some comment. Airspeed control became more difficult in the presence of turbulence and slight, closed-loop oscillatory tendencies were occasionally noted. In general, the comments, if not the ratings, indicated slightly less desirable characteristics than those exhibited by the basic configuration.

As $-M_w$ was decreased from the basic level, the difficulty of controlling the pitch attitude and hence air-speed increased markedly. Complaints centred on apparent aperiodic pitch instabilities and high steady-state pitch responses to elevator inputs. The pitch control was classed as sluggish and, for the more unstable values of M_w, pilots indicated a propensity towards pilot induced oscillations. The minimum breakout height to which the pilots would be prepared to fly under instrument conditions showed a general increase although the pilots' assessments of the difficulty encountered and the performance achieved in flight path control did not vary significantly with decreasing stiffness. The flare caused difficulty at the lowest stiffness level because of the P.I.O. tendency.

In general, the difficulty in controlling the airspeed increased first with the introduction of IMC and then further with the introduction of turbulence for all but the basic configuration. Height rate control showed a similar increase in difficulty with the introduction of IMC but was not significantly affected by the introduction of turbulence. The control of the rate of change of height was considered to be less difficult than that of airspeed.

Summarizing, the effects of decreasing the stiffness to levels below the basic value caused marked changes in the following:

- Pitch Characteristics

  Pitch characteristics appeared to become sluggish.

  Pitch appeared to become increasingly unstable.

  Tendencies towards low frequency P.I.O.'s in pitch became increasingly significant.

  Interaction between thrust inputs and pitch response became noticeable.

- Airspeed Control

  As airspeed was controlled essentially through the pitch control loop, deterioration in airspeed control was linked to that in pitch.

- Rate of Change of Height Control

  As the primary task of controlling pitch demanded more attention, the control of height rate tended to become more difficult.

The small effect of decreasing stiffness on the remaining tasks, namely on glidepath and localizer control and on turning and flare manoeuvres, could be attributed to the lessened attention available for their control with increasing primary control task difficulty.

5.1.3.2 Configurations 6-9, $Z_w = -.25$, $2\zeta_{SP}\,\omega'_{SP} = 1.75$

The basic configuration for the group (#7) with

$$\frac{q}{M_{\delta e}\cdot\delta e}(s) \simeq \frac{1}{s + 1.5}$$

was rated to be slightly worse than the corresponding configuration with $Z_w = -.5$. The pitch was characterized by a tendency to wander at low frequencies and this resulted in airspeed control problems. On the whole, however, the configuration appeared to exhibit reasonable handling qualities.

Increasing the stiffness seemed to reduce the pitch looseness, probably because of the influence of θ_o, and thus eased the airspeed control problem. However, because of the insidious character of low frequency height rate errors resulting from the long time constant in heave, difficulty could be experienced in recovering from the large errors in height or height rate that could arise prior to perception by the pilot in turning manoeuvres or glide slope control. The pitch response to thrust inputs also became objectionable.

Decreasing the stiffness resulted in the same deterioration in pitch characteristics as for the higher $-Z_w$ configurations but, in addition, the undesirable influence of low $-Z_w$ on the precision of maintaining control over height rate was more pronounced. On the credit side, however, was the apparently reduced influence of turbulence on both pitch and heave responses.

5.1.3.3 Configurations 10-15, $Z_w = -1.0$, $2\zeta_{SP}\,\omega'_{SP} = 1.75$

The basic configuration for the group (#11) was characterized by

$$\frac{q}{M_{\delta e}\cdot\delta e}(s) \simeq \frac{1}{s + .75}$$

The assessment of this and all the other configurations of the group with different stiffnesses was dominated by the difficulty experienced in controlling pitch which was generally described as loose or sloppy. Strong propensities towards pilot induced oscillations existed. Turbulence effects, particulary on pitch and thus on airspeed, were much more pronounced than for the lower levels of $-Z_w$. Surprisingly, even though the time constant associated with the control of heave was reduced, a factor which should allow greater precision in height and height-rate control, the pilots often reported getting high on the glidepath. Some comments were made to the effect that the maximum selectable control gearing (Z_{δ_T} = 15.0 ft/sec^2/in) was perhaps a little low for these configurations. In general the configurations were considered to be unacceptable and the pilots would not be prepared to remain IMC to the desired breakout height of 200 ft A.G.L.

5.1.3.4 Summary of the Effect of Varying Z_w at $2\zeta_{SP}\ \omega'_{SP} = 1.75$

The statistical properties of the pilots' comments for the basic configurations at the three levels of Z_w are presented in Figure 28 and those of Pilot A's control usage in Figure 31.

From the pilots' assessments of the configurations it is seen that, as shown in Section 5.1.1.2, increasing $-Z_w$ at a constant $2\zeta_{SP}\ \omega'_{SP}$ increases the time constant associated with the control of pitch through elevator, and that this results in a very real deterioration in handling qualities when $2\zeta_{SP}\ \omega'_{SP} + Z_w$ becomes small. For example, all the configurations with $Z_w = -1.0$ and $2\zeta_{SP}\ \omega'_{SP} = 1.75$ were deemed unacceptable irrespective of the level of M_w.

At the other limit of very small Z_w one finds that the control of normal velocity becomes less precise, even with a normal thrust vector, because of the need to make acceleration-like commands to achieve the desired responses.

It is thus seen that a requirement exists for $2\zeta_{SP}\omega'_{SP} + Z_w$ to be sufficiently large for pitch control to remain acceptable and for $-Z_w$ to be sufficiently large to allow precise control of normal velocity related quantities. Even for adequate levels of $2\zeta_{SP}\omega'_{SP} + Z_w$, however, an upper limit needs to be placed on $-Z_w$ to restrain the acceleration response to gusts in heave to acceptable levels.

5.1.3.5 Configurations 16-17, $Z_w = -.5$, $2\zeta_{SP}\omega'_{SP} = 1.4$

The intent of this and the next group of configurations was to investigate the influence of reducing the short period damping at a constant Z_w.

The basic configuration (#17) with

$$\frac{q}{M_{\delta e}\delta e}(s) \simeq \frac{1}{s + 0.9}$$

exhibited characteristics considerably worse than those of Configuration 2 at the higher damping level, with pitch and airspeed control being singled out for their poor low frequency characteristics. This, coupled with normal velocity control problems, caused difficulty in maintaining the desired glide slope.

Increasing the stiffness improved the low frequency pitch characteristics and resulted in a marked improvement in rating.

5.1.3.6 Configurations 18-20, $Z_w = -.5$, $2\zeta_{SP}\omega'_{SP} = 1.0$

The basic configuration (#19) with

$$\frac{q}{M_{\delta e}\delta e}(s) \approx \frac{1}{s + .5}$$

exhibited poor pitch characteristics and these were not improved noticeably by changing the stiffness. Again, the low frequency pitch wander or looseness was the source of most of the control problems encountered and resulted in the pilot's overdriving the aircraft into low frequency, pilot induced oscillations. Airspeed control, normal velocity control and glide slope control all suffered and proved to be difficult.

5.1.3.7 Summary of the Effect of Varying $2\zeta_{SP}\ \omega'_{SP}$ at $Z_w = -.5$

The effect of decreasing $2\zeta_{SP}\ \omega'_{SP}$ at constant Z_w led to a rapid deterioration in handling qualities when the basic pitch control time constant was increased to more than about one second. The deterioration could generally be traced to the more sluggish pitch response to elevator which resulted in a requirement for the pitch control form to become an acceleration rather than rate command type if sufficiently great initial responses were to be attained without very large steady state responses. Some alleviation of this sluggish character could be provided by increasing the stiffness through M_w for the intermediate damping level, but no stiffness level was found to compensate adequately for these characteristics at the lowest damping level.

5.2 GROUP II Variations of Flight-Path Characteristics in the Presence of Good Pitch Control Characteristics

Removing the constraint of zero Z_u applied to the Group I configurations is likely to affect the flight-path control significantly in that it tends to result in a non-minimum phase response of height rate to elevator inputs. Previous investigations have indicated that even slight non-minimum phase values can cause significant deterioration in handling qualities during the approach task. It was thus considered important to attempt to isolate this outer control loop from the inner pitch control loop as much as possible by augmenting the pitch stability to desirable levels.

To be effective, it is required that the authority of a stability augmentation system be sufficient to produce pitch characteristics which allow the pilot to change predictably and precisely from one attitude to another. Furthermore, it is necessary that the desired attitude not be disturbed either markedly by external disturbances or unpredictably by cross-coupling effects from his controls.

Many of the configurations of Group I exhibited unacceptable pitching characteristics and it thus appeared appropriate to investigate whether, with the simple pitch attitude and rate feedback augmentation system illustrated schematically in Figure 3, it was possible firstly to make the handling qualities associated with pitch control acceptable and secondly, to ascertain whether this system dominated these ensuing handling qualities to the extent of reducing the influence of external disturbances and crosscoupling from the other controls to insignificant levels.

5.2.1 Assessment of the Effectiveness of the Pitch S.A.S.

Three configurations from Group I with $Z_w = -.5$ were chosen to assess the effectiveness of the pitch stability augmentation system:

Configuration	Basic Short-Term Pitch Characteristics	
1	Good Damping,	Good Stiffness
4	Good Damping,	Poor Stiffness
19	Poor Damping,	Good Stiffness

The pilots' ratings for these configurations may be seen from Figure 15 and their comments from Table III.

The augmented short-term modal characteristics of ω_{ST} = 1.5 r/s, ζ_{ST} = 0.7 were anticipated to produce desirable control characteristics. The aircraft states, θ and q, were fed back at appropriate gains to achieve these characteristics and the feed forward characteristics of the pilots' elevator control could be adjusted to result in either pitch rate or attitude command forms. No optimization of the augmentation systems was undertaken by the pilots, firstly because it was felt that once the pitching characteristics were easily controllable, minor variations in these characteristics would not affect the pilot's control task significantly, and secondly for the more mundane reason of keeping the experimental programme within manageable bounds.

It may be seen from the pilots' comments in Table III and their ratings in Figure 16 that the objective of the augmentation system was achieved. To within the scatter of ratings found in the evaluation of any specific model caused by, for example, external factors or pilot variability, the handling qualities of all three configurations were, by the rate command system, improved to the level exhibited by the unaugmented Configuration 1. Furthermore these handling qualities, because of the desirable pitch characteristics, allowed ready control of both longitudinal and normal velocities and also exhibited good gust and control-crosscoupling moment rejection.

The attitude command system allowed greater precision in the control of steady state values and thereby made the tracking task easier than when it was undertaken with the rate command system but, in favour of the latter system, one observes a more significant propensity towards pilot induced oscillations with the attitude command form.

Comparison of the pilots' comments about configurations R1, R4 and R19 and about their progenies with non zero Z_u does not show significant differences at a given level of Z_u, thus supporting further the contention that these augmented characteristics would override the basic pitching characteristics. The differences remaining in the open-loop modes of motion could be readily controlled by the pilot without altering his assessment of the overall handling qualities.

It is not the intention here to imply that the command forms of the augmented systems were near optimum for all conditions, only that for a given command form the pitch control task was essentially normalized for the pilot.

5.2.2 Analytical Considerations of Flight Path Control

In the presence of easily controlled pitching characteristics, many of the salient features of flight-path control through elevator may be expressed in terms of the pitching motion rather than the higher-order pilot's elevator motion, as was originally implied in Reference 6 and subsequently reiterated in different forms in several more recent publications. This remains true at least for those cases where the forces on the aircraft due to elevator movement are significant only in the production of pitching moments. In these circumstances, the characteristic equation and the transfer functions for height and speed control in terms of the pitch change generated through elevator become respectively

$$\Delta = s^2 - (X_u + Z_w)s - X_w Z_u + X_u Z_w \,, \tag{12}$$

$$\frac{\dot{h}}{\theta}(s)\Big|_{\delta e} = -\,UZ_w\left[s - \frac{Z_u}{Z_w}\left(\frac{g}{U} - X_w\right) - X_u - \frac{g}{U}\,\theta_o\right]\Big/\Delta \,, \tag{13}$$

$$\frac{u}{\theta}(s)\Big|_{\delta e} = -\left[W_o\, s^2 + \left(g - W_o Z_w - U_o X_w\right)s - g\left(Z_w - X_w\theta_o\right)\right]\Big/\Delta \,. \tag{14}$$

If $|Z_w| >> |X_w\theta_o|$ and $\frac{g}{U} >> |X_w|$, Equation 14 may be simplified to:

$$\frac{u}{\theta}(s)\Big|_{\delta e} = -\left[\left(s - Z_w\right)\left(W_o s + g\right)\right]\Big/\Delta \,. \tag{15}$$

[As an aside, it should be noted that, in the linear range, variations in both $X_w Z_u - X_u Z_w$ and $W_o Z_w + U_o X_w$ due to a small angular rotation θ_o are zero and that these groupings rather than the individual derivatives should be considered in handling qualities investigations of flight path control when either X_w or X_u deviate markedly from the values caused primarily by aerodynamic drag changes.]

The levels of W_o typically attained in the landing approach phase are such that the lead produced by it in the speed response to pitch attitude variations is not significant in the long-term flight-path control mode. Equation 15 may thus be further approximated as:

$$\frac{u}{\theta}(s)\bigg|_{\delta e} = -\left[g(s - Z_w)\right] / \Delta \ . \tag{16}$$

For the situation which normally arises in practice, of $|X_u + Z_w|$ being considerably larger than $\left|X_w \frac{Z_u}{Z_w}\right|$, one may finally write:

$$\frac{u}{\theta}(s)\bigg|_{\delta e} = \frac{-g}{s - X_u + X_w \frac{Z_u}{Z_w}} \tag{17}$$

During the landing approach task, a quantity of importance to the pilot is the relative response of the rate of change of height and longitudinal speed resulting from pitch attitude changes made by means of the elevator control.

This is given, for the above approximations, by

$$\frac{\dot{h}}{u}(s)\bigg|_{\delta e \to \theta} = \frac{UZ_w}{g} \, \frac{\left[s - \frac{g}{U}\left(\frac{Z_u}{Z_w} + \theta_o\right) - X_u\right]}{s - Z_w} \; . \qquad (18)$$

The well known result of speed-instability occurs when a non-minimum phase value is attained in this expression and the height-rate loop is closed with pitch attitude. Even for the situation of a zero in the left half of the root locus plane, one finds that the initial relative response of height-rate to velocity decreases with decreasing $- UZ_w$, thereby making the short-term control of height rate with elevator less effective than that to which pilots have become accustomed in more conventional aircraft exhibiting higher values of $\frac{C_{L_\alpha}}{C_{L_o}}$ in the landing approach phase $\left(\frac{U}{g} Z_{w_{AERO}} \simeq - \frac{C_{L_\alpha}}{C_{L_o}}\right)$.

5.2.3 Configuration Characteristics Evaluated

The parameter chosen as possibly being the most appropriate open-loop measure of the long-term flight path control problems likely to be encountered is the steady state ratio, $\frac{\dot{h}}{u}\Big|_{\delta e \to \theta_{ss}}$, between the rate of change of height and velocity for a change in pitch attitude through elevator. This velocity ratio is obtained approximately from Equation 18 as:

$$\frac{\dot{h}}{u}\bigg|_{\delta e \to \theta_{ss}} \simeq \frac{Z_u}{Z_w} + \frac{U}{g} X_u + \theta_o \; . \qquad (19)$$

It is related to the change in flight path angle caused by speed changes, used for this same purpose in Reference 7, through

$$\frac{\dot{h}}{u} = U \frac{\gamma}{u} . \tag{20}$$

Rate of change of height rather than flight-path angle is chosen here for use in the identifying parameter both because of the ensuing non-dimensional nature of the parameter and because $\dot{h}$ and U are the two predominant state variables which the pilot modulates in his long-term control of trajectory.

As well as giving the long-term relative velocity changes obtained through pitch modulation, the parameter gives an indication of the compensatory thrust that would be required to maintain or achieve the desired speed and trajectory when the inner pitch loop is closed by the pilot on one or other of the velocity components in the longitudinal plane.

It is seen from Equation 19 that changes in the parameter can arise from changes in both the X and Z force derivatives. Lack of an independent means of controlling longitudinal forces of the simulator in question, however, restricted the investigation to one of assessing the effect of variations in the dominant normal force derivatives, Z_u and Z_w.

The three levels of Z_w investigated in Group I were evaluated with non-zero Z_u, the latter being limited to values less than the 'pure' aerodynamic value of

$$Z_u = -\ 2g/U_o = -0.635\ .$$

In addition, the ratio Z_u/Z_w was not allowed to exceed a value of 1.2. [For aerodynamically generated forces, $Z_u/Z_w \approx 2\ C_{L_o}/C_{L_\alpha}$.]

5.2.3.1 Characteristics of Pitch Stability Augmentation System

The control surface movement for the attitude command system utilized was related to the pilot's control displacement and the aircraft pitch states by

$$M_{\delta e}\delta e_s = M_{\delta e}\delta e_p + M_{\theta_{SAS}}\cdot\theta + M_{q_{SAS}}\cdot q\ , \qquad (21)$$

whilst that for the rate command system was related by

$$M_{\delta e}\delta e_s = M_{\delta e}\left[\frac{s^2 - (M_q + M_{\dot\alpha})s - M_\theta}{s(s - M_q - M_{\dot\alpha})}\right]\delta e_p + M_{\theta_{SAS}}\cdot\theta + M_{q_{SAS}}\cdot q \quad (22)$$

The pre-filtering applied to the pilot's elevator control diplacements for the rate command form was chosen to provide, with a minimum of adjustable components, an approximate pole-zero cancellation of the second-order short-term characteristic mode, and to replace this mode with a pair of roots, one of which was located at the origin.

The introduction of pitch attitude feedback to the moment equation alters the short-term pitch response to elevator inputs obtained from the expansion of the transfer function about the zero location, given in Equation 3, to the following:

$$\frac{\theta}{M_{\delta e}\delta e}(s) = \frac{1}{s^2 + 2\zeta_A \omega_A + \omega_A^2}\left[\frac{s^3 + 2\zeta_{SP}\omega_{SP}s^2 + \omega_{SP}^2 s - Z_w \omega_A^2}{s^3 + 2\zeta_{SP}\omega_{SP}s^2 + \omega_{SP}^2 s - Z_w M_\theta}\right], \tag{23}$$

where
$$2\zeta_A \omega_A = 2\zeta_{SP}\omega_{SP} + Z_w$$
$$= -(M_q + UM_{\dot{w}}),$$
$$\omega_A^2 = \omega_{SP}^2 + 2\zeta_A \omega_A Z_w$$
$$= -(UM_w + UM_{\dot{w}} Z_w + M_\theta)$$

If the stabilization authority is high in comparison to the basic moment characteristics, that is, if $|M_\theta| >> |U(M_w + M_{\dot{w}} Z_w)|$, one may write $\omega_A^2 \simeq - M_\theta$. In this case the high frequency pitch response for the attitude command form, A, is well approximated by

$$\frac{\theta_{HF}}{M_{\delta e}\delta e}(s) \simeq \frac{1}{s^2 + 2\zeta_A \omega_A s + \omega_A^2}, \tag{24}$$

whereas that for the rate command form, R, with the control law shaping of Equation 22 becomes

$$\frac{\theta_{HF}}{M_{\delta e}\delta e}(s) \simeq \frac{1}{s(s - M_q - UM_{\dot{w}})}. \tag{25}$$

The steady state error of these approximations is readily obtained from Equation 23.

The non-zero values of Z_u for this group of configurations also mean that one of the phugoid or long-term roots is no longer precisely cancelled by the low frequency zero in the $\frac{\theta}{\delta e}$ (s) transfer function (see Table II). At low frequencies, this causes a further deviation between the predicted responses of Equations 24 and 25 and the actual responses. However, this deviation should not prove to be significant in the bandwidth of concern to the pilot for the short-term control of the pitch attitude loop.

5.2.3.2 Configuration Matrix

The following configurations were evaluated:

Basic Config'n	Z_w \ Z_u		0	-.05	-.1	-.2	-.6
1	-.5	$\dot{h}/u \mid \delta e_{ss}$ EVALUATED	-.24 R			.20 R	1.07 A, R
4	-.5	$\dot{h}/u \mid \delta e_{ss}$ EVALUATED	-.24 R		-.02 A	.20 A, R	1.07 A, R
19	-.5	$\dot{h}/u \mid \delta e_{ss}$ EVALUATED	-.24 R		-.02 R	.20 R	1.07 A, R
8	-.25	$\dot{h}/u \mid \delta e_{ss}$ EVALUATED	-.23 A, R	-.01 A, R		.64 A, R	
14	-1.0	$\dot{h}/u \mid \delta e_{ss}$ EVALUATED	-.24 A, R			.02 A, R	.41 A, R

where R signifies evaluations with the rate command system

A signifies evaluations with the attitude command system

All configurations were stabilized to possess the same short-period characteristics, $\omega_{SP} = 1.5$, $\zeta_{SP} = 0.7$.

The relationship between this group of configurations and the others evaluated is illustrated in Figure 12.

5.2.4 Pilots' Assessments of Handling Qualities

5.2.4.1 Configurations Based on No's 1, 4 and 19 with $Z_w = -0.5$

These configurations have already been referred to in Section 5.2.1 with regard to the pitch stabilization system and it was therein indicated that the system essentially normalized the pitch response for the pilot. It thus becomes possible to treat the configurations at a given level of Z_u as a group.

(a) Rate Command System

The pilots' comments about these configurations are presented in Table III and their ratings are plotted in Figure 16. The comments for conglomerates of configurations with the same Z_u regarding the difficulty experienced and the precision attained in each flight phase are also presented in a statistical manner in Figure 29. The statistical properties of the pilots' control usage are given in Figures 32-35.

It is noteworthy that, for this group, the average difficulty experienced and precision attained in all flight phases, including the localizer tracking, followed the same trend with variation in Z_u and that this trend repeats the one found in the overall average of the pilots' ratings of Figure 16.

As the detailed aspects of the configuration control characteristics are presented in Figure 29, only what are considered to be the causal parameters will be considered here.

Movement away from the optimum region, defined approximately by $\left|\frac{\dot{h}}{u}\right|_{\delta e_{ss}} < 0.3 - 0.5$, is characterized chiefly by a deterioration in speed control and its ensuing influence on height rate control.

The speed control, for the constant pitching characteristics of this group, may be affected firstly by the control technique employed by the pilot and secondly by the speed response to attitude changes or, in more detail, by the following factors.

(i) When $\left.\frac{\dot{h}}{u}\right|_{\delta e_{ss}} > 0$, speed instability may result if the pilot attempts to close on height rate errors with pitch attitude. Any such tendency would be destabilizing.

(ii) The open-loop speed response to pitch attitude is governed to good approximation by Equation 17 and it is seen from this equation that both the time constant and the magnitude of the steady state response increase as $-\left(X_u - X_w \frac{Z_u}{Z_w}\right)$ tends towards zero. Increases in $-Z_u$ for the X_w of the simulator thus tend to make pitch attitude a rate control for speed throughout the time scales of interest to the pilot.

Either of the above two factors, or a combination thereof, could explain the worsening speed control but, in view of the improvement afforded to the configurations with introduction of the attitude command system described in the next section, it is suspected that the factor (ii) was the more important.

In summary, when $- Z_u$ is increased to values beyond the optimum region, the configurations with the rate-command pitch control system are characterized by a deterioration in all control phases except that of the inner pitch loop. This deterioration is attributed to a worsening in the control over airspeed and the increased coupling between airspeed and vertical speed. The latter factor results in a greater heave response to longitudinal gusts, wind shear and speed perturbations arising from the pilot's control inputs.

Perturbations from these sources, which could remain undetected until they became quite large because of the low level of acceleration cues typifying the configurations, could cause wide variations in control difficulty during any portion of the task.

(b) Attitude Command System

The pilots' comments about these configurations are presented in Table III and their ratings are plotted in Figure 15.

Comparison of the comments with those on the rate command system at any level of Z_u shows a decrease in difficulty and an increase in precision for all task phases except the flare for the zero Z_u case. For this configuration, a greater propensity towards pilot induced oscillations resulted in difficulty because of the higher control gains that pilots tend to use when close to the ground. The pilots' ratings were degraded correspondingly.

The improvement in the control of other task phases, in particular that at the highest level of $-Z_u$, was without doubt due to the greater precision with which steady state airspeed could be controlled. When the longitudinal speed response to pitch attitude is governed by a long time constant because of a small value of $-\left\{X_u - X_w \frac{Z_u}{Z_w}\right\}$, direct control over pitch attitude becomes an advantage to the pilot as an aid to the precise long-term control of speed. The pilots' estimates of their greatest undesired speed fluctuations did not show a noticeable improvement with the attitude command form until the highest level of $-Z_u$ was reached. However, frequent comments were made about the good pitch and speed hold characteristics.

The turbulence response in heave emerged as one of the worse features whereas height rate, airspeed and pitch control were classed amongst the better features of all the configurations.

The requirement to trim the elevator forces during steady manoeuvres such as turns did not elicit unfavourable comments.

5.2.4.2 Configurations Based on No. 8 with $Z_w = -0.25$

The pilots' comments about and their ratings of these configurations are presented in Table III and Figure 17 respectively.

(a) Rate Command System

For zero Z_u, airspeed and vertical velocity control in general and height control during turns proved to be more difficult than for the configurations with $Z_w = -0.5$. It is apparent that the long time constant associated with the low value of Z_w resulted in a lack of precision in the control of the normal velocities and that this concerned the pilots. When $-Z_u$ was increased to make $\left.\frac{\dot{h}}{u}\right|_{\delta e_{ss}}$ zero, airspeed control improved somewhat but the height rate control problem remained. A further increase in $-Z_u$ caused a deterioration in most flight phases in a manner similar to that experienced for the configurations with $Z_w = -.5$ and for the same reasons.

The trends are thus similar to those for $Z_w = -0.5$, but the added difficulty of controlling the long-term height rate results in a general degradation in pilots' ratings by as much as two rating points.

(b) Attitude Command System

The attitude command system, in comparison with the rate command system, again improved the general precision of speed control. The ensuing rating was more favourable, particularly for the highest $-Z_u$ level. At the zero Z_u level, however, neither system improved upon the stiffest unaugmented configuration for this Z_w level, indicating that the origin of the difficulty experienced lay in the heave rather than the pitch control loop.

5.2.4.3 Configurations Based on No. 14 with $Z_w = -1.0$

The pilots' comments about and their ratings of these configurations are presented in Table III and Figure 17 respectively.

The premise that most of the control problems associated with the unaugmented configurations 10-15 lay with the long effective time constant associated with the pitch control loop was supported by the improvements obtained with both the rate and attitude command pitch stability augmentation systems.

Pitch control and hence speed control improved markedly. The general level of ratings was still somewhat worse than for the configurations with $Z_w = -.5$ and much of this difference can be attributed to the sharper responses to turbulence in heave which resulted in an unsteady feeling. The differences in control task difficulty arising between the attitude and rate command forms were not as great as for the configurations with smaller Z_w.

The crosscoupling between longitudinal and vertical velocities became noticeable at the highest $- Z_u$ level, but did not achieve the magnitude needed to dominate all other characteristics.

5.2.5 Summary of the Effect of Varying Flight Path Characteristics

The influence on handling qualities of varying flight path characteristics through Z_u was quite dependent on the pitch characteristics of the configuration - on both the numerators and the denominator of the various pitch response transfer functions.

A general observation that may be made is that the pilots showed a preference for a near zero level of steady state rate of change of height with the elevator inputs - at least for these configurations evaluated with thrust vectors that were almost normal to the flight path and thereby encouraged the control of height rate through thrust modulation. When the level of Z_u was varied away from the rather flat optimum level centred on zero, the deterioration in handling qualities was dependent on how well the low frequency airspeed perturbations could be controlled. The attitude command, pitch stabilized system proved advantageous in this respect as it allowed a somewhat more precise control of the long-term pitch attitude variations which governed airspeed.

Positive $\left.\frac{\dot{h}}{u}\right|_{\delta e_{ss}}$ did not appear to cause dominant speed instability problems and this factor is indicative that the pilots recognized the need to control airspeed with elevator rather than thrust. However, the need to closely constrain airspeed as an inner loop for satisfactory height control added considerably to the pilot's workload, particularly as the acceleration cues indicating deviations in airspeed were generally small.

When Z_w was varied, it was found that a value of

$Z_w = -.5$ exhibited the best compromise between precise control of height rate, which deteriorates with decreasing $-Z_w$, and excessive accelerations in heave due to turbulence which arises with increasing $-Z_w$.

5.3 GROUP III Simultaneous Variations in Both Short and Long-Term Characteristics Through Z_u

Removing the pitch stability augmentation system returns the pitch characteristics of the configurations to their often poor original state. The purpose of evaluating the resulting group was to assess the influence of changing the long-term characteristics through variations in Z_u in the presence of typical unaugmented short-term characteristics of STOL aircraft.

5.3.1 Analytical Considerations

The analytical considerations for the previous two groups remain in effect but, in addition, the pilot is faced with the control of the long-term or phugoid mode which may be strongly excited by his elevator inputs. Group I configurations were characterized by a pole-zero cancellation in this mode, whereas the pitch stabilization of the Group II configurations resulted in the mode being well damped. In this group neither condition prevails for non-zero Z_u. As the modulus of this derivative is increased, the pilot needs to concern himself not only with the problems associated with $\left.\frac{\dot{h}}{u}(s)\right|_{\delta e}$ but also with the additional task of precisely controlling pitch attitude in the presence of more significant disturbing influences.

The total damping is unaffected by variations in Z_u. Its effect, just as that of M_w, lies with the distribution of the damping and stiffness between the modes. However, whereas the influence of M_w was apparent mainly in the short-term mode, that of Z_u makes itself felt more in the long-term mode.

As the time constants associated with each of these modes converge, the classical separation between the modes can no longer always be assumed valid. It is found that Z_u may transfer some of the damping traditionally associated with the short-period mode to the phugoid mode and vice versa depending on whether M_w Z_u is positive or negative. The less the modes are separated in stiffness, the more pronounced the effect. To the pilot concerned principally with closing a tight loop on attitude, this redistribution is apparent mainly in the phasing of his moment cues. When M_w and Z_u are negative, a poorly damped, complex long-term mode tends to result, and the initial swing back of attitude, due to this mode, following an elevator input may lull the pilot into a false sense of security and cause him to lag behind the aircraft. For positive M_w and negative Z_u, the long-term mode is well damped at the expense of an aperiodic instability in the 'short' term mode. The pilot is thereby made aware earlier of a need to compensate for the ensuing error. One example of this latter phenomenon is obtained amongst the configurations of this group.

5.3.2 Configuration Characteristics Evaluated

The characteristics of certain configurations of Group I were varied through changes in Z_u as indicated below.

Config.	Z_w \ Z_u		0	-.2	-.6
1	-0.5		-.24	.20	1.07
2(Basic)	-0.5		-.24	.20	1.07
4	-0.5		-.24	.20	1.07
19(Basic)	-0.5	$\frac{\dot{h}}{u}\Big\rvert_{\delta e_{ss}}$	-.24	.20	1.07
7(Basic)	-0.25		-.23	.64	-
8	-0.25		-.23	.64	-
11(Basic)	-1.0		-.24	-	.41
14	-1.0		-.24	.02	.41

The designation 'basic', as before, indicates a short-term pole-zero cancellation in the $\frac{q}{\delta e}$ (s) transfer function. This particular pole-zero cancellation was virtually unaffected for the range of Z_u evaluated.

The configuration characteristics may be obtained from Tables I and II whereas the relationship between this group of configurations and the others may be seen from Figure 12.

5.3.3 Pilots' Assessments of Handling Qualities

Only those characteristics altered by non-zero Z_u will be considered in detail in this section. For consistency with the Group II presentation, the ratings are again plotted against

$\left.\frac{\dot{h}}{u}\right|_{\delta e_{ss}}$ although it is recognized that the characteristic modes take on added significance.

5.3.3.1 Configurations with $Z_w = -0.5$: No's 1, 1-2, 1-3; 2, 2-2, 2-3; 4, 4-2, 4-3; 19, 19-2, 19-3

The pilots' comments and ratings are presented in Table III and Figure 18 respectively. It is seen that there is a trend indicating a monotonic worsening in handling qualities with increasing $-Z_u$ for all configurations except No. 4. This is the only configuration with positive M_w. It is thus characterized by an unstable aperiodic mode ($T_2 \simeq 6$ secs) and a well damped, low frequency complex pair. This combination resulted in ratings that were slightly more favourable (but perhaps insignificantly so) than those of Configuration 4 with $Z_u = 0$.

The difference in ratings between the configurations with $2\zeta\omega = 1.75$ and $Z_u = 0$ noted when the short-period stiffness was changed, was no longer apparent with $Z_u = -.2$ despite the significant difference in root locations between the configurations.

All configurations exhibited unacceptable handling qualities at the highest level of $-Z_u$.

Perusal of the pilots' comments indicates that the pilots were concerned first and foremost with the pitch characteristics and their effect on the control of airspeed and height rate. At the highest level of $-Z_u$, the coupling between airspeed and vertical speed achieved the 'Most Objectionable Features' category. Even for $Z_u = -0.2$, the level of difficulty experienced in controlling vertical velocity approached moderate from the slight category typical for the better configurations at $Z_u = 0$. It is this increase in difficulty and its effect on flight path control to which the worsening in rating is attributed even though the coupling did not attain a 'Most Objectionable Feature' designation.

Finally, the influence of turbulence in disturbing both pitch and heave increased to objectionable levels for $Z_u = -0.6$.

5.3.3.2 Configurations with $Z_w = -0.25$: No's 7, 7-2; 8, 8-2

The general level of ratings is seen from Figure 19 to worsen to the same unacceptable level for both configurations with $Z_u = -.2$.

Lack of pitch stiffness was held to be mainly responsible and the coupling between airspeed and vertical speed was considered to be an important contributing factor.

5.3.3.3 Configurations with $Z_w = -1.0$: No's 11, 11-2; 14, 14-1, 14-2

Again, as seen from the pilot's comments and Figure 19, the introduction of Z_u only worsened the already poor control over pitch and resulted in unacceptable configurations. Positive M_w did not result in the slight improvement in handling qualities noted with the introduction of moderate Z_u at $Z_w = -.5$.

5.3.4 Summary of the Effects of Varying Z_u

The handling qualities of all configurations with negative M_w worsened progressively with the introduction of Z_u. The only and slight improvement obtained in ratings for non-zero Z_u was with $Z_u = -.2$ at $Z_w = -0.5$ and positive M_w.

The deterioration in handling qualities was apparent mainly in the increased difficulty experienced in precisely controlling pitch caused by the additional excitation of the phugoid or long-term mode with elevator inputs. The coupling between airspeed and vertical speed added to the general difficulty in controlling either parameter. Turbulence response in both pitch and heave also added noticeably to the pilot's workload.

The evaluations indicate that the handling qualities of Group I, with $Z_u = 0$, are likely to be as good as can be obtained for these configurations with poor short-period characteristics and low inherent speed-damping. It is suggested that this is both because of the minimal excitation through elevator of the long-term modes that occurs with $Z_u = 0$ and because of the reasonable level of $\left.\frac{\dot{h}}{u}\right|_{\delta e_{ss}}$ for Group I.

5.4 GROUP IV Simultaneous Variations in Both Short and Long-Term Characteristics Through M_u

For this group, the final major constraint of $M_u = 0$, imposed in the previous groups, was removed.

Evaluations for non-zero M_u were only undertaken for configurations without pitch stability augmentation as the latter tends to alleviate the effects of variations in M_u too much to warrant an investigation.

5.4.1 Analytical Considerations

Whereas the major effect of non-zero Z_u u occurs in the equation governing normal velocity and affects the pitching moment equation only through the ensuing feedback terms $M_{\dot{w}}\dot{w}$ and $M_w w$, that of M_u is fed back directly to the pitching moment equation through $M_u u$ and can thus be expected to affect the short-term mode more than did Z_u for the levels of $M_{\dot{w}}$ prevailing.

Just as for variations in Z_u, the total damping of all the characteristic modes remains insensitive to variations in M_u. However, M_u does affect the stiffness of both modes, that of the short-term being decreased and that of the long-term increased as M_u is made more positive. Providing that the modes are well separated, only a very slight redistribution of total damping between the two modes occurs. As the separation between the modes decreases, however, the distribution of damping between them may also be affected noticeably by M_u. A short and long term aperiodic root may combine into a complex pair exhibiting levels of total damping and stiffness lying somewhere between the 'pure' short and long term modes. The damping of this pair is derived at the expense of the remaining aperiodic root near the origin and can result in an aperiodic instability. The distribution of the damping between the complex pair and aperiodic root depends critically on the value of M_u - positive values of which lead to oscillatory instabilities and negative values to aperiodic instabilities. However, the total damping of these three roots near the origin does not vary significantly.

Root locus plots illustrating three forms of the effect of M_u on the short and long term modes are presented in Figure 26. They are representative of configurations whose 'pure' modes exhibit differing degrees of separation.

The intermediate configuration (19-2) is of interest in that whilst the short and long term modes remain separated, a significant exchange of total damping between them occurs.

A situation of some concern arises when attempts are made to categorize configurations with least separation. If, as usual, requirements are to be based on the separate application of short and long term criteria, it is seen that very small variations in M_u can turn an acceptable into an unacceptable configuration. Some means needs to be devised to take into account the exchange of damping between the roots close to the origin which can easily be reversed by the pilot through closing an airspeed to elevator loop without his having to provide lead.

Apart from its effect on the characteristic modes, M_u also affects the control task through its effect on the pitch response to turbulence. The appropriate numerator is given by

$$N_{u_g}^{\theta}(s) = s[(M_u + Z_u M_{\dot{w}})s + Z_u M_w - Z_w M_u] .$$

For small θ_o and no attitude stabilization, the low frequency asymptote remains at the same gain level. The turbulence response is thus minimized when $M_u + Z_u M_{\dot{w}} = 0$.

5.4.2 Configuration Characteristics Evaluated

Representative configurations of Group III were chosen for M_u variations. In general, the level of M_u required to obtain either an aperiodic divergence represented by $\lambda = 0.1$, or an unstable oscillatory mode with $\zeta\omega = -0.1$, was chosen. In addition M_u was not allowed to exceed a value of $|M_u| = 0.005$.

The following configuration groups, encompassing a wide range of short-term characteristics (shown in Table II and Figure 12) were evaluated.

Conf	Z_w	Z_u	0	-.2	-.6
1	-.5		+, -	+, -	+, -
2	-.5			+	
4	-.5			+	
19	-.5	M_u	+, -	+, -	+, -
8	-.25		+	+, -	
11	-1.0			+	
14	-1.0		+	-	+

5.4.3 Pilots' Assessments of Handling Qualities

5.4.3.1 Configurations with $Z_w = -0.5$ Based on No. 1

The pilots' comments and their ratings are presented in Table III and Figure 20 respectively.

The basic configuration exhibited good short-period stiffness and damping. The effects of varying Z_u have already been assessed in Section 5.3.3.1, and the additional ones due to changes in M_u at each level of Z_u are now considered.

Because of the good separation between the short and long term responses, M_u does not significantly affect the total damping of either mode but does change the stiffness of each mode.

(i) $Z_u = 0$

The pilots' main concern remained correlated with the changes in the long-term characteristics as M_u was varied. For negative M_u, the complaints were about the lack of pitch stiffness associated with the aperiodic instability of $\lambda = 0.1$, whereas for positive M_u, the resulting long-term complex mode of relatively short period and low damping led to a tendency towards pilot induced oscillations. The one evaluation made with negative M_u returned a surprisingly good rating in view of the rapidity of the aperiodic divergence (time to double amplitude $\simeq$ 7 secs) but, as the rate of divergence is very sensitive to small changes in M_u, its control should not cause too much difficulty providing that the pilot is able to devote sufficient attention to this aspect of the task.

The configurations with non-zero M_u were disturbed noticeably more in pitch by the effects of turbulence and also made the pilot more aware of the pronounced response in pitch to thrust modulation arising from the large value of M_w.

(ii) $Z_u = -0.2$

The characteristics exhibited at $Z_u = 0$ with changing M_u again came to the fore but this time were even more apparent. The value of M_u required to generate the aperiodic instability was considerably greater than before and led to comments about the requirement for reversed force trim with steady state velocity changes. Positive M_u did not result in a significant deterioration in handling qualities, but even the best configurations of this group were barely acceptable.

(iii) $Z_u = -0.6$

The characteristic modes remained complex with $M_u = -.005$. All configurations were rated as unacceptable because the poor pitch characteristics, coupled with the strong interaction between the airspeed and normal velocity, proved to make the control task too difficult.

5.4.3.2 Configurations with $Z_w = -0.5$ Based on No's 2-2 and 4-2

In this group, the basic short period damping remained high but the stiffness was reduced.

(i) Configuration 2-2, $Z_u = -0.2$

The pilots' comments and ratings are presented in Table III and Figure 20 respectively.

Configuration 2-2 exhibited a complex long-term mode and a short-term pole-zero cancellation in the $\theta/\delta e$ (s) transfer function. Some damping of the long-term mode was transferred to the short-term mode with increasing M_u but the pole-zero cancellation essentially remained unaltered.

The increase in M_u made the pilot more aware of the oscillatory long-term mode, because of the resulting decreased damping and increased frequency of this mode. The deterioration in oscillatory character and the increased response to turbulence rendered the configuration unacceptable for two of the three pilots who evaluated it.

The configuration with negative M_u was not evaluated.

(ii) Configuration 4-2, $Z_u = -0.2$

The pilots' comments and ratings are presented in Table III and Figure 21 respectively.

The short-term stiffness was reduced further and, in Configuration 4-2, resulted in the combining of a short and long term root into a complex pair of moderate frequency and damping, and an unstable aperiodic root.

The aperiodic instability did not cause undue concern. When M_u was increased, however, this and the other short-term root were stabilized at the expense of the complex pair. The ensuing oscillation, which was easily excited, became difficult to suppress and resulted in the configuration being rated as unacceptable.

5.4.3.3 Configurations with Z_w = -0.5 Based on No. 19

The pilots' ratings and comments are presented in Figure 21 and Table III respectively.

This group of configurations had a lower basic short-period damping of $2\zeta\omega_{SP} = 1.0$ than the previous three groups and a short-period pole-zero cancellation in the $\frac{\theta}{\delta e}(s)$ transfer function. Because the total damping was decreased while the stiffness was held at the same level as in Configuration 4, the short-term aperiodic roots tended to be closer together and neither was as close to the origin as in Configuration 4. The short and long-term roots tended to remain more separated as a result but positive M_u did transfer significant total damping from the long-term to the short-term mode.

(i) $Z_u = 0$

The unstable long-term oscillation dominated the unacceptable handling qualities for the configuration with positive M_u, whereas that with zero M_u was marred by the general sloppiness of the pitch characteristics which resulted in overcontrol by the pilot.

(ii) $Z_u = -0.2$

The characteristics which dominated were much the same as at $Z_u = 0$. The configuration evaluated with an unstable aperiodic root in this group again did not cause a noticeable deterioration in rating, which seems to indicate that no significant difficulty was added by the need to control it. This configuration with negative M_u is marked by minimum pitch response to u_g.

(iii) $Z_u = -0.6$

All configurations proved to be unacceptable because of both the pitch characteristics and the coupling between airspeed and normal velocity. The aperiodic instability caused considerable difficulty for these configurations already characterized by other pronounced deficiencies in handling qualities.

5.4.3.4 Configurations with $Z_w = -0.25$ Based on No. 8

The pilots' comments and their ratings are presented in Table III and Figure 22.

Marked redistribution of the total damping between the short and long-term roots occurs just as for the higher Z_w level for the same basic stiffness.

The mean ratings at both levels of Z_u were insensitive to the M_u variations undertaken and remained at the acceptable-unacceptable borderline. The general looseness of the control, particularly in pitch, was the chief source of difficulty at zero Z_u, whereas, at the higher Z_u level, the coupling between longitudinal and vertical velocities compounded the difficulties.

The aperiodic instability with negative M_u again was not cause for undue concern.

5.4.3.5 Configurations with Z_w = -1.0 Based on No. 14

The pilots' ratings and their comments are presented in Figure 23 and Table III respectively.

The redistribution of total damping between short and long term modes through M_u was marked.

M_u variations had the same general effect as at Z_w = -0.5, but in a more pronounced manner. The already poor pitching characteristics, in particular their oscillatory nature and their response to turbulence, deteriorated even further and no acceptable configurations were found.

5.4.3.6 Summary of the Effect of Varying M_u

Perhaps the most important outcome of this portion of the investigation was the confirmation, seen also from the evaluations of Group III, that when the short and long term modes were no longer well separated and the influence of longitudinal velocity perturbations in the short-term mode was not negligible, then the combination of a phugoid and short period root into a reasonably damped long period oscillatory pair and a corresponding unstable aperiodic root of quite divergent characteristics did not necessarily result in unacceptable handling qualities. The sensitivity of these three roots to small M_u variations indicates that the pilot would have no difficulty in redistributing the total damping of the three roots near the origin by closing a low gain airspeed to elevator loop and thereby stabilizing the unstable aperiodic root.

In general, the variations in M_u did not improve the handling qualities of any configurations that were initially acceptable. The added response to turbulence, the establishment of easily excited long-term oscillatory characteristics and the redistribution of the already meagre damping of the long term mode to the short term mode when it would have been more beneficial to the former, all added to the control difficulty.

The effects of these changes were most pronounced in those configurations already exhibiting poor pitching characteristics.

5.5 GROUP V Effect of Non-Zero $\frac{Z_{\delta e}}{M_{\delta e}}$ on Selected Configurations

Many aircraft in the STOL class experience a change in lift force when the motivater providing pitching moment control is activated. The intent of this somewhat limited investigation was to ascertain whether significant handling qualities problems would ensue when realistic coupling levels were introduced.

It appeared to be appropriate to consider the effect of this crosscoupling term firstly on a basic configuration exhibiting some undesirable pitching characteristics to ensure that the elevator was moved significantly by the pilot, and secondly on a stabilized configuration in which the pilot was no longer linked directly through his control column to the motivater movement.

The basic configuration chosen was No. 1-2 in both its unstabilized form and its stabilized form with rate command.

Typical values of tail-arm coupling for this class of aircraft led to the choice of

$$\frac{Z_{\delta e}}{M_{\delta e}} = 7.5 \ , \ 15$$

as being suitable for investigation.

5.5.1 Pilots' Assessments of Handling Qualities

The pilots' comments and ratings are presented in Table III and Figure 24 respectively.

(a) Stabilized Configuration

The pilots' ratings were not affected significantly by factors which could be attributed directly to this control crosscoupling. However, uncertainty about the height-rate control characteristics were commented upon by Pilot B.

(b) Unstabilized Configuration

For the unstabilized configuration, Pilot A became more aware of the increased difficulty in controlling height rate as $\frac{Z_{\delta e}}{M_{\delta e}}$ was increased, mainly as a secondary effect. Pilot B's major concern did not change from that over the pitch characteristics.

5.5.2 Summary of the Effect of Varying $\frac{Z_{\delta e}}{M_{\delta e}}$

The influence of $Z_{\delta e}/M_{\delta e}$ on the general handling qualities remained secondary to the pilot throughout the range evaluated. It did, however, affect the background difficulty level experienced by the pilot in his control task.

5.6 GROUP VI Effect of Non-Zero $\frac{M_{\delta T}}{Z_{\delta T}}$ on Configuration 2-2

The control crosscoupling effect complementing that investigated in the previous group, is that due to thrust modulation on the aircraft's pitching moment.

Configuration 2-2 was chosen as the basic configuration for these tests because of its inherent coupling between speed and rate of change of height, which encourages some thrust modulation, and because of its relatively pure pitch response to elevator inputs. It was thereby hoped to focus attention on the effects of $M_{\delta T}$.

The variations made were as follows:

$$\frac{M_{\delta T}}{Z_{\delta T}} = -0.0064,\ +\ 0.0064,\ +\ 0.0128\ .$$

The most pronounced effect of $M_{\delta T}\delta T$ occurs in the $\theta/\delta T$ (s) transfer function and it is found that the initial pitch response is minimized when

$$\frac{M_{\delta T}}{Z_{\delta T}} = -M_{\dot{w}} = .00412$$

for this configuration.

5.6.1 Pilots' Assessments of Handling Qualities

The pilots' comments and ratings are presented in Table III and Figure 25 respectively.

A study of these comments indicates that the pilots were quite aware of the control crosscoupling for the extreme values of $M_{\delta T}/Z_{\delta T}$ and were concerned that situations might arise where this coupling could be dangerous. Pilot B classified the crosscoupling under 'Most Objectional Features'. At the intermediate level of $M_{\delta T}/Z_{\delta T}$, the crosscoupling, rather than standing in isolation as a dominant parameter, appeared to contribute to the general background level of difficulty.

Thus, the effects of $M_{\delta T}/Z_{\delta T}$, although not producing a monotonic variation in overall pilots' ratings, were more directly apparent to the pilot than were the effects of $Z_{\delta e}/M_{\delta e}$ and were recognized as being potentially hazardous. This added awareness of the coupling was probably due to the fact that the pitch disturbances caused by thrust changes are readily noticed by the pilot who is trying to maintain tight control over pitch in order to suppress his speed variations.

5.7 Statistical Analysis of the Pilots' Control Inputs

Few data were available, for the class of aircraft evaluated, of the pilot's control usage during the approach to landing. To supplement these data and to obtain insight into the sensitivity of the form of the pilot's control application to changing longitudinal handling qualities, several representative approaches were chosen for analysis. The statistical analysis was restricted to that of obtaining the power spectral density and amplitude distributions of the pilot's elevator control movement. The same analysis is not presented for the thrust lever movement because, in the quasi-stationary portion of the approach selected for analysis (approximately 50 seconds on the approach), only a few discrete adjustments to thrust were in general made and, quite often, a significant linear trend in the thrust modulation existed during this time period. Such a time history does not lend itself well to statistical categorization by means of frequency and amplitude distributions.

Details of the analysis and its results are presented in Appendix E and in Figures 30 to 35.

The form of the power spectral density distributions of each pilot's elevator control movements for the group of configurations analyzed was, in general, relatively insensitive to the configuration characteristics being evaluated. If the open-loop configuration characteristics were known, one could discern trends in the pilot's control movements which supported closed-loop expectations, particularly when the power spectral density distributions were viewed in conjunction with the amplitude distributions and time histories. For example, in the group of configurations evaluated by Pilot A in which the short-term stiffness was reduced by variations in M_w (Figure 30), there was a tendency on the pilot's part to hunt, at low frequency, for the appropriate pitch trim position when the short-term pitch stiffness became negative, (Conf. 5L; see also Section 5.1.1.1). The change in the statistical distributions of the elevator movement with M_w is nonetheless small when viewed in the light of the very pronounced change in the pilot's rating due predominantly to the changing pitch control characteristics.

Similar observations may be made about the effect of variations in Z_w.

In the group of configurations for which Z_u was the variable, it may again be seen that the statistical distributions of the elevator control movement were relatively insensitive to configuration changes. This, however, is not surprising in view of the essentially constant pitch control characteristics of these configurations. Of interest is the pilots' use of thrust modulation. It is seen from the time histories that even when operating on the extreme backside of the power required curve, the pilots did not significantly vary the form of their thrust-control usage. Thrust modulation was used only for long term control and this remained true for all the configurations evaluated.

Some correlation between the root mean square (r.m.s.) of the elevator control movements and the pilot's workload existed but, as the r.m.s. can be noticeably affected by changes in parameters that need not affect the workload significantly, for example, changes in the turbulence level or increases in the pitch stiffness through M_w, it can only be used as a relative rather than absolute indication of the pilot's workload.

In summary, statistical analysis of the pilots' elevator movements showed weak correlation between control activity and workload, but this correlation was not sufficiently unique or pronounced to allow the use of the statistical analysis for more than a substantiating role to other forms of analysis.

5.8 Comparison with MIL-F-83300

The portions of the MIL-F-83300 specifications relevant to the group of configurations evaluated are those dealing with the longitudinal characteristics in Sections 3.3.1 and 3.3.2 of those specifications.

Underlying the current limits and parameters therein utilized is the attempt to specify desirable pitch responses to elevator inputs. The total flight path control problem, however, has not yet been addressed in a quantitative manner.

Longitudinal equilibrium is established through the device of pitch-controller force and position gradients with respect to both attitude and speed changes, whereas the dynamics are specified in terms of the characteristic modes of motion of the configuration. The characteristic modes are separated into conglomerates of two pairs of roots, each pair having to satisfy certain requirements.

With regard to the longitudinal equilibrium, no Level 1 configuration which contravened the appropriate requirements was found. This factor could, however, equally well be a reflection of the simultaneously poor dynamic characteristics as of the contravention of the equilibrium conditions per se.

The dynamic requirements are expressed in terms of a short term mode, characterized by ω_n, $2\zeta_n\omega_n$, ζ_n and the short-term response to elevator parameter,

$$\left.\frac{\omega_n^2}{\frac{n}{\alpha}}\right|_{u=0}$$

, and by a low frequency, phugoid-type mode characterized by ω_{ph}, ζ_{ph}, T_2.

The previous analysis in this report has indicated that the implementation of the appropriate separation of the roots into two pairs can give rise to ambiguity. Moreover, whether or not the requirements are satisfied, is sensitive to the choice of pairs made, a situation which leaves much to be desired.

It is suggested that when the separation between the short and long term modes is small, some other means of categorizing the handling qualities which does not require modal separation into pairs of roots be established. Included should be a more direct measure of all the responses to elevator of concern to the pilot than is given by $\omega_n^2/\frac{n}{\alpha}$ or, its equivalent, $\frac{g}{U}\,\frac{\ddot{\theta}_{initial}}{\dot{\theta}_{final}}$, for those configurations exhibiting small modal separation and low pitch stiffness.

Some of the analysis presented in previous sections, which attempts to highlight the responses to controls in the time scales of interest to the pilot, is appropriate to such considerations.

It was found, when establishing minimum acceptable short-term stiffness and damping levels, that the pilots' major concern was not with ω_n and $2\zeta_n\omega_n$ per se but rather with the apparent initial (high frequency) pitch stiffness and damping in response to elevator inputs. As is shown in Section 5.1, the pitch response depends not only on the short-term characteristic mode, but also on the short-term zero in the $\frac{\theta}{\delta e}$ (s) transfer function, the location of which is essentially established by the magnitude of the damping in heave derivative Z_w. The present requirements address the limit for minimum stiffness through the parameter, $\omega_n^2/\frac{n}{\alpha}\Big|_{u=0}$, which, in terms of the pitch responses to rapid elevator inputs, relates the initial pitch acceleration to the final pitch rate that would be achieved if speed were to remain constant. During evaluations, it was found that the intermediate pitch response was also of importance to the pilot when flying low stiffness configurations, and this factor would suggest that the minimum stiffness requirement should be a function not only of Z_w but also of short-period damping, much as is the high frequency pitch stiffness ω_A^2 calculated in Section 5.1.

Similarly, flight evaluations demonstrated that the lower limit on total damping would be more appropriately related to $(2\zeta_n \omega_n + Z_w)$ rather than to $2\zeta_n \omega_n$ as in the present requirements.

Of the parameters not restricted explicitly in the requirements, flight path control would appear to be the most important remaining. This investigation indicates that

$\left.\frac{\dot{h}}{u}\right|_{\delta e_{ss}}$ may well be the parameter to be considered for this definitive role. It should be noted, however, that a marked interaction exists between the quality of pitch control and the ease of controlling the flight path.

5.9 Preliminary Summary of Handling Qualities Investigated

The foregoing investigation of a wide range of longitudinal handling qualities and their effect on a steep, low-speed instrument approach was intended to distinguish those characteristics which most critically affected the successful completion of this flight task.

The intent of this summary is to place the detailed investigations into perspective.

The dominant feature, whatever the other characteristics, was the control of pitch attitude. The more easily, predictably and precisely this could be controlled the less the significance of other undesirable characteristics.

In the first group investigated, in which the pitching characteristics were altered whilst those of the long-term speed and flight path control were maintained at favourable levels, it was found that the short-term characteristic mode no longer provided a unique parametric reference for the ensuing handling qualities when either the stiffness or the total damping of the mode became small. Under these circumstances the pitch response to elevator becomes particularly sensitive to the location of the high frequency zero of the $\frac{\theta}{\delta e}$ (s) transfer function relative to the roots comprising the short-term mode. It is this pole-zero conglomerate rather than the poles alone which critically determines the short-term handling qualities of the configuration. The pilot was sensitive to reductions in the high frequency pitch stiffness and damping characteristics for which second order approximations are developed in Section 5.1.1. With M_u and Z_u constrained to zero, no configuration was found which remained acceptable to the pilots for positive values of M_w, let alone for negative values of the short-period stiffness, $(- UM_w + M_q Z_w)$.

For low short-period stiffness arising from positive M_w, and when the influence of longitudinal velocity perturbations on the short-term mode is pronounced because of non-zero Z_u, it is found that the three roots near the origin can combine into a different configuration of a well damped complex pair and an unstable aperiodic root. (For example, compare configurations 4 and 4-2.) Flight evaluations of such configurations resulted in essentially the same ratings as those for the configurations with $Z_u = 0$ which had the same total damping derived from three stable or neutral roots near the origin. The new complex pair does not have the same character as the classical phugoid in that it has high residue in all three degrees of freedom. A redistribution of the damping between the roots can be caused by closing the elevator loop on airspeed with low gain - a technique which would not be successful in the control of the classical phugoid. Only limited stabilization governed by the inherent damping of the three roots near the origin is, however, possible with this technique.

The question raised is one of the definition of long-term and short-term modes to be used in these circumstances if compliance with requirements based on these separate modes needs to be demonstrated.

The derivative Z_w is of significance in many aspects of the control task. It critically affects the pitch response to elevator inputs and establishes the time constant of all motions in the normal plane. The turbulence response increased with increasing $-Z_w$. Moreover, for a given set of short term characteristics exhibiting low total damping, pitch control was worse at the higher levels of $-Z_w$. When $-Z_w$ became too small, although the turbulence response decreased, the imprecision of the long-term control of the vertical motion caused much concern. In the present investigation, a value of $Z_w = -0.5$ led to a better compromise of these conflicting characteristics than did values of $Z_w = -0.25$ and -1.0.

When the pitch stability is well augmented, it is found that larger positive steady state values of $\dot{h}/u$ for elevator inputs can be tolerated than in the absence of augmentation. The more positive the value of $\left.\frac{\dot{h}}{u}\right|_{\delta e_{ss}}$, the more advantageous the attitude command control form becomes because of its capabilities in allowing precise control of the steady state pitch attitude. The levels of $\left.\dot{h}/u\right|_{\delta e_{ss}}$ that could be accommodated by the pilot were considerably higher, with the good attitude command form and the normal thrust control vector of the experiment, than has previously been reported.

The effects of control crosscoupling could be disturbing in the overall task. That of thrust modulation on the aircraft's pitching moment was more readily isolated by the pilot as a causal factor than was the effect on lift of elevator displacements.

The statistical analysis of the pilot's elevator control movements during representative evaluations indicated that the shape of the power spectral density and amplitude distributions was only weakly and not very consistently correlated with the pilot's workload and rating. The thrust magnitude modulation by the pilot was of such frequency content as to indicate that he used thrust only as a long-term control.

The influence of simulating a pilot's station 25 feet ahead of the centre of gravity instead of the inherent 3 feet did not affect assessments noticeably.

Finally, the surprisingly large proportion of approaches during which the pilot complained of pronounced wind shear and the ensuing requirements for very large changes in steady state descent rates or large heading changes to compensate for the significant errors that built up before being detected, needs to be singled out. The sensitivity of the configurations in heave, in particular through the derivative Z_u, played a significant role in the frequency of comments about this aspect.

6.0 CONCLUSIONS

An in-flight investigation of a variety of longitudinal handling qualities during steep, low-speed instrument approaches resulted in the following general observations:

- The pitch control characteristics dominated the handling qualities. Pilots were sensitive to variations in both the short and long term pitch control characteristics.
- Pilots were prepared to accept operation well along the backside of the power-required curve providing that the long-term control of airspeed through pitch modulation was not difficult.
- When the characteristic modes of motion were not well separated, longitudinal handling qualities criteria could no longer be uniquely established on the basis of separating out two pairs of second order characteristic modes. The location of the zeros relative to the roots, particularly in the pitch response transfer functions, played a significant role in establishing the handling qualities.
- The magnitude of the derivative, Z_w, proved to be of importance as a handling qualities parameter because of its pronounced effect on the responses in and the control of both the pitch and heave degrees of freedom.

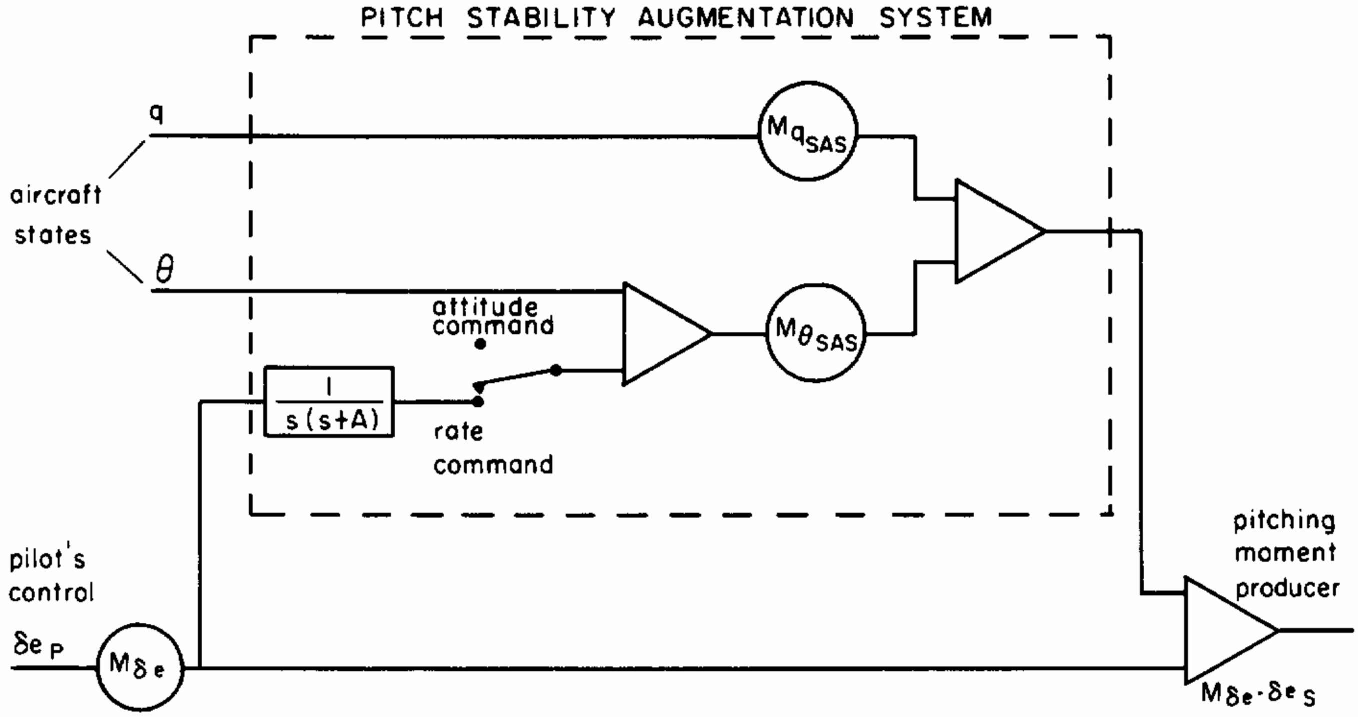
- The statistical characteristics of the pilots' elevator control movements could, at best, only be correlated weakly with the pilots' assessments of the handling qualities. Thrust modulation was used primarily as a long-term control.
- Atmospheric turbulence, wind and wind shear could have a significant effect on the control task during steep, low-speed, instrument approaches.

FIG I EVALUATION PILOT'S COCKPIT LAYOUT

PARAMETER	ELEVATOR	AILERON	RUDDER	THRUST LEVER
Static Characteristics				
Spring Gradient (lb/in)	2.2	1.3	10.5	0
Preload Force (lb)	0.8	0.4	6.5	0
Dry Friction (lb)	0.7	0.3	6	Adjustable
Travel (ins)	±4	±3	±3	-1.5, +4.0
Linear* Dynamic Characteristics				
Trim Rate (ins/sec)	±0.75	±0.55	Manual	N/A
ω_o (rad/sec)	8.2	7.7	8.2	N/A
ζ_o	0.3	0.4	0.3	N/A

* The dynamic characteristics due only to the spring gradient, viscous damping and inertia of the control system.

FIG. 2 EVALUATION PILOT'S CONTROL CHARACTERISTICS



$$A = -(M_q + M_{\dot{\alpha}}) = \text{TOTAL DAMPING} + X_u + Z_w$$

RATE COMMAND:

$$M_{\delta e}\delta e_S = M_{\delta e}\left[\frac{S^2 - (M_q + M_{\dot{\alpha}})S - M_{\theta\,SAS}}{S(S - M_q - M_{\dot{\alpha}})}\right]\delta e_P + M_{\theta_{SAS}}\cdot\theta + M_{q_{SAS}}\cdot q$$

ATTITUDE COMMAND:

$$M_{\delta e}\cdot\delta e_S = M_{\delta e}\delta e_P + M_{\theta_{SAS}}\cdot\theta + M_{q_{SAS}}\cdot q$$

FIG 3 SCHEMATIC OF STABILITY AUGMENTATION SYSTEM

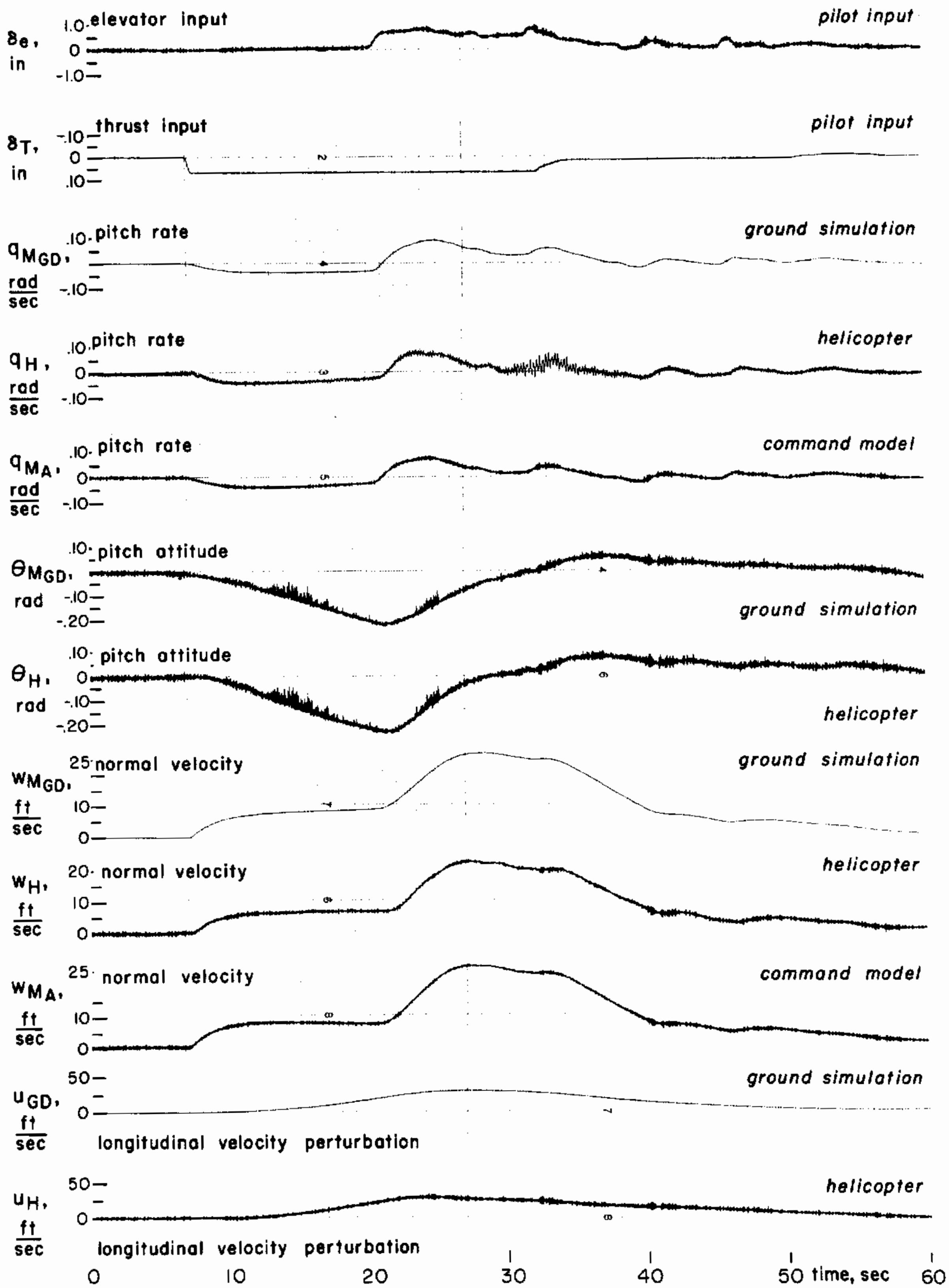


FIG 4 COMPARISON OF HELICOPTER RESPONSE TO CONTROL INPUTS WITH THAT COMMANDED IN AIR AND WITH THAT EXPECTED FROM GROUND SIMULATION - CONFIGURATION NO. I

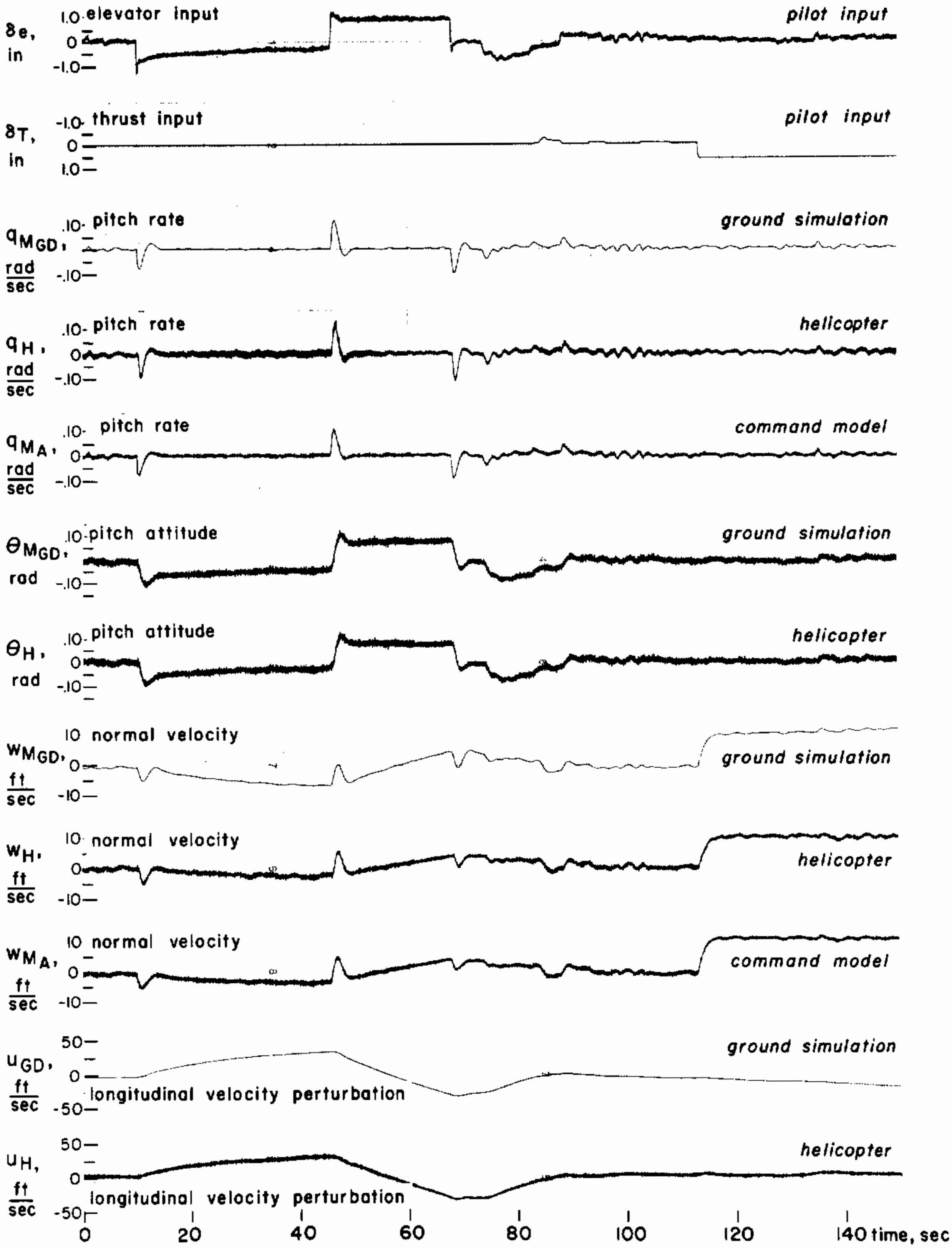


FIG 5 COMPARISON OF HELICOPTER RESPONSE TO CONTROL INPUTS WITH THAT COMMANDED IN AIR AND WITH THAT EXPECTED FROM GROUND SIMULATION - CONFIGURATION NO. A14-1

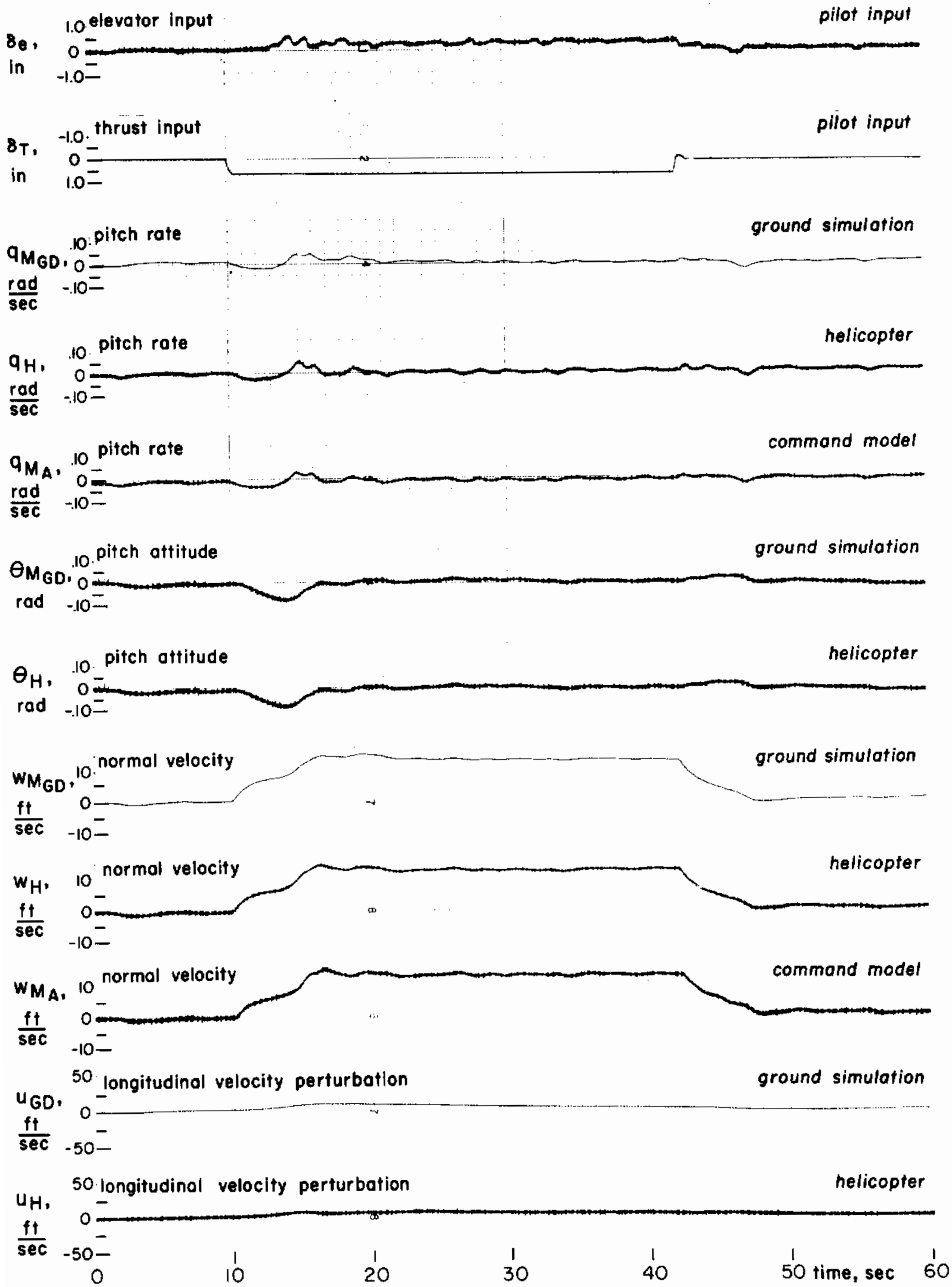


FIG 6 COMPARISON OF HELICOPTER RESPONSE TO CONTROL INPUTS WITH THAT COMMANDED IN AIR AND WITH THAT EXPECTED FROM GROUND SIMULATION - CONFIGURATION NO.1-2P(δ_T input)

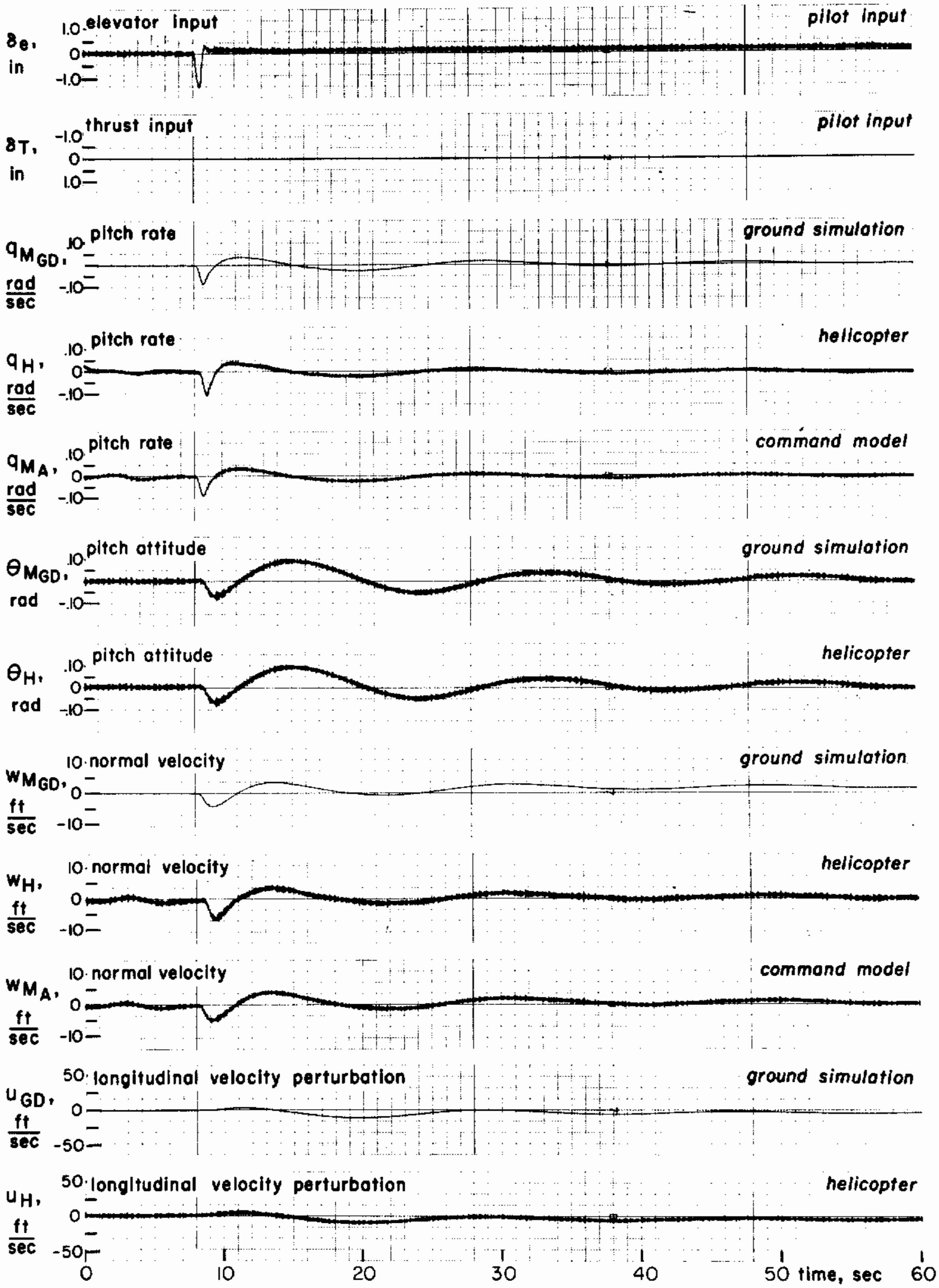


FIG 7 COMPARISON OF HELICOPTER RESPONSE TO CONTROL INPUTS WITH THAT COMMANDED IN AIR AND WITH THAT EXPECTED FROM GROUND SIMULATION - CONFIGURATION NO.1-2P (δ_e input)

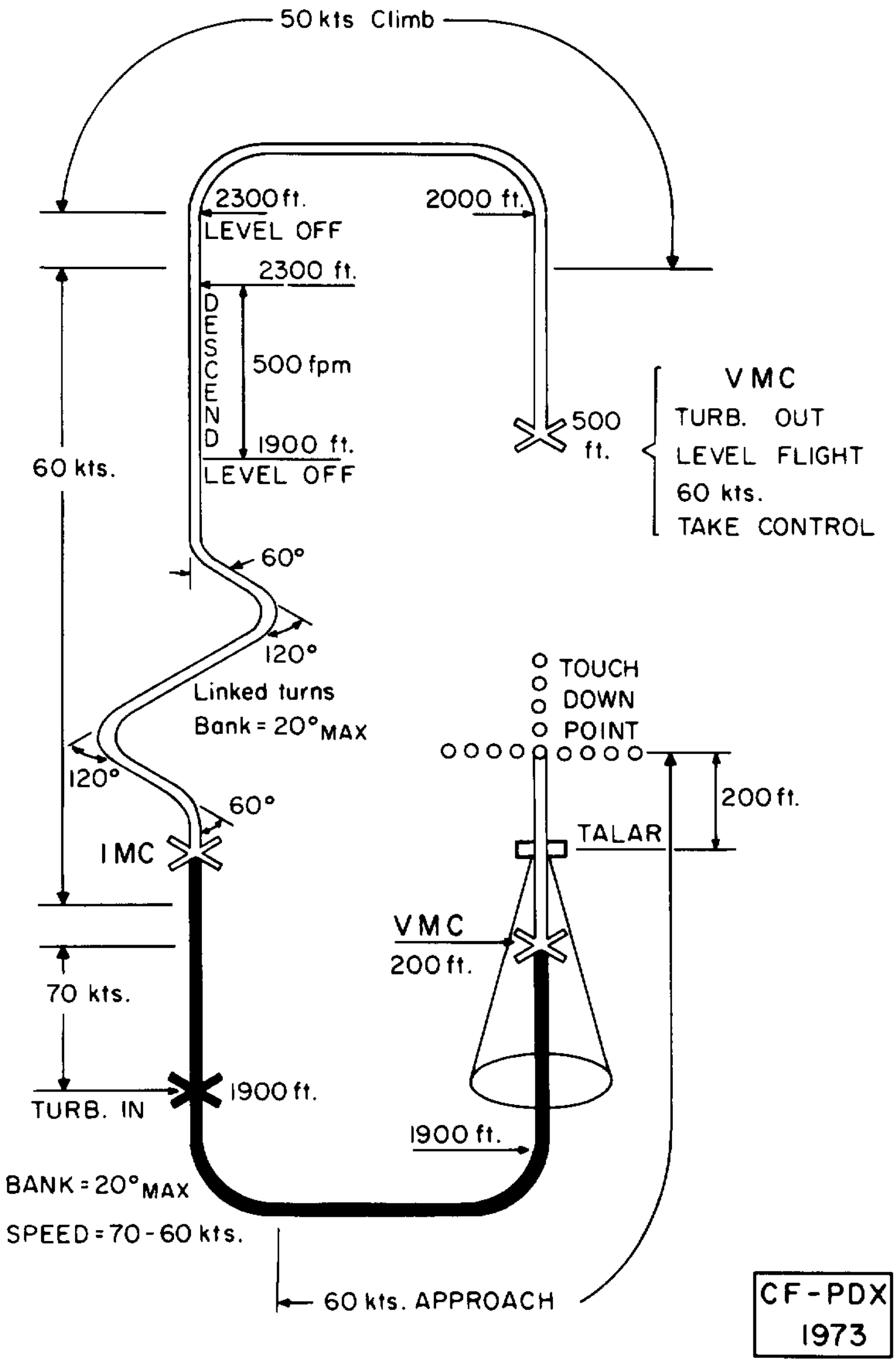


FIG 8 TASK FOR LONGITUDINAL DYNAMICS INVESTIGATION

EVALUATION DATA SHEET

Pilot	
Date	
Time	
Flight No	
Configuration	
Rating	

Wind	
Temperature	
Pressure	

	External Turbulence	Wind Shear
Negligible		
Light/Small		
Moderate		

1. CONTROL FEEL CHARACTERISTICS

Forces

	δ_E
High	
Satisfactory	
Low	

Displacements

	δ_E	δ_T
Too large		
Satisfactory		
Too small		

Trim Rate

	δ_E
Too fast	
Satisfactory	
Too slow	

2. AIRCRAFT RESPONSE TO CONTROL INPUTS REQUIRED TO PERFORM TASK

Initial response to

	δ_E	δ_T
Too great		
Satisfactory		
Too small		

Final Response to

	δ_E	δ_T
Too great		
Satisfactory		
Too small		
Not assessable		

Control Sensitivities (Face Values)

δ_E POTG	
δ_T POTF	

3. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal Velocity			Vertical Velocity		
Turbulence	OUT		IN	OUT		IN
	VMC	IMC	IMC	VMC	IMC	IMC
Great Difficulty						
Moderate "						
Slight "						
No "						

Reason for difficulty ____________________

MAXIMUM UNDESIRED VELOCITY FLUCTUATIONS

Longitudinal (knots)	Vertical (fpm)

4. RESIDUAL OSCILLATORY CHARACTERISTICS

Amplitude

	Pitch	Heave
Large		
Moderate		
Small		
Zero		

Period

	Pitch	Heave
Short		
Medium		
Long		

Damping

	Pitch	Heave
High		
Moderate		
Low		
Zero		
Negative		

How excited?

	δ_E	δ_T	Turb	Unknown Sources
Easily				
Moderately				
Hardly				

How Controlled?

	δ_E	δ_T	Both
Not attempted			
Effective			
Ineffective			
Aggravating			

Comments ____________________

5. THRUST REQUIREMENTS IN TURNS

Thrust demanded to maintain vertical velocity in a 20° banked turn

Excessive	
Large	
Moderate	
Small	
Negligible	

Ease of compensating for thrust demands whilst changing bank angle

Great difficulty	
Moderate	
Slight	
No	

Reason for difficulty ____________________

6. FLIGHT PATH CONTROL

Difficulty experienced and precision attained in the following approach phases

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localiser	Glide path	Localiser	Glide path	Localiser
Difficulty Great						
Moderate						
Slight						
No						
Precision Very poor						
Poor						
Fair						
Good						

Minimum acceptable breakout altitude if greater than 200 ft ☐

Reason for difficulty: ____________________

7. BREAKOUT AND FLARE

Ease of arresting rate of descent

Great difficulty	
Moderate "	
Slight "	
No "	

Reason for difficulty: ____________________

Precision of attaining touch down point

Very poor	
Poor	
Fair	
Good	

8. CONTROL TECHNIQUE

If control technique used differed from longitudinal velocity control with elevator and vertical velocity control with thrust lever, comment

____

9. LATERAL DIRECTIONAL CHARACTERISTICS

Effect on final assessment

Large	
Moderate	
Small	
None	

Reason ____________________

10. LEAST OBJECTIONABLE FEATURES

____

11. MOST OBJECTIONABLE FEATURES

____

12. MISCELLANEOUS

____

13. RATING ☐

FIG 9 PILOT'S COMMENT AND RATING SHEET

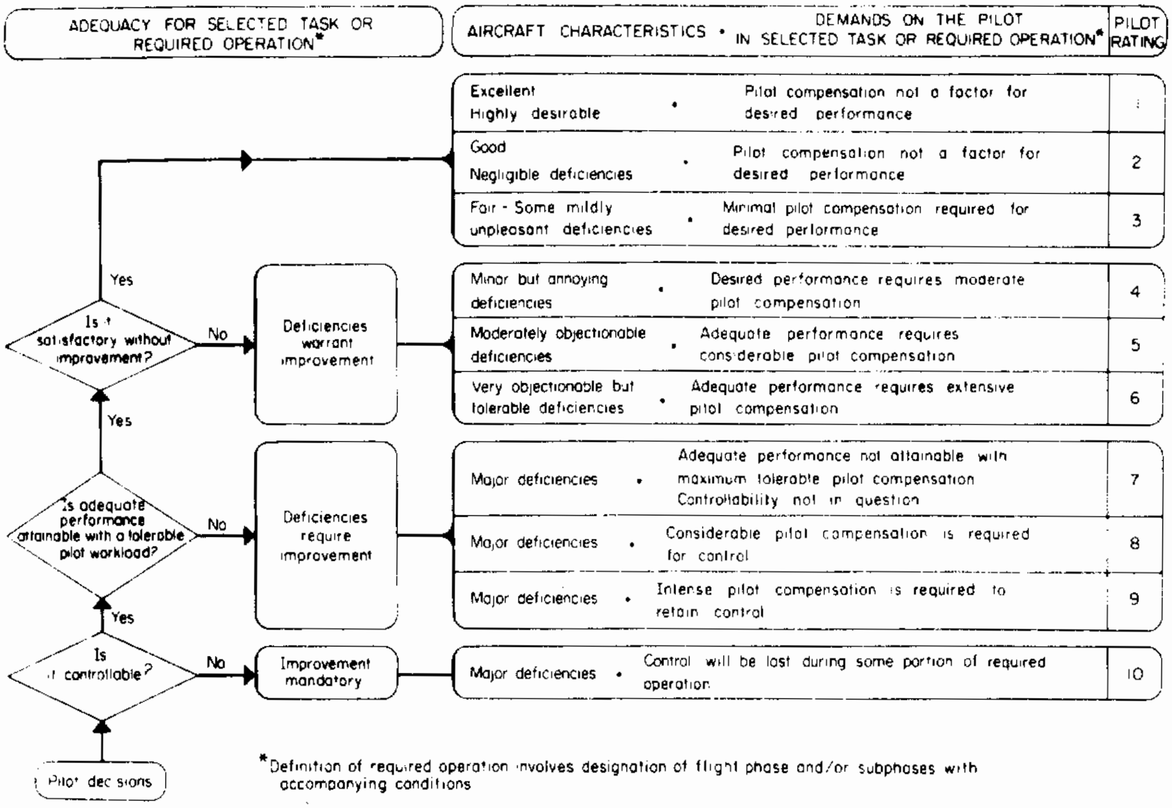


FIG 10 COOPER-HARPER PILOT'S RATING SCALE

INCREASE OF PILOT EFFORT WITH TURBULENCE	DETERIORATION OF TASK PERFORMANCE WITH TURBULENCE	RATING
NO SIGNIFICANT INCREASE	NO SIGNIFICANT DETERIORATION	A
MORE EFFORT REQUIRED	NO SIGNIFICANT DETERIORATION	B
	MINOR	C
	MODERATE	D
	MODERATE	E
BEST EFFORTS REQUIRED	MAJOR (BUT EVALUATION TASKS CAN STILL BE ACCOMPLISHED)	F
	LARGE (SOME TASKS CANNOT BE PERFORMED)	G
UNABLE TO PERFORM TASKS		H

FIG 11 TURBULENCE EFFECT RATING SCALE

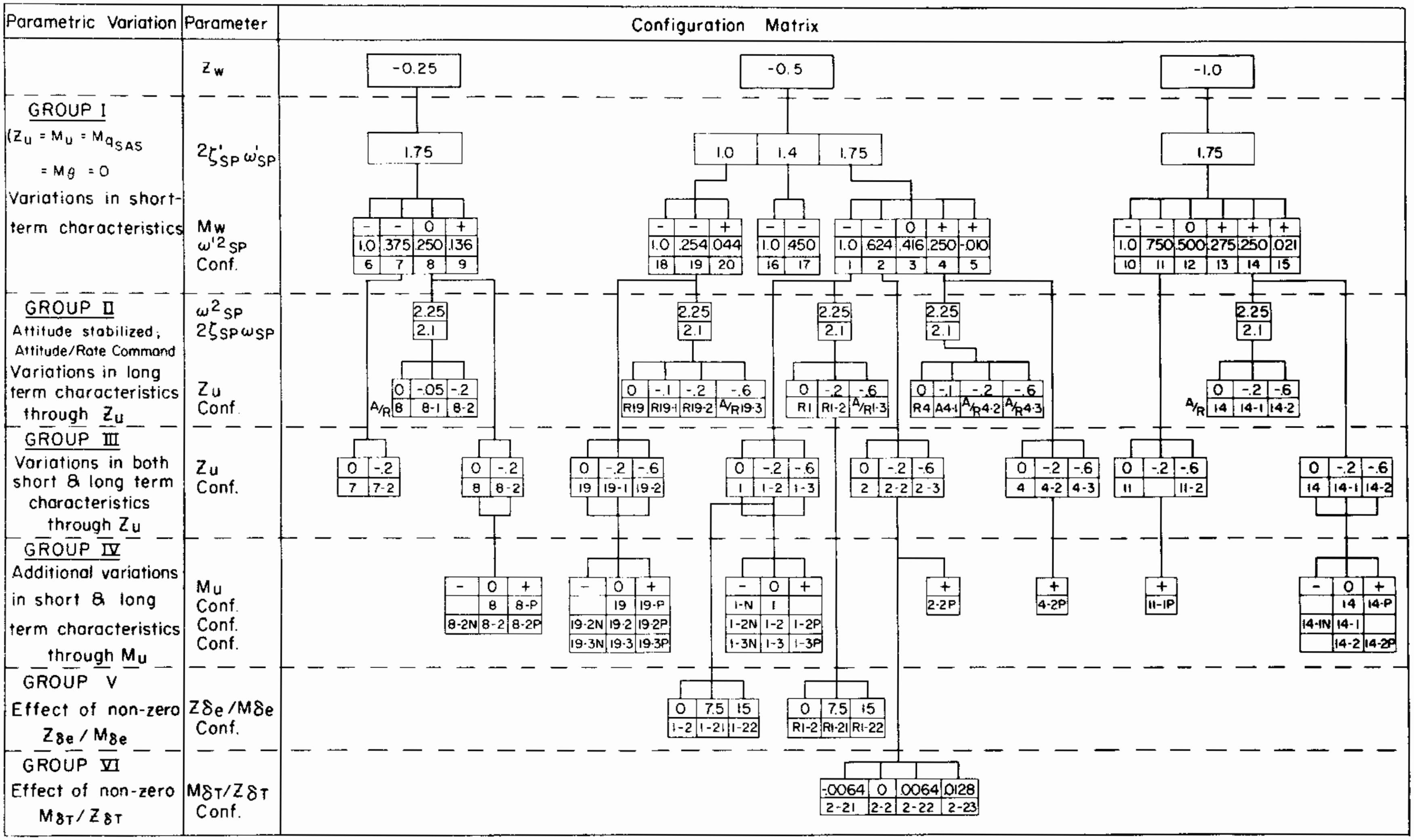
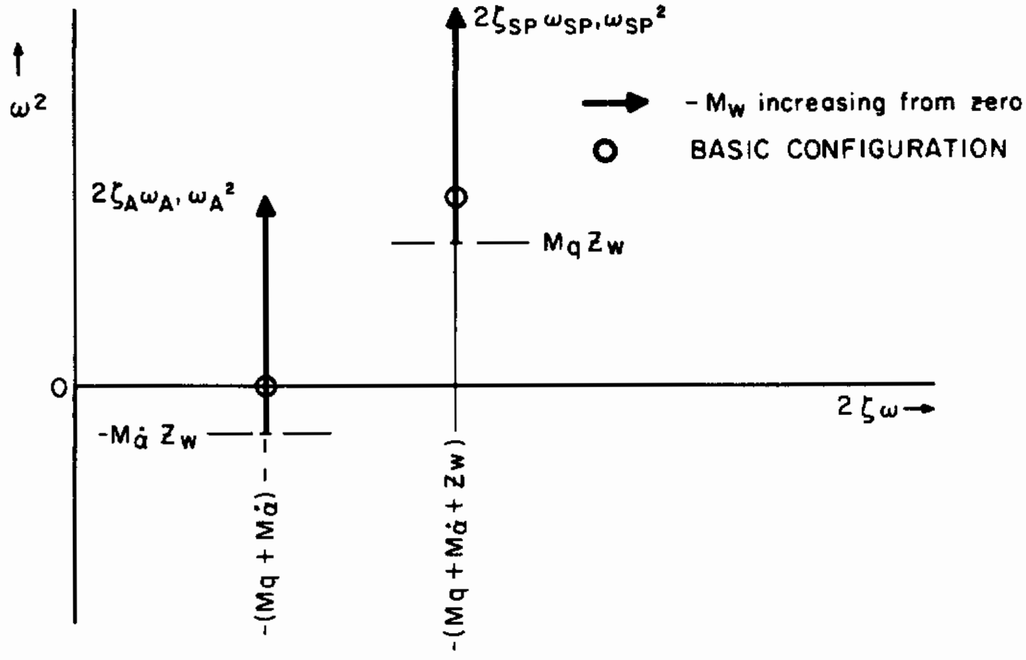
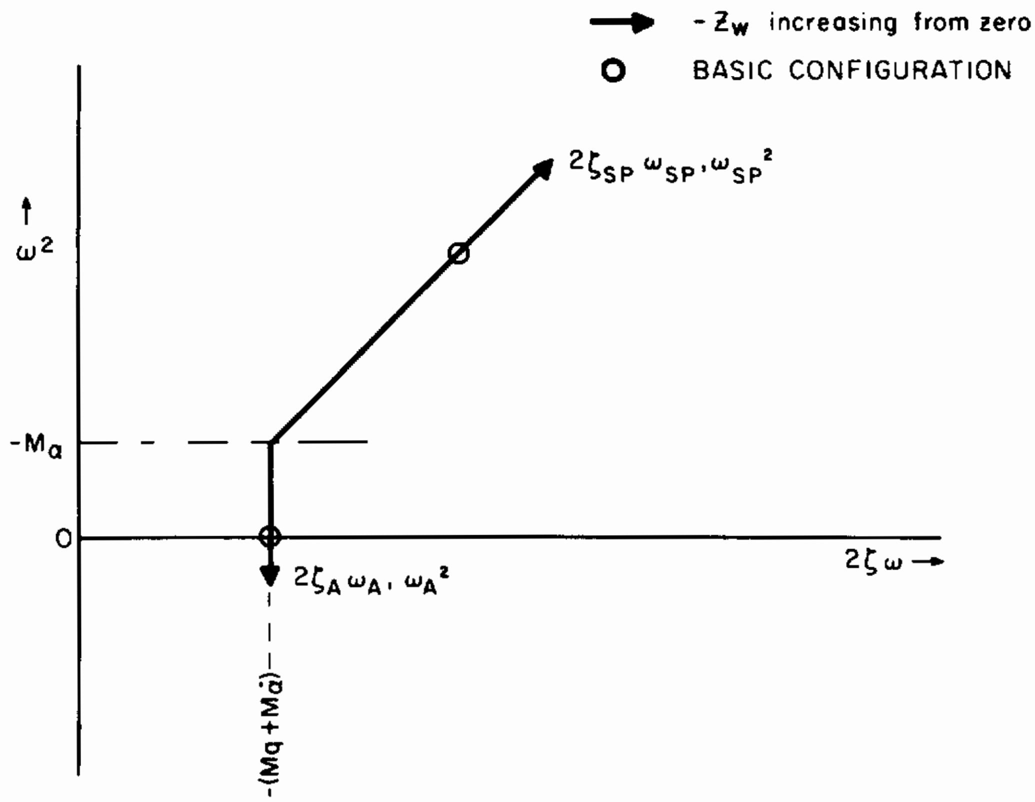


FIG 12 CONFIGURATION MATRIX EVALUATED



(a) LOCI FOR M_w VARIATIONS



(b) LOCI FOR Z_w VARIATIONS

FIG 13 LOCI OF SHORT PERIOD ROOTS AND OF ROOTS CHARACTERIZING THE HIGH FREQUENCY PITCH RESPONSE TO ELEVATOR

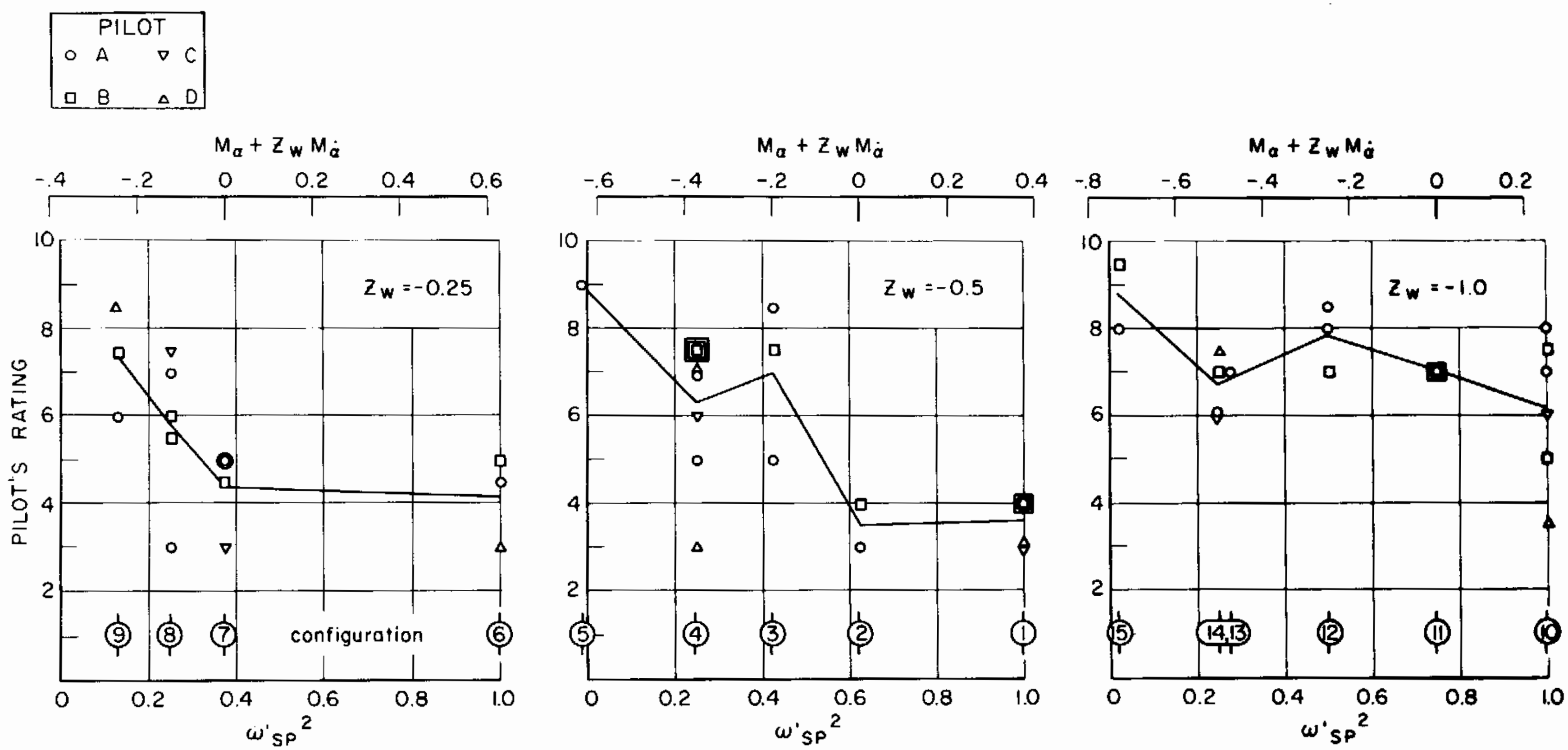


FIG 14 UNAUGMENTED SHORT PERIOD CHARACTERISTICS - EFFECT ON PILOT'S RATING OF VARIATIONS IN M_α AT DIFFERENT Z_W FOR $2\zeta\omega_{SP} = 1.75$

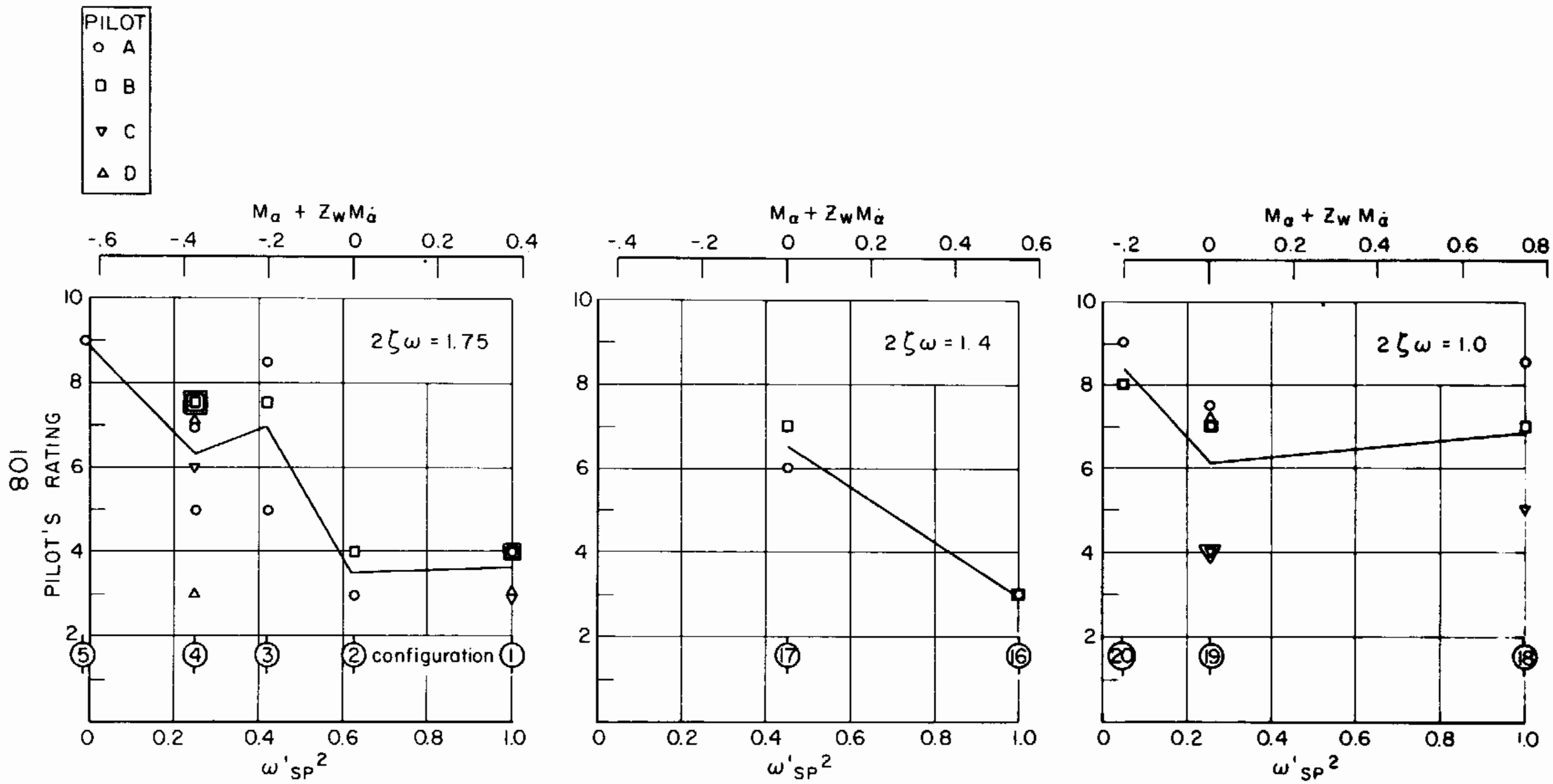


FIG 15 UNAUGMENTED SHORT PERIOD CHARACTERISTICS - EFFECT ON PILOT'S RATING OF VARIATIONS IN M_α AT DIFFERENT DAMPING LEVELS FOR $Z_w = -.5$

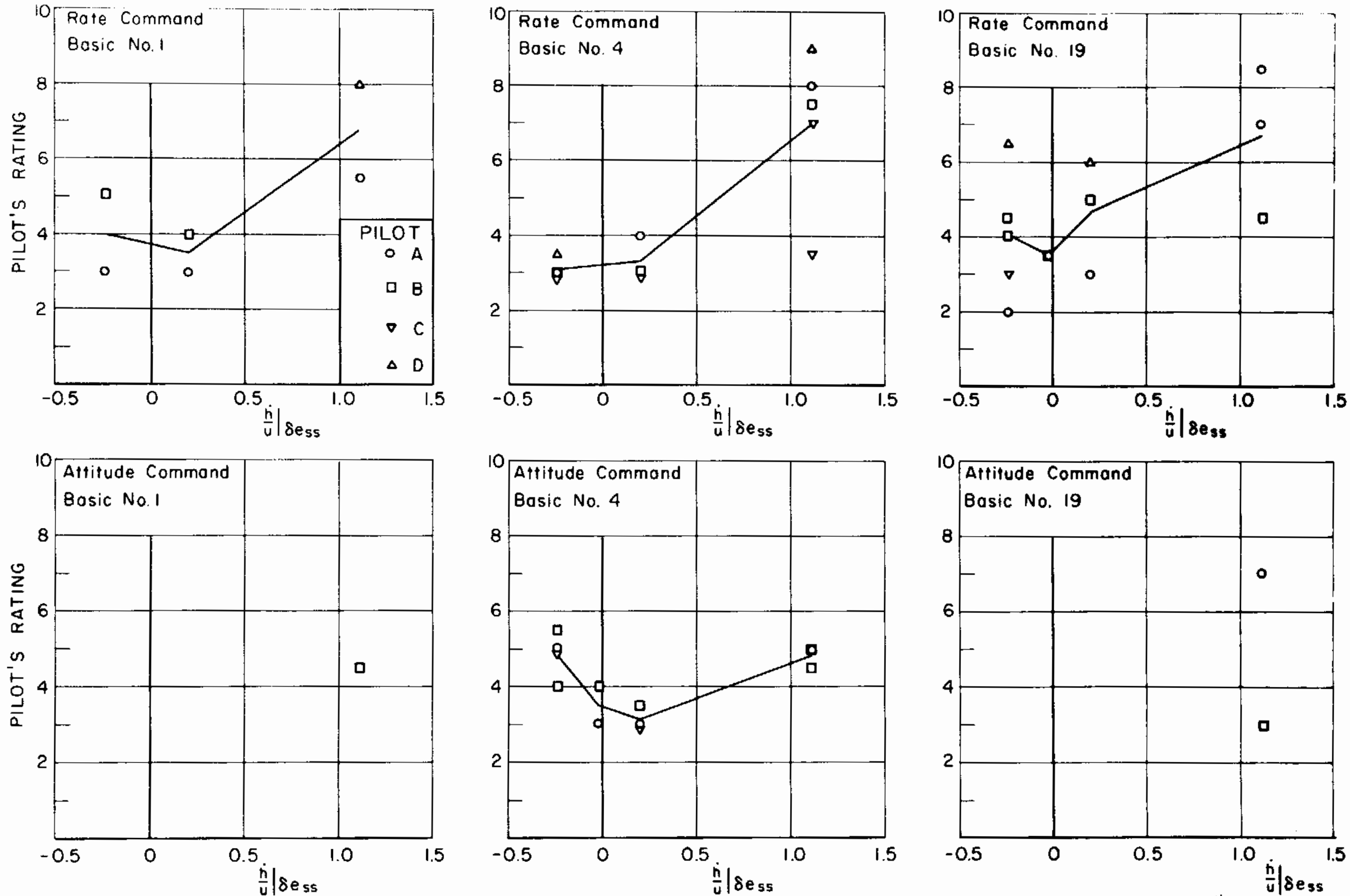


FIG 16 AUGMENTED PITCH CONFIGURATIONS – EFFECT ON PILOT'S RATING OF VARIATIONS IN $\dot{h}/u|\delta e_{ss}$ FOR DIFFERENT MOMENT DERIVATIVES AT $Z_w = -0.5$ AND $\omega_{sp} = 1.5$ r/s, $\zeta_{sp} = 0.7$

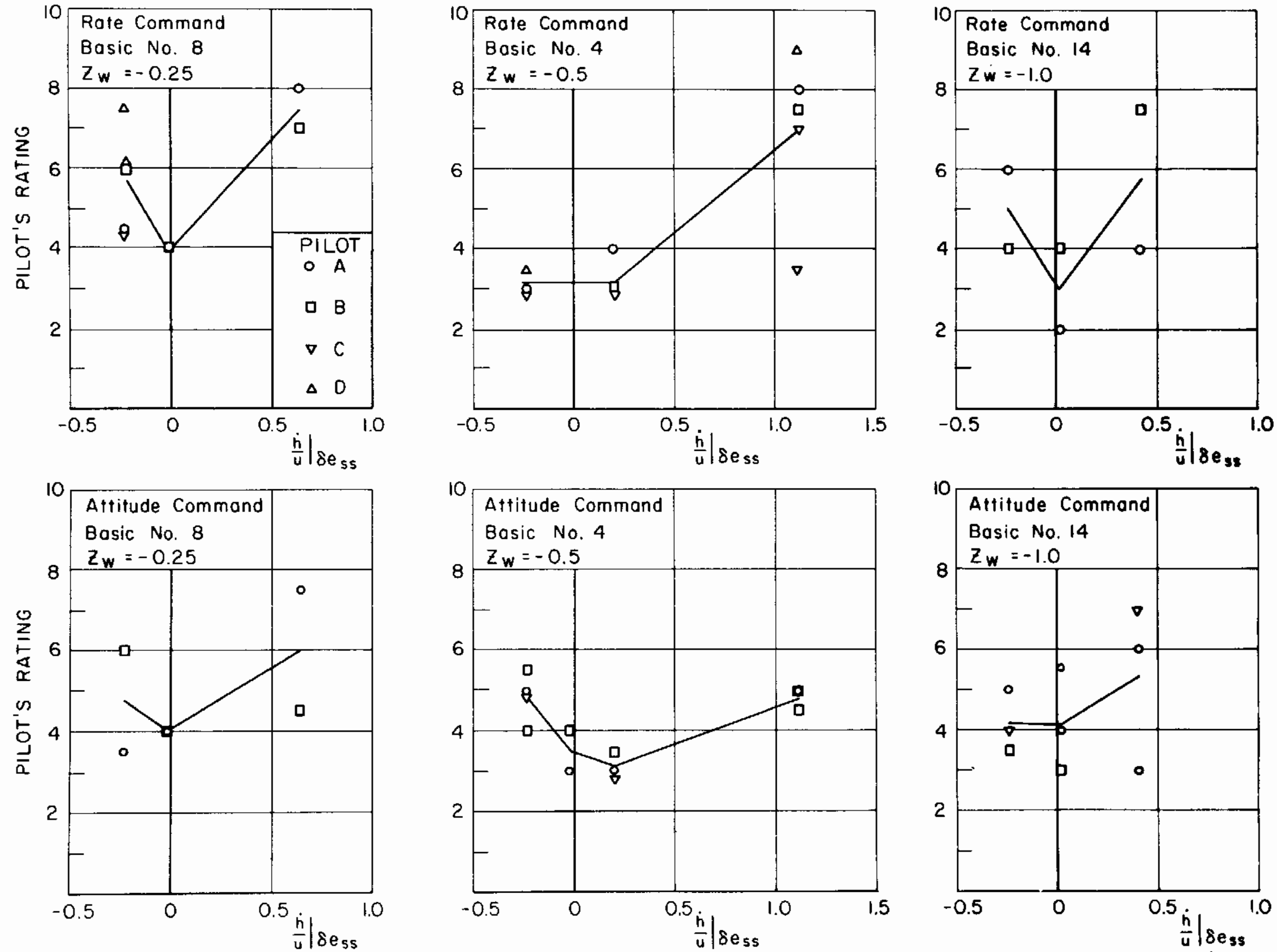


FIG 17 AUGMENTED PITCH CONFIGURATIONS - EFFECT ON PILOT'S RATING OF VARIATIONS IN $\dot{h}/u|\delta e_{ss}$ FOR $Z_w = -0.25$, -0.5 AND -1.0, AND $\omega_{SP} = 1.5$ r/s, $\zeta_{SP} = 0.7$

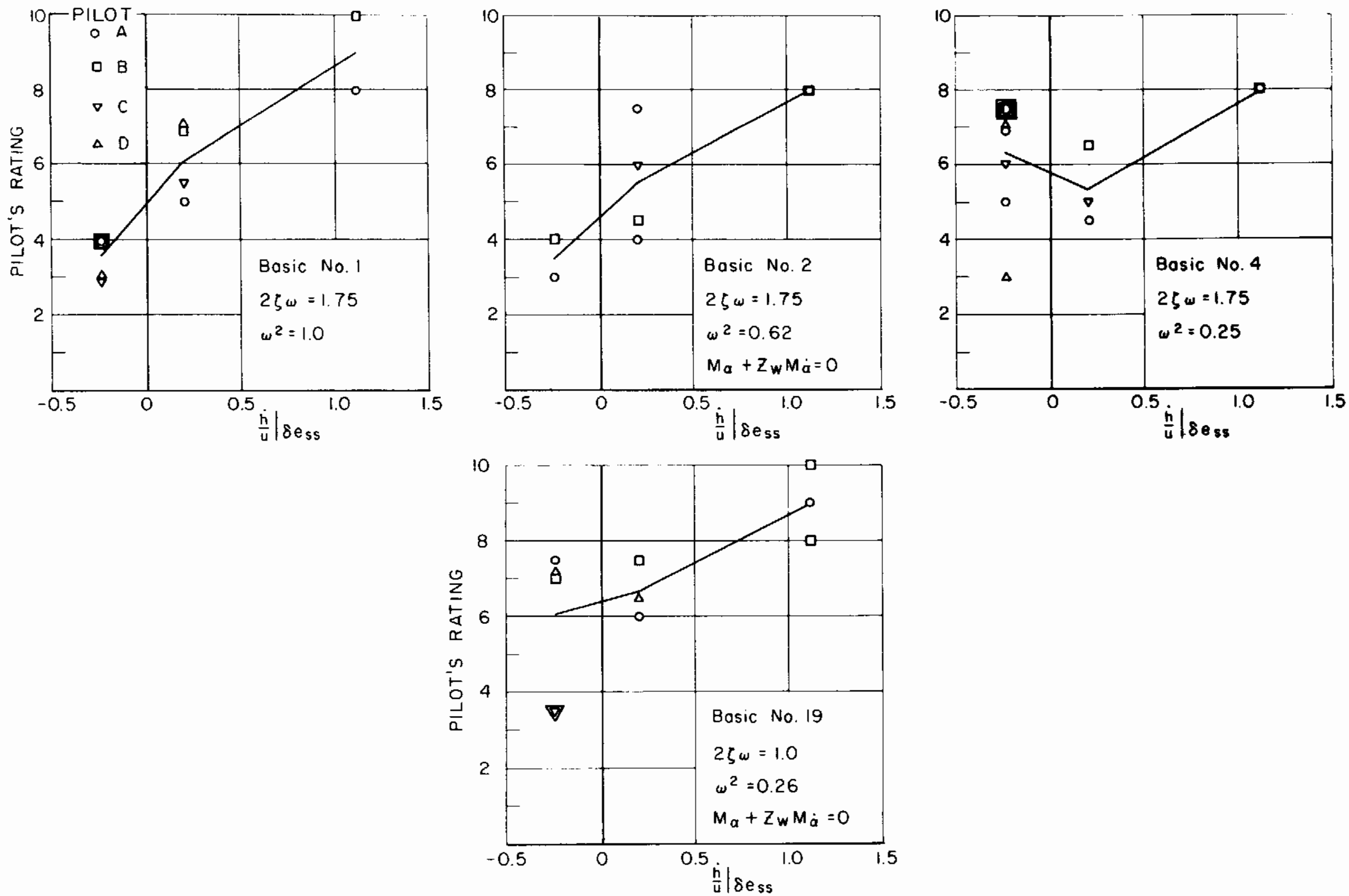


FIG 18 UNAUGMENTED SHORT PERIOD CHARACTERISTICS - EFFECT ON PILOT'S RATING OF VARIATIONS IN $\dot{h}/u|\delta e_{ss}$ FOR DIFFERENT TOTAL DAMPING AND STIFFNESS LEVELS AT $Z_w = -0.5$

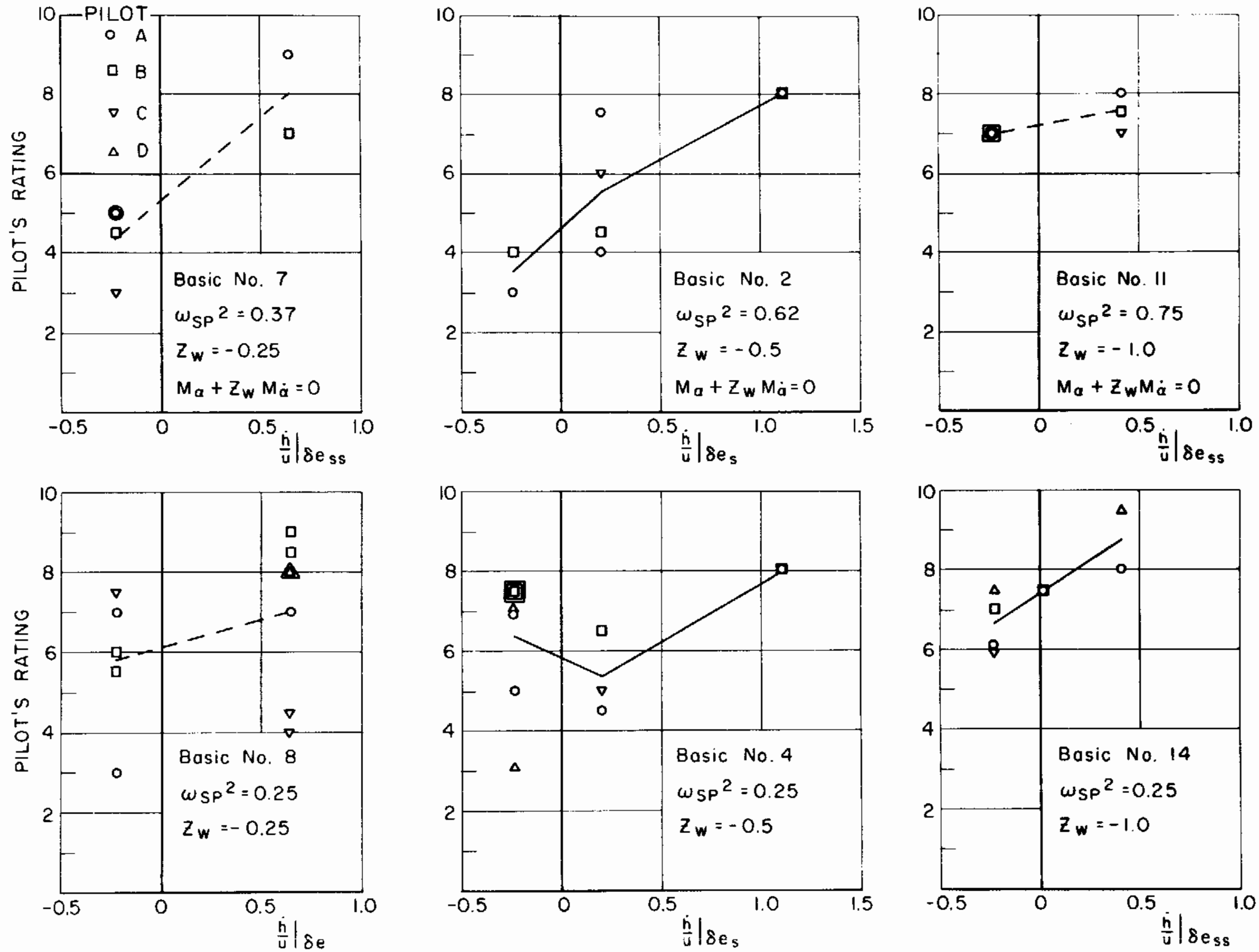


FIG 19 UNAUGMENTED SHORT PERIOD CHARACTERISTICS - EFFECT ON PILOT'S RATING OF VARIATIONS IN $\dot{h}/u|\delta e_{ss}$ FOR DIFFERENT Z_w AND STIFFNESS LEVELS AT $2\zeta\omega_{SP} = 1.75$

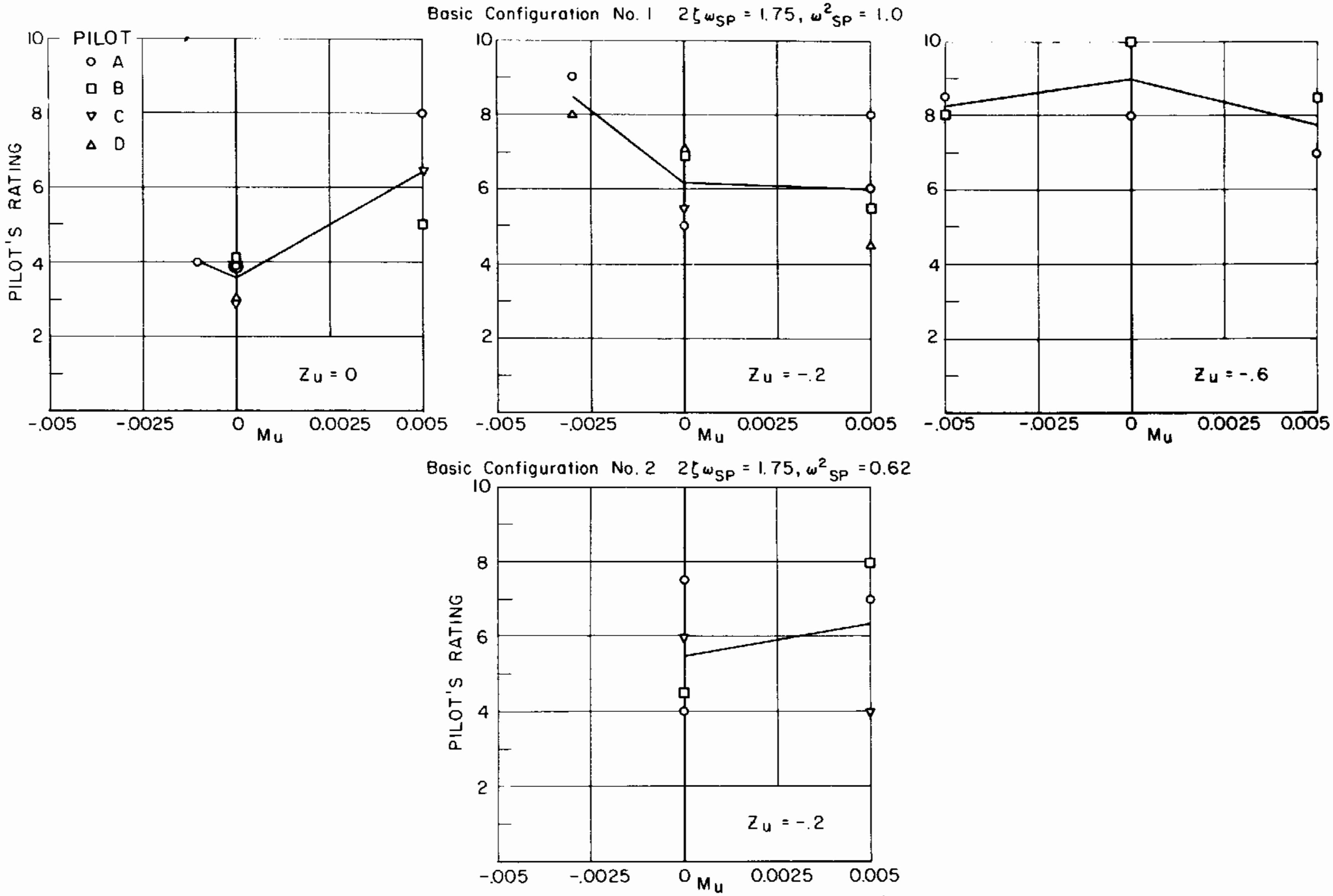


FIG 20 UNAUGMENTED PITCH CHARACTERISTICS - EFFECT ON PILOT'S RATING OF VARIATIONS IN M_u FOR DIFFERENT Z_u AND STIFFNESS LEVELS AT $Z_w = -0.5$

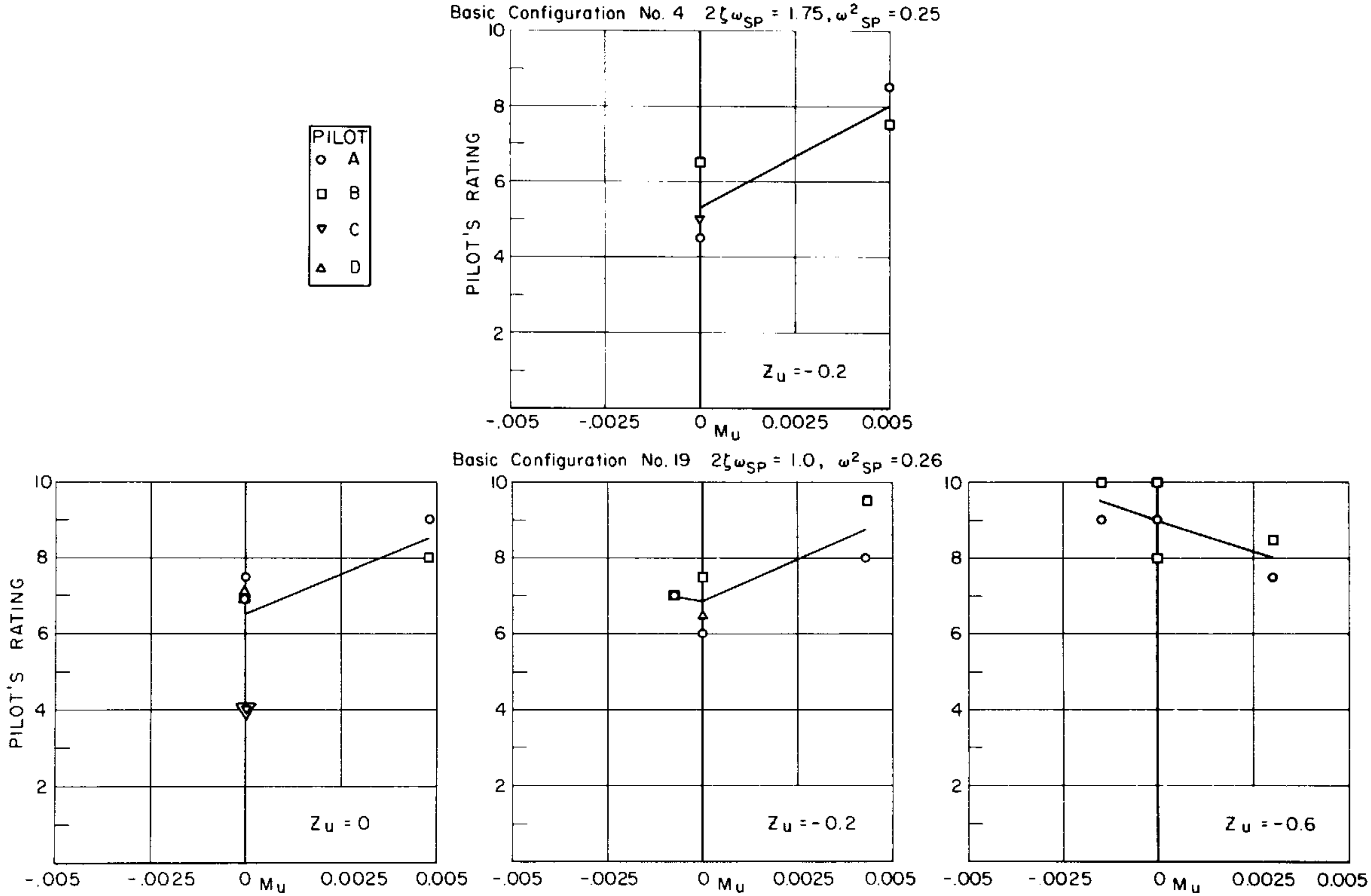


FIG 21 UNAUGMENTED PITCH CHARACTERISTICS - EFFECT ON PILOT'S RATING OF VARIATIONS IN M_u FOR DIFFERENT Z_u AND DAMPING LEVELS AT $Z_w = -0.5$

Basic Configuration No. 8 $2\zeta\omega_{SP} = 1.75,\ \omega^2_{SP} = 0.25$

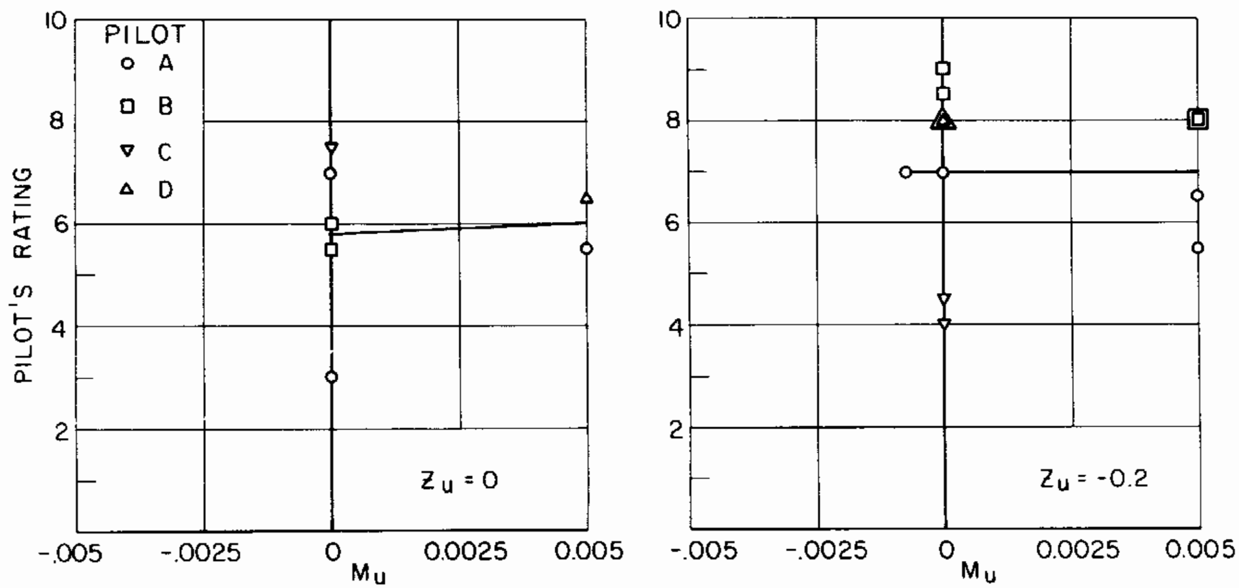


FIG 22 UNAUGMENTED PITCH CHARACTERISTICS - EFFECT ON PILOT'S RATING OF VARIATIONS IN M_u FOR DIFFERENT Z_u AT $Z_w = -0.25$

Basic Configuration No. 14 $2\zeta\omega_{SP} = 1.75$, $\omega^2_{SP} = 0.25$

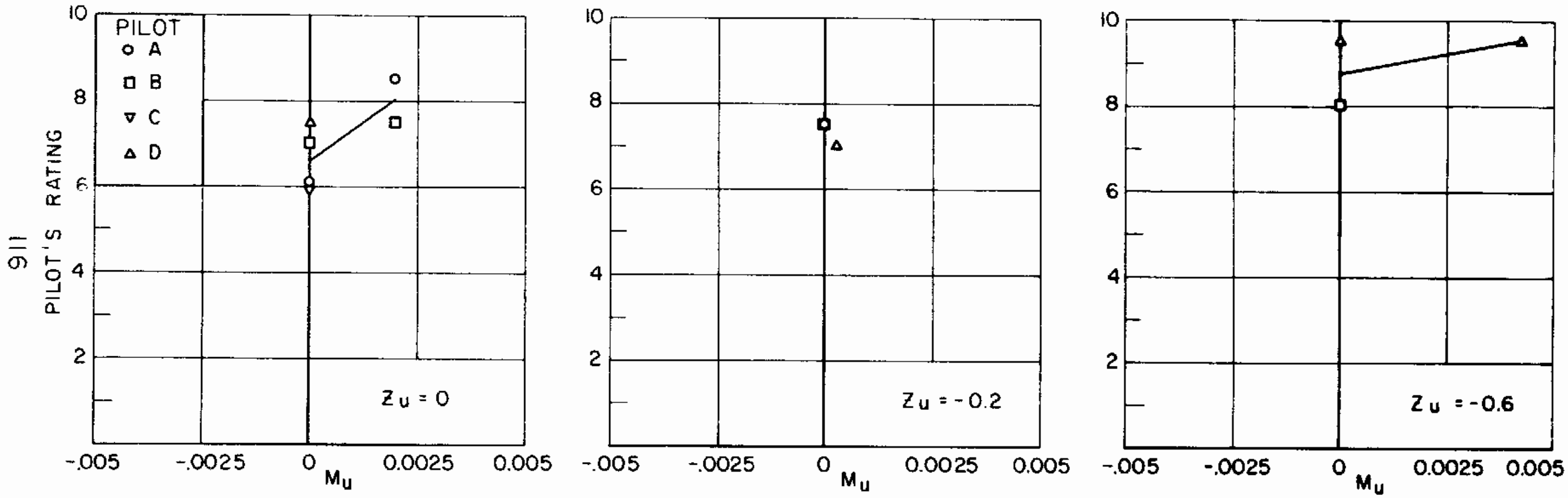


FIG 23 UNAUGMENTED PITCH CHARACTERISTICS - EFFECT ON PILOT'S RATING OF VARIATIONS IN M_u FOR DIFFERENT Z_u AT $Z_w = -1.0$

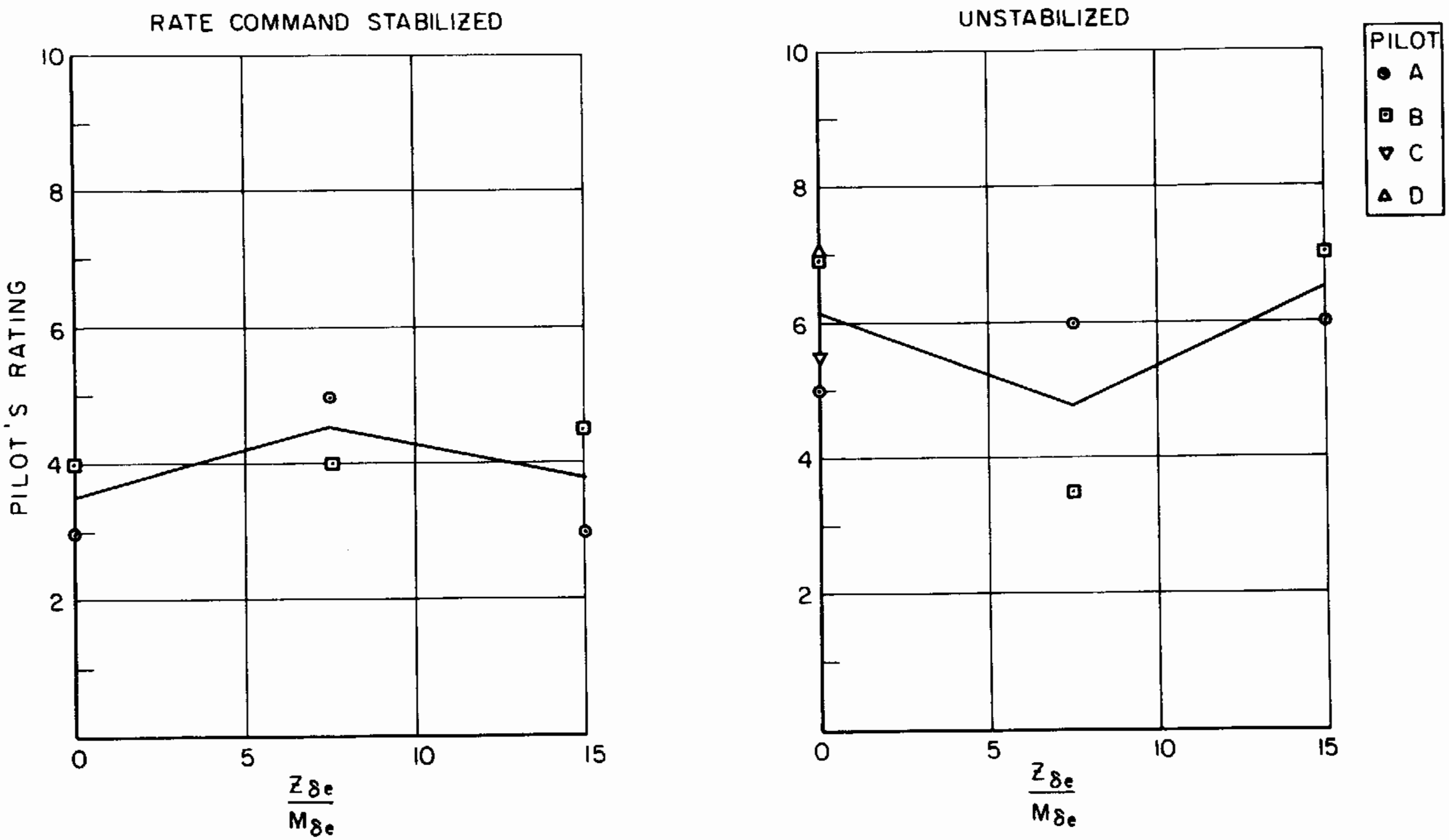


FIG 24 EFFECT ON PILOT'S RATING OF VARIATIONS IN $\frac{Z_{\delta e}}{M_{\delta e}}$ ON BOTH STABILIZED AND UNSTABILIZED CONFIGURATIONS BASED ON NO 1-2

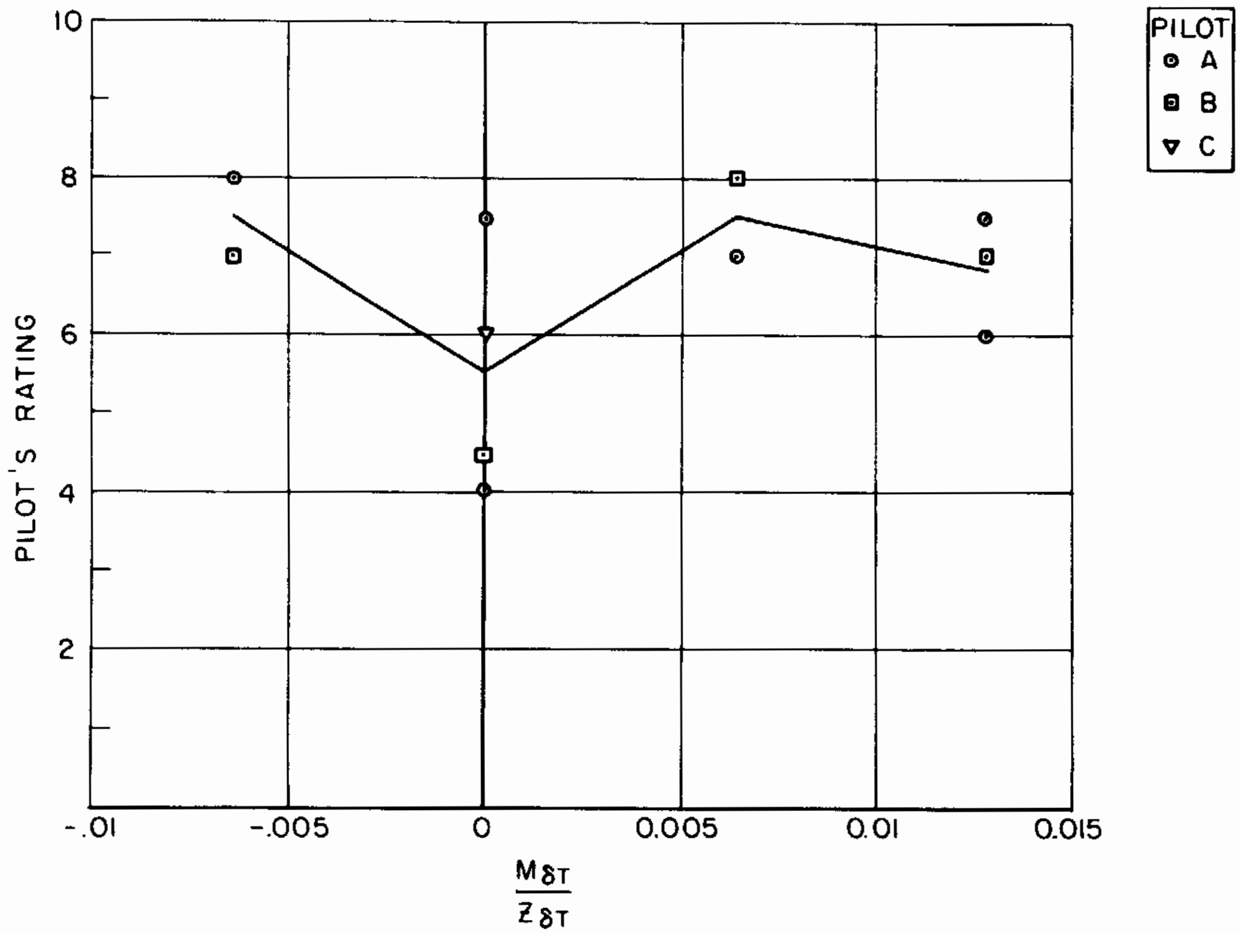


FIG 25 EFFECT ON PILOT'S RATING OF VARIATIONS IN $\frac{M_{\delta T}}{Z_{\delta T}}$ ON CONFIGURATIONS BASED ON NO 2-2

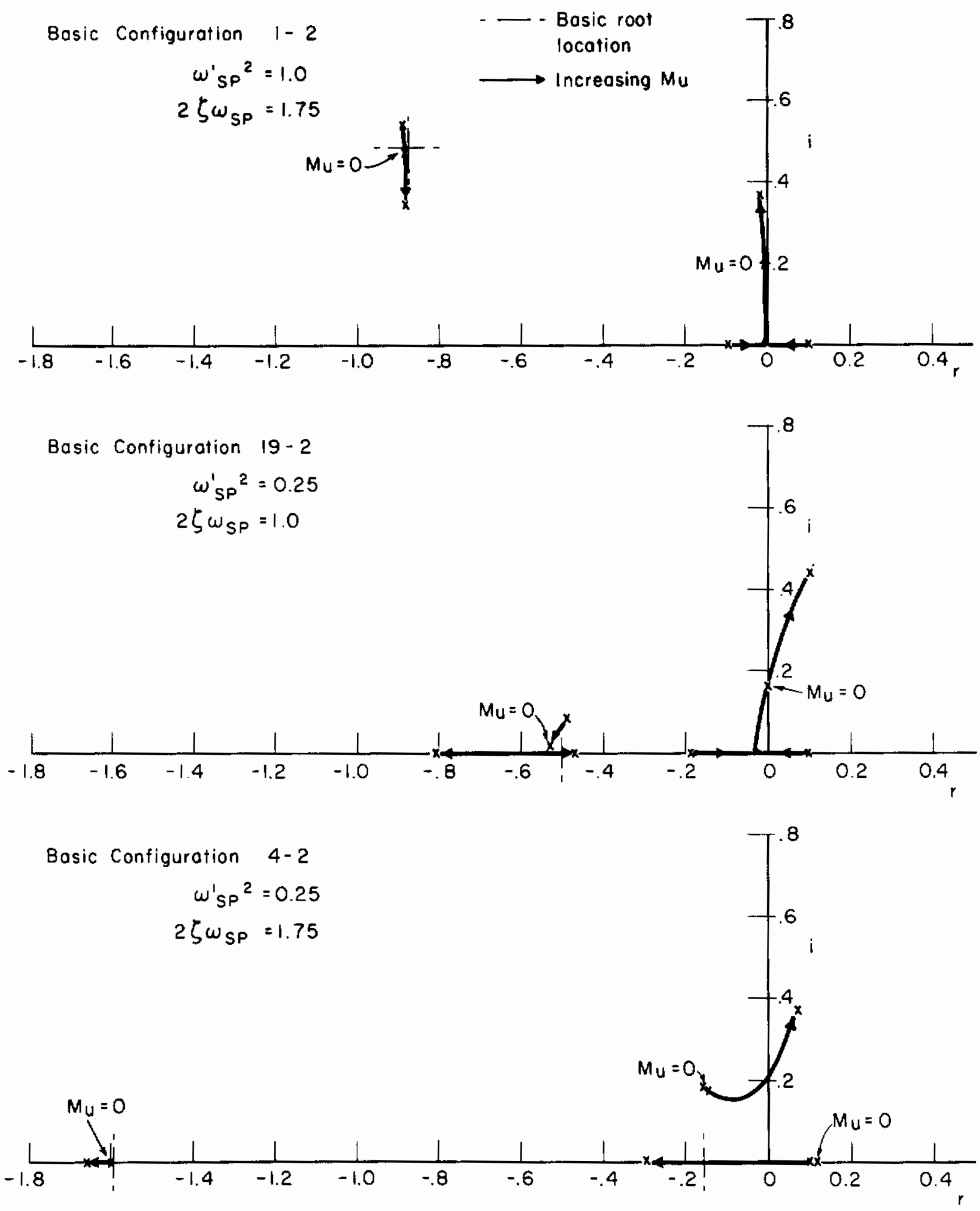


FIG 26 EFFECT ON ROOT LOCI OF VARYING Mu FOR CONFIGURATIONS WITH DIFFERENT LEVELS OF SHORT-TERM STIFFNESS AND TOTAL DAMPING

CONTROL PHASE	CONF.	No. OF ASSESS.	DIFFICULTY (none / slight / moderate / great)	PRECISION (good / fair / poor / very poor)	MEAN PILOTS' RATING
AIRSPEED	1	5		±7 knots	3.6
	2	2		±6	3.5
	3	3		±8	7.0
	4	8		±10	6.3
	5	1		±8	9
VERTICAL SPEED	1	5		±200 fpm	
	2	2		–	
	3	3		–	
	4	8		±200	
	5	1		–	
TURNS	1	5			
	2	2			
	3	3			
	4	8			
	5	1			
GLIDE PATH (FINAL TRACK)	1	5			
	2	2			
	3	3			
	4	8			
	5	1			
LOCALIZER (FINAL TRACK)	1	5			
	2	2			
	3	3			
	4	8			
	5	1			
FLARE	1	5			
	2	2			
	3	3			
	4	8			
	5	1			
MINIMUM BREAKOUT HEIGHT (FT)	1	5	Mean 260 Max 500 Min 200		
	2	2	250 300 200		
	3	3	500 800 200		
	4	8	300 500 200		
	5	1	1000 1000 1000		
PITCH CHARACTERISTICS	1	5	Reasonable: noticeable trim change with δ_T		
	2	2	Good attitude stability		
	3	3	Large steady state pitch response to δ_E - appears to be divergent		
	4	8	Sluggish control, divergent pitch response to elevator		
	5	1	Unstable		
OSCILLATORY CHARACTERISTICS	1	5	Virtually non-existent		
	2	2	Zero		
	3	3	Zero		
	4	8	Low frequency PIO tendency in pitch		
	5	1	PIO for large δ_E input		
TURBULENCE RESPONSE	1	5	Sensitive to turbulence: affects airspeed control		
	2	2	Very little influence		
	3	3	Disturbs pitch attitude significantly		
	4	8	" (causes high workload)		
	5	1	"		
LEAST OBJECTIONABLE FEATURES	1	5	Pitch control easy, changes fairly slow		
	2	2	Good pitch stability and speed hold, little response to turbulence		
	3	3	Good height control		
	4	8	Good height control		
	5	1			
MOST OBJECTIONABLE FEATURES	1	5	Airspeed control and turbulence sensitivity		
	2	2	Too much attention required to control airspeed, low heave damping		
	3	3	Turbulence response in pitch, high steady state pitch response to δ_E		
	4	8	Pitch control; sluggish, PIO tendency, turbulence upsets, high $(\theta/\delta_e)_{ss}$		
	5	1			

⊙ MEAN
├─┤ STAND DEV.
▭ RANGE

FIG 27 GROUP I: EFFECT ON PILOT'S ASSESSMENT OF TASK DIFFICULTY AND PRECISION; M_α VARIATIONS FOR $Z_w = -0.5$ AND $2\zeta\omega'_{SP} = 1.75$

CONTROL PHASE	CONF.	No. OF ASSESS.	DIFFICULTY (none / slight / moderate / great)	PRECISION (good / fair / poor / very poor)	MEAN PILOTS' RATING
AIRSPEED	7	4		±9 knots	4.4
	2	2		±6	3.5
	11	3		±10	7
VERTICAL SPEED	7	4		±250 fpm	
	2	2		–	
	11	3		±200	
TURNS	7	4			
	2	2			
	11	3			
GLIDE PATH (FINAL TRACK)	7	4			
	2	2			
	11	3			
LOCALIZER (FINAL TRACK)	7	4			
	2	2			
	11	3			
FLARE	7	4			
	2	2			
	11	3			
MINIMUM BREAKOUT HEIGHT (FT)	7	4	Mean 350 Max 500 Min 200		
	2	2	250 300 200		
	11	3	450 500 300		
PITCH CHARACTERISTICS	7	4	Good stability and damping, but some wander		
	2	2	Good attitude stability		
	11	3	Poor, high $(\theta/\delta e)_{ss}$, needs close attention		
OSCILLATORY CHARACTERISTICS	7	4	Zero		
	2	2	Zero		
	11	3	Slight PIO tendency in pitch – long period		
TURBULENCE RESPONSE	7	4	Very little influence		
	2	2	"		
	11	3	Disturbs pitch		
LEAST OBJECTIONABLE FEATURES	7	4	Good pitch stability and speed hold, little response to turbulence		
	2	2	"		
	11	3	None		
MOST OBJECTIONABLE FEATURES	7	4	Thrust modulation; nose wander		
	2	2	Too much attention required to control airspeed; low heave damping		
	11	3	Pitch control; turbulence and δ_E affect pitch and speed undesirably		

ʘ MEAN

├─┤ STAND DEV.

▭ RANGE

FIG 28 GROUP I: EFFECT ON PILOT'S ASSESSMENT OF TASK DIFFICULTY AND PRECISION; BASIC CONFIGURATIONS WITH Z_W VARIATIONS AT $2\zeta\omega'_{SP} = 1.75$

CONTROL PHASE	CONF.	No. OF ASSESS	DIFFICULTY: none	slight	moderate	great	PRECISION: good	fair	poor	very poor	MEAN PILOTS' RATING
AIRSPEED	R1,4,19,	11					±6 knots				3.7
	" -1	2					±6				3.5
	" -2	8					±8				3.9
	" -3	10					±11				6.9
VERTICAL SPEED	R1,4,19	11					±200 fpm				
	" -1	2					±200				
	" -2	8					±200				
	" -3	10					±300				
TURNS	R1,4,19	11									
	" -1	2									
	" -2	7									
	" -3	9									
GLIDE PATH (FINAL TRACK)	R1,4,19	11									
	" -1	2									
	" -2	8									
	" -3	10									
LOCALIZER (FINAL TRACK)	R1,4,19	11									
	" -1	2									
	" -2	8									
	" -3	10									
FLARE	R1,4,19	11									
	" -1	2									
	" -2	8									
	" -3	10									
MINIMUM BREAKOUT HEIGHT (FT)	R1,4,19	11	Mean 250 Max 500 Min 200								
	" -1	2	250 300 200								
	" -2	8	210 300 200								
	" -3	10	280 500 200								
PITCH CHARACTERISTICS	R1,4,19	11	Good damping, stability								
	" -1	2	"								
	" -2	8	"								
	" -3	10	"								
OSCILLATORY CHARACTERISTICS	R1,4,19	11	Virtually non-existent								
	" -1	2	"								
	" -2	8	"								
	" -3	10	"								
TURBULENCE RESPONSE	R1,4,19	11	Insignificant in pitch, noticeable in heave								
	" -1	2	" "								
	" -2	8	" "								
	" -3	10	Worse than above in heave, wind shear effects significant								
LEAST OBJECTIONABLE FEATURES	R1,4,19	11	Pitch stability, predictable control, low pitch response to turbulence								
	" -1	2	"								
	" -2	8	"								
	" -3	10	"								
MOST OBJECTIONABLE FEATURES	R1,4,19	11	None								
	" -1	2	None								
	" -2	8	Turbulence response in heave								
	" -3	10	Interaction between airspeed and vertical speed, turbulence → heave								

○ MEAN
├─┤ STAND DEV.
▭ RANGE

FIG 29 RATE COMMAND SYSTEM: EFFECT ON PILOTS' ASSESSMENT OF TASK DIFFICULTY AND PRECISION: Z_u VARIATIONS AT $Z_w = -0.5$

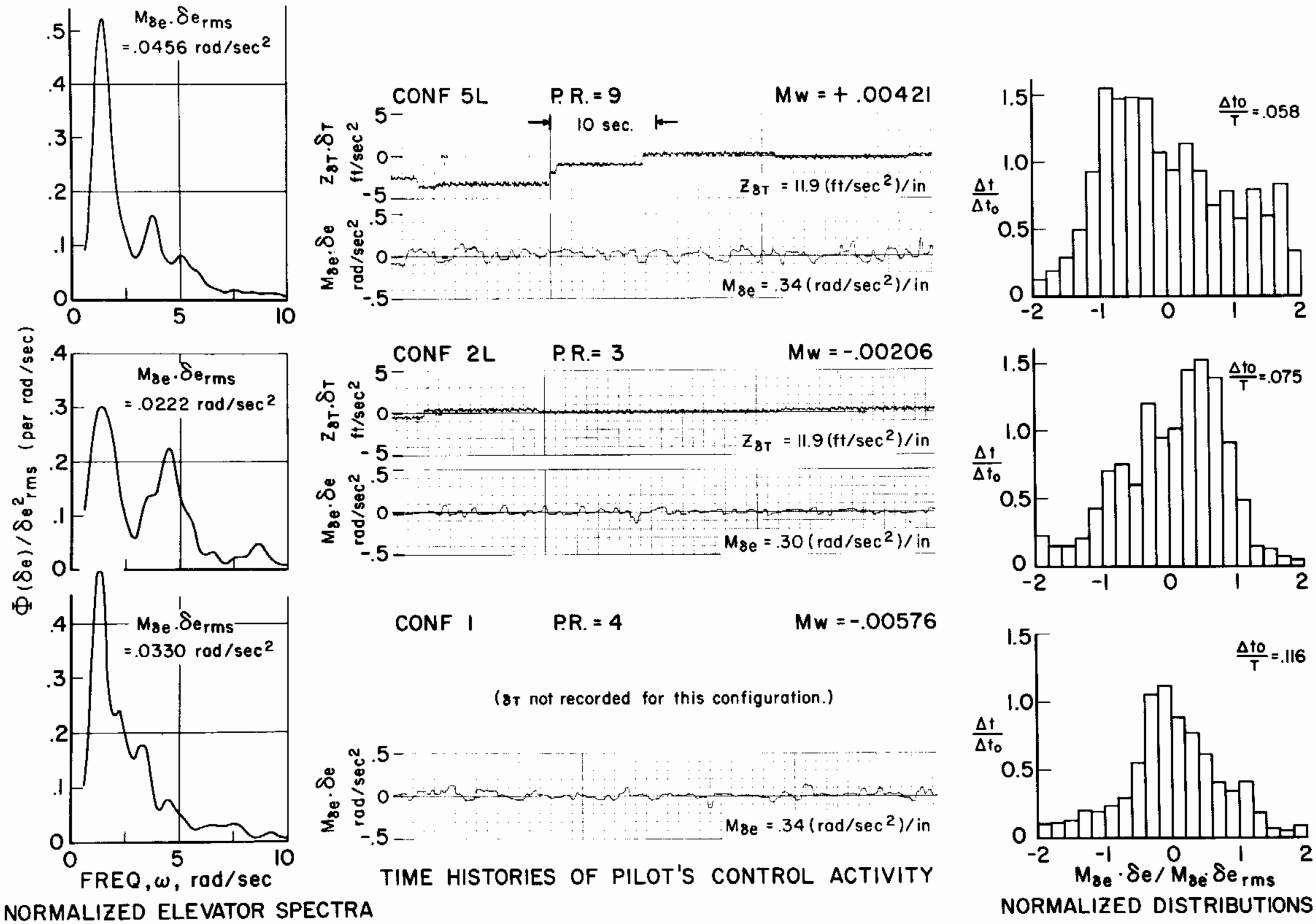


FIG 30 STATISTICAL PROPERTIES OF PILOT'S CONTROL ACTIVITY - EFFECT OF Mw - PILOT A

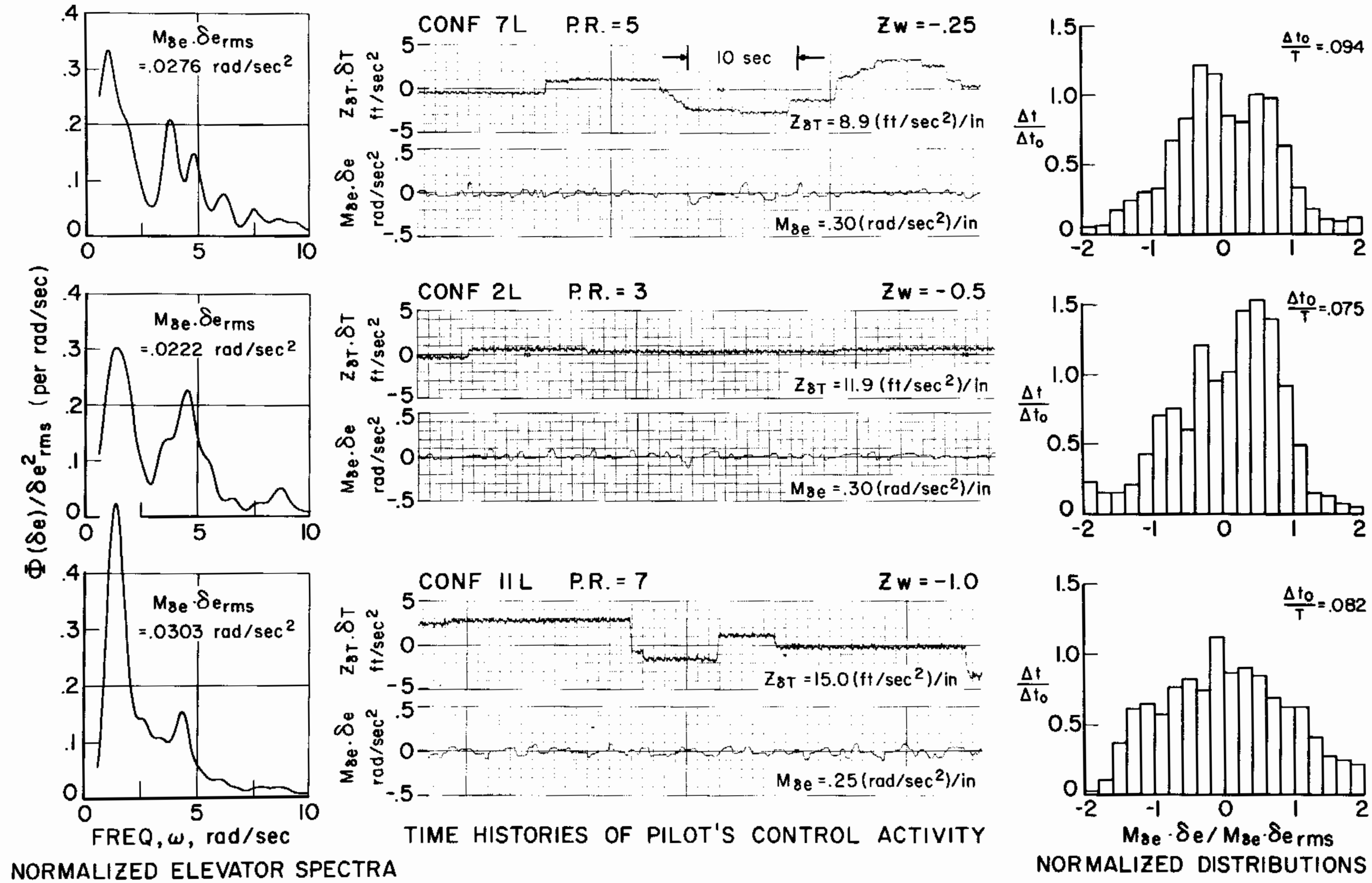
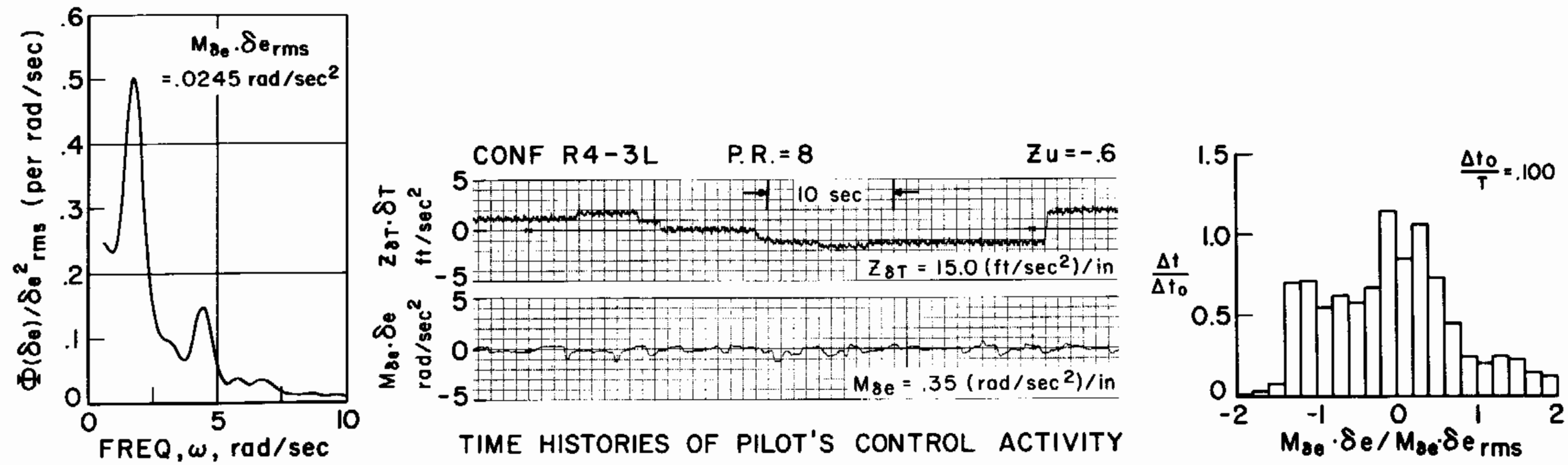


FIG 31 STATISTICAL PROPERTIES OF PILOT'S CONTROL ACTIVITY - EFFECT OF Zw - PILOT A

Zu = 0 not analysed for pilot A

Zu = -.2 not analysed for pilot A



NORMALIZED ELEVATOR SPECTRA

TIME HISTORIES OF PILOT'S CONTROL ACTIVITY

NORMALIZED DISTRIBUTIONS

FIG 32 STATISTICAL PROPERTIES OF PILOT'S CONTROL ACTIVITY - EFFECT OF Zu - PILOT A

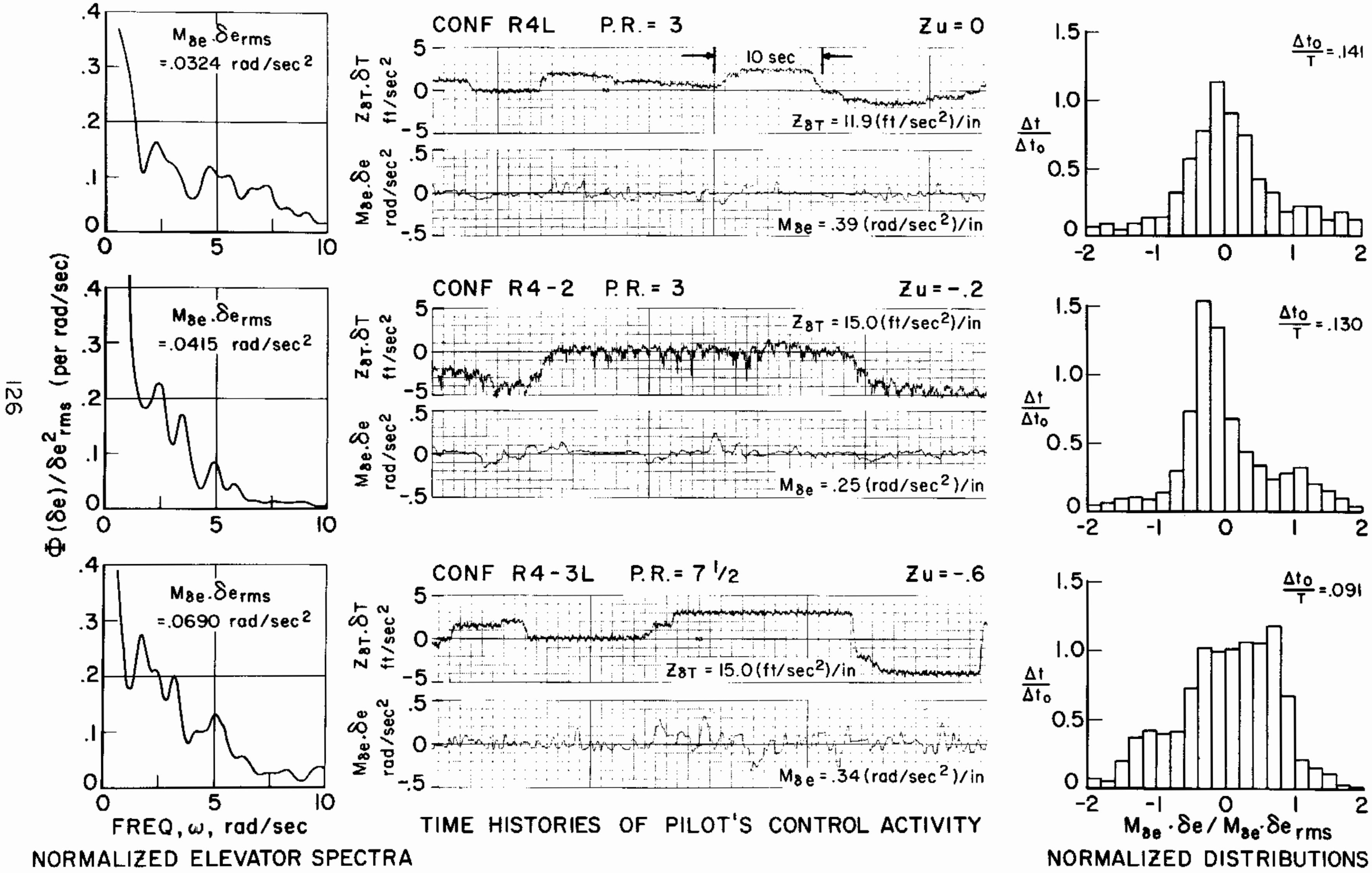


FIG 33 STATISTICAL PROPERTIES OF PILOT'S CONTROL ACTIVITY - EFFECT OF Zu - PILOT B

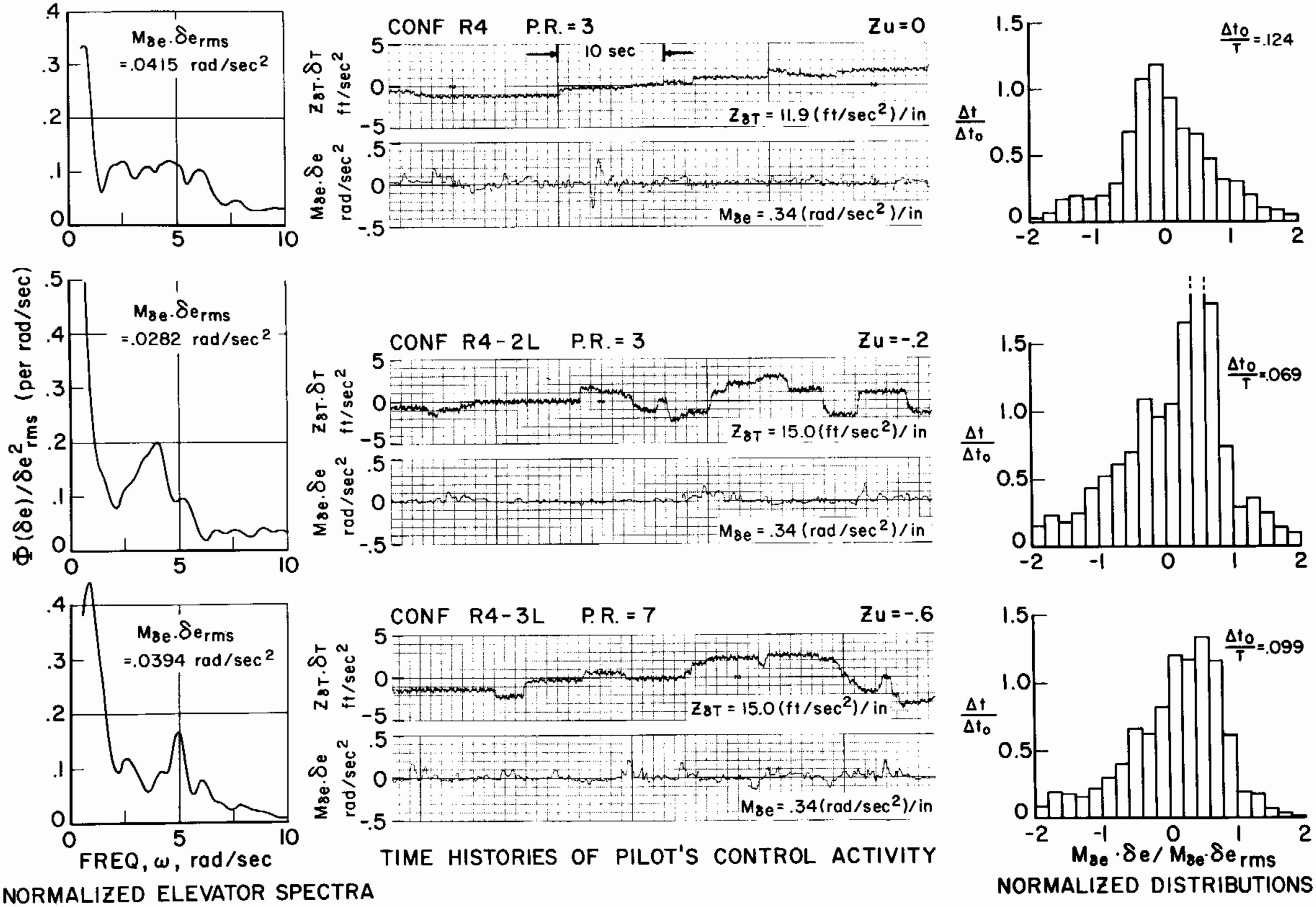


FIG 34 STATISTICAL PROPERTIES OF PILOT'S CONTROL ACTIVITY - EFFECT OF Zu - PILOT C

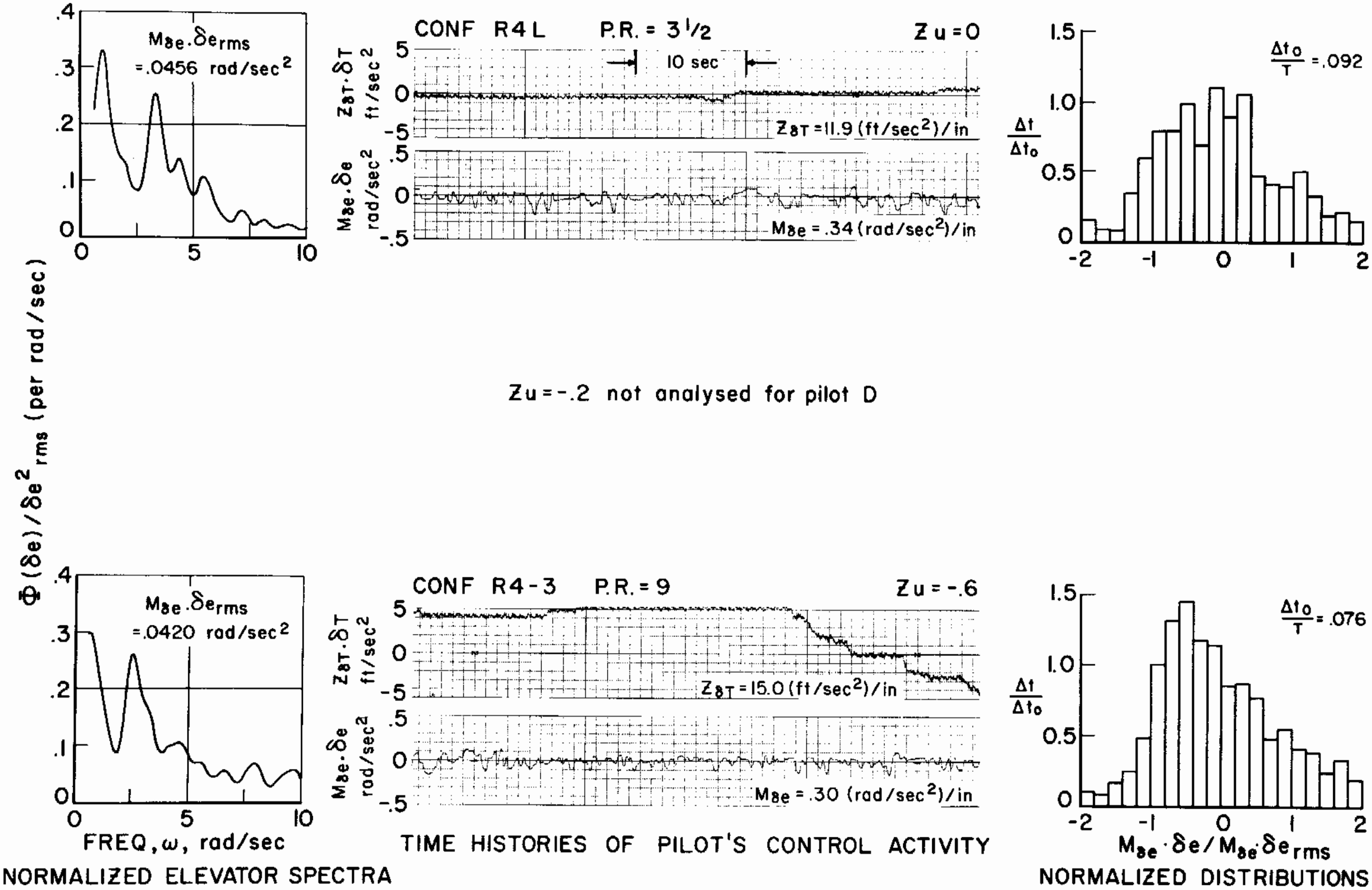


FIG 35 STATISTICAL PROPERTIES OF PILOT'S CONTROL ACTIVITY-EFFECT OF Zu - PILOT D

TABLE I LONGITUDINAL DERIVATIVES OF CONFIGURATIONS EVALUATED

Group	Conf.		M_q	M_u	M_w	$M_{\dot{w}}$	M_θ	$M_{\delta_T}/Z_{\delta_T}$	Z_u	Z_w	$Z_{\delta_E}/M_{\delta_E}$
I SHORT PERIOD CHARACTERISTICS											
	1		-.833	0	-.00576	-.00412	0	0	0	-.5	0
	2		↓	↓	-.00206	↓	↓	↓	↓	↓	↓
	3				0						
	4				+.00165						
	5				+.00421						
	6		-1.0	0	-.00740	-.00493	0	0	0	-.25	0
	7		↓	↓	-.00123	↓	↓	↓	↓	↓	↓
	8				0						
	9				+.00118						
	10		-.50	0	-.00493	-.00247	0	0	0	-1.0	0
	11		↓	↓	-.00247	↓	↓	↓	↓	↓	↓
	12				0						
	13				+.00222						
	14				+.00247						
	15				+.00473						
	16		-.60	0	-.00692	-.00296	0	0	0	-.5	0
	17		↓	↓	-.00148	↓	↓	↓	↓	↓	↓
	18		-.295	0	-.00874	-.00220	0	0	0	-.5	0
	19		↓	↓	-.00114	↓	↓	↓	↓	↓	↓
	20				+.00102						

Group	Conf.		M_q	M_u	M_w	$M_{\dot{w}}$	M_θ	$M_{\delta_T}/Z_{\delta_T}$	Z_u	Z_w	$Z_{\delta_E}/M_{\delta_E}$
II	VARIATIONS OF FLIGHT PATH CHARACTERISTICS IN THE PRESENCE OF GOOD PITCH CONTROL CHARACTERISTICS. (PITCH SAS with ATTITUDE (PREFIX A) and RATE (PREFIX R) COMMAND FORMS)										
	R 1		-1.57	0	-.00576	-.00412	-1.65	0	0	-.5	0
	R 1-2		-1.57	↓	↓	↓	-1.64	↓	-.2	↓	↓
	R/A 1-3		-1.58				-1.64		-.6		
	R/A 4		-1.82	0	+.00165	-.00412	-2.8	0	0	-.5	0
	A 4-1		-1.82	↓	↓	↓	-2.8	↓	-.1	↓	↓
	R/A 4-2		-1.85				-2.8		-.2		
	R/A 4-3		-1.93				-2.93		-.6		
	R 19		-1.87	0	-.00114	-.00220	-2.25	0	0	-.5	0
	R 19-1		-1.87	↓	↓	↓	↓	↓	-.1	↓	↓
	R 19-2		-1.89						-.2		
	R/A 19-3		-1.89						-.6		
	R/A 8		-1.62	0	0	-.00493	-2.37	0	0	-.25	0
	R/A 8-1		↓	↓	↓	↓	↓	↓	-.05	↓	↓
	R/A 8-2								-.2		
	R/A 14		-2.3	0	+.00246	-.00247	-3.2	0	0	-1.0	0
	R/A 14-1		↓	↓	↓	↓	↓	↓	-.2	↓	↓
	R/A 14-2								-.6		

TABLE I (III) (cont'd)

Group	Conf.		M_q	M_u	M_w	$M_{\dot{w}}$	M_θ	$M_{\delta_T}/Z_{\delta_T}$	Z_u	Z_w	$Z_{\delta_E}/M_{\delta_E}$
III	SIMULTANEOUS VARIATIONS IN BOTH SHORT AND LONG TERM CHARACTERISTICS THROUGH Z_u.										
	1-2		-.833	0	-.00576	-.00412	0	0	-.2	-.5	0
	1-3		↓	↓	-.00576	↓	↓	↓	-.6	↓	↓
	2-2		↓	↓	-.00206	↓	↓	↓	-.2	↓	↓
	2-3		↓	↓	-.00206	↓	↓	↓	-.6	↓	↓
	4-2		↓	↓	+.00165	↓	↓	↓	-.2	↓	↓
	4-3		↓	↓	+.00165	↓	↓	↓	-.6	↓	↓
	19-2		-.295	0	-.00874	-.00220	0	0	-.2	-.5	0
	19-3		↓	↓	↓	↓	↓	↓	-.6	↓	↓
	7-2		-1.0	0	-.00123	-.00493	0	0	-.2	-.25	0
	8-2		↓	↓	0	↓	↓	↓	↓	↓	↓
	11-2		-.5	0	-.00247	-.00247	0	0	-.6	-1.0	0
	14-1		↓	↓	+.00247	↓	↓	↓	-.2	↓	↓
	14-2		↓	↓	+.00247	↓	↓	↓	-.6	↓	↓

TABLE I (IV) (cont'd)

Group	Conf.		M_q	M_u	M_w	$M_{\dot{w}}$	M_θ	$M_{\delta_T}/Z_{\delta_T}$	Z_u	Z_w	$Z_{\delta_E}/M_{\delta_E}$
IV	SIMULTANEOUS VARIATIONS IN BOTH SHORT AND LONG TERM CHARACTERISTICS THROUGH M_u.										
	1-P		-.833	+.005	-.00576	-.00412	0	0	0	-.5	0
	1-N		↓	-.001	↓	↓	↓	↓	0	↓	↓
	1-2P		↓	+.005	↓	↓	↓	↓	-.2	↓	↓
	1-2N		↓	-.003	↓	↓	↓	↓	-.2	↓	↓
	1-3P		↓	+.005	↓	↓	↓	↓	-.6	↓	↓
	1-3N		↓	-.005	↓	↓	↓	↓	-.6	↓	↓
	2-2P		-.833	+.005	-.00206	-.00412	0	0	-.2	-.5	0
	4-2P		-.833	+.005	+.00165	-.00412	0	0	-.2	-.5	0
	19-P		-.295	+.0048	-.00114	-.0022	0	0	0	-.5	0
	19-N		↓	-.0003	↓	↓	↓	↓	0	↓	↓
	19-2P		↓	+.0043	↓	↓	↓	↓	-.2	↓	↓
	19-2N		↓	-.00075	↓	↓	↓	↓	-.2	↓	↓
	19-3P		↓	+.003	↓	↓	↓	↓	-.6	↓	↓
	19-3N		↓	-.0015	↓	↓	↓	↓	-.6	↓	↓
	8-P		-1.0	+.005	0	-.00493	0	0	0	-.25	0
	8-2P		↓	+.005	↓	↓	↓	↓	-.2	↓	↓
	8-2N		↓	-.00075	↓	↓	↓	↓	-.2	↓	↓
	11-1P		-.5	+.0029	-.00247	-.00247	0	0	-.2	-1.0	0
	14-P		-.5	+.002	0	-.00247	0	0	0	-1.0	0
	14-1N		↓	+.00025	↓	↓	↓	↓	-.2	↓	↓
	14-2P		↓	+.00425	↓	↓	↓	↓	-.6	↓	↓

TABLE I (V) (cont'd)

Group	Conf.	M_q	M_u	M_w	$M_{\dot{w}}$	M_θ	$M_{\delta_T}/Z_{\delta_T}$	Z_q	Z_θ	Z_u	Z_w	$Z_{\delta_E}/M_{\delta_E}$
V EFFECT OF NON-ZERO $Z_{\delta_E}/M_{\delta_E}$ ON SELECTED CONFIGURATIONS (CONFIGURATION 1-2 WITH AND WITHOUT PITCH SAS)												
	1-21	-.833	0	-.00576	-.00412	0	0	0	0	-.2	-.5	7.5
	1-22	"	"	"	"	"	"	0	0	"	"	15.0
	R1-21	-1.57	0	-.00576	-.00412	-1.64	0	-11.8	-12.3	-.2	-.5	7.5
	R1-22	"	"	"	"	"	"	-23.6	-24.6	"	"	15.0
VI EFFECT OF NON-ZERO $M_{\delta_T}/Z_{\delta_T}$ ON CONFIGURATION 2-2												
	2-21	-.833	0	-.00206	-.00412	0	-.0064	0	0	-.2	-.5	0
	2-22	↓	↓	↓	↓	↓	+.0064	↓	↓	↓	↓	↓
	2-23	↓	↓	↓	↓	↓	+.0128	↓	↓	↓	↓	↓

For all the above configurations, the X-force derivatives are given by:

$X_u = -3M_u - .04$

$X_w = -3M_w - .03$

$X_{\dot{w}} = -3M_{\dot{w}}$

$X_q = -3M_q - .022$

$X_\theta = -3M_\theta$

$X_{\delta_E} = -3M_{\delta_E}$

$X_{\delta_T} = -3M_{\delta_T}$

The operating point conditions were $U_o = 60$ knots, $\theta_o = -7$ degrees, $W_o = U_o(\theta_o - \gamma_o)$

TABLE II PREDOMINANT MODAL PARAMETERS OF CONFIGURATIONS EVALUATED : U_o = 101.3, W_o = 1.77, θ_o = -.1222

Group	Conf.		Δ λ_1	Δ λ_2	Δ λ_3	Δ λ_4	$N \frac{\theta}{\delta_e}(s)$ λ_1	$N \frac{\theta}{\delta_e}(s)$ λ_2	$N \frac{n}{\delta_e}(s)$ λ_1	$N \frac{\dot{h}}{\delta_e}(s)$ λ_1	$N \frac{w}{\delta_e}(s)$ λ_1	$N \frac{w}{\delta_e}(s)$ λ_2	$\frac{\dot{h}}{u}\Big\vert\delta_{e_{ss}}$
I SHORT PERIOD CHARACTERISTICS													
	1		-.023	-.040	-.864±	.480i	-.040	- .50	-.460	-.075	-.040	-.039	-.238
	2		-.013	-.040	-.499	-1.24	↓	↓	↓	↓	↓	↓	↓
	3		0	-.040	-.298	-1.45	↓	↓	↓	↓	↓	↓	↓
	4		.021	-.040	-.192	-1.58	↓	↓	↓	↓	↓	↓	↓
	5		.093	-.040	-.102	-1.74	↓	↓	↓	↓	↓	↓	↓
	6		-.030	-.040	-.860±	.479i	-.040	- .25	-.232	-.073	-.040	-.039	-.227
	7		-.013	-.040	-.250	-1.49	↓	↓	↓	↓	↓	↓	↓
	8		0	-.040	-.171	-1.58	↓	↓	↓	↓	↓	↓	↓
	9		.024	-.040	-.116	-1.66	↓	↓	↓	↓	↓	↓	↓
	10		-.020	-.040	-.865±	.476i	-.04	-1.0	-.92	-.077	-.040	-.039	-.242
	11		-.013	-.040	-.733	-1.00	↓	↓	↓	↓	↓	↓	↓
	12		0	-.040	-.369	-1.38	↓	↓	↓	↓	↓	↓	↓
	13		.026	-.040	-.212	-1.57	↓	↓	↓	↓	↓	↓	↓
	14		.031	-.040	-.199	-1.58	↓	↓	↓	↓	↓	↓	↓
	15		.093	-.040	-.116	-1.73	↓	↓	↓	↓	↓	↓	↓
	16		-.028	-.040	-.686±	.710i	-.040	- .50	-.460	-.075	-.040	-.039	-.238
	17		-.013	-.040	-.500	- .887	"	"	"	"	"	"	"
	18		-.034	-.040	-.492±	.875i	-.040	- .50	-.460	-.075	-.040	-.039	-.238
	19		-.018	-.040	-.500±	.058i	↓	↓	↓	↓	↓	↓	↓
	20		.042	-.040	-.101	- .959	↓	↓	↓	↓	↓	↓	↓

TABLE II (II) (CONT'D)

Group	Conf.		Δ				$N^{\theta}_{\delta_e}(s)$		$N^{u}_{\delta_e}(s)$	$N^{\dot{h}}_{\delta_e}(s)$	$N^{w}_{\delta_e}(s)$		$\frac{\dot{h}}{u}\Big\vert_{\delta_{ess}}$
			λ_1	λ_2	λ_3	λ_4	λ_1	λ_2	λ_1	λ_1	λ_1	λ_2	
II	VARIATIONS OF FLIGHT PATH CHARACTERISTICS IN THE PRESENCE OF GOOD PITCH CONTROL CHARACTERISTICS (PITCH SAS WITH ATTITUDE COMMAND FORM. NB. THE PILOT'S ELEVATOR CONTROL OUTPUT IS MODIFIED AS SHOWN IN FIG. 3 FOR THE RATE COMMAND FORM).												
	A 1		- .379	-.040	-1.05±	1.06i	-.040	- .500	-.460	-.075	-.040	-.039	- .238
	A 1-2		- .336	-.082	-1.06±	1.05i	-.027	- .513	↓	.063	-.041±	.251i	.197
	A 1-3		- .208±	.098i	-1.07±	1.03i	-.004	- .536	↓	.350	-.044±	.432i	1.07
	A 4		- .621	-.040	-1.06±	1.06i	-.040	- .500	-.460	-.075	-.040	-.039	- .238
	A 4-1		- .646	-.029	-1.05±	1.06i	-.034	- .506	↓	-.006	-.040±	.178i	- .019
	A 4-2		- .674	-.019	-1.06±	1.04i	-.027	- .513	↓	.063	-.041±	.251i	.197
	A 4-3		- .759	.015	-1.08±	1.05i	-.004	- .536	↓	.350	-.044±	.432i	1.07
	A19		- .499	-.040	-1.05±	1.08i	-.040	- .500	-.460	-.075	-.040	-.039	- .238
	A19-1		- .506	-.037	-1.05±	1.08i	-.034	- .506	↓	-.006	-.040±	.178i	- .019
	A19-2		- .512	-.034	-1.05±	1.07i	-.027	- .513	↓	.063	-.041±	.251i	.197
	A19-3		- .539	-.022	-1.05±	1.06i	-.004	- .536	↓	.350	-.044±	.432i	1.07
	A 8		- .265	-.040	-1.05±	1.06i	-.040	- .250	-.232	-.072	-.040	-.039	- .227
	A 8-1		- .278	-.033	-1.05±	1.06i	-.033	- .257	↓	-.004	-.040±	.126i	- .011
	A 8-2		- .312	-.014	-1.04±	1.06i	-.015	- .276	↓	.206	-.041±	.251i	.635
	A14		-1.43	-.040	-1.06±	1.05i	-.040	-1.00	-.919	-.077	-.040	-.039	- .242
	A14-1		-1.46	-.028	-1.05±	1.06i	-.034	-1.01	↓	-.008	-.041±	.251i	- .024
	A14-2		-1.52	-.007	-1.03±	1.07i	-.022	-1.02	↓	.133	-.044±	.432i	.413

TABLE II (III) (CONT'D)

Group	Conf.		Δ				$N\frac{\theta}{\delta_e}(s)$		$N\frac{1}{\zeta_e}(s)$	$N\frac{\dot{h}}{\delta_e}(s)$	$N\frac{w}{\delta_e}(s)$		$\frac{\dot{h}}{u}\Big\vert_{\delta_{ess}}$
			λ_1	λ_2	λ_3	λ_4	λ_1	λ_2	λ_1	λ_1	λ_1	λ_2	
III	SIMULTANEOUS VARIATIONS IN BOTH SHORT AND LONG TERM CHARACTERISTICS THROUGH Z_u												
	1-2		-.010±	.194i	-.886±	.476i	-.027	- .513	-.460	.063	-.041±	.251i	.197
	1-3		-.027±	.321i	-.926±	.471i	-.004	- .536		.350	-.044±	.432i	1.07
	2-2		-.015±	.145i	-.504	-1.26	-.027	- .513		.063	-.041±	.251i	.197
	2-3		.006±	.245i	-.510	-1.30	-.004	- .536		.350	-.044±	.432i	1.07
	4-2		-.157±	.181i	.119	-1.60	-.027	- .513		.063	-.041±	.251i	.197
	4-3		-.169±	.289i	.175	-1.64	- 004	- .536		.350	-.044±	.432i	1.07
	19-2		0 ±	.163i	-.530±	.020i	-.027	- .513		.063	-.041±	.251i	.197
	19-3		.040±	.260i	-.492	- .649	.004	- .536	↓	.350	-.044±	.432i	1.07
	7-2		-.013±	.143i	-.261	-1.51	-.015	- .276	-.232	.206	-.041±	.251i	.635
	8-2		-.098±	.115i	0	-1.60	-.015	- .276	"	.206	-.041±	.251i	.635
	11-2		.016±	.242i	-.783	-1.04	-.022	-1.02	-.919	.133	-.044±	.432i	.413
	14-1		-.173±	.193i	.152	-1.60	-.034	-1.01		-.008	-.041±	.251i	- .024
	14-2		-.196±	.302i	.227	-1.63	-.022	-1.02	↓	.133	-.044±	.432i	.413

TABLE II (IV) (CONT'D)

Group	Conf.		Δ				$N\frac{\theta}{\delta_e}(s)$		$N\frac{u}{\delta_e}(s)$	$N\frac{\dot{h}}{\delta_e}(s)$	$N\frac{v}{\delta_e}(s)$		$\frac{\dot{h}}{u}\Big\vert\delta_{ess}$
			λ_1	λ_2	λ_3	λ_4	λ_1	λ_2	λ_1	λ_1	λ_1	λ_2	
IV	SIMULTANEOUS VARIATIONS IN BOTH SHORT AND LONG TERM CHARACTERISTICS THROUGH M_u												
	1-P		-.046±	.308i	-.857±	.338i	-.040	- .500	-.460	-.075	-.040	-.039	- .238
	1-N		.1	-.153	-.867±	.504i	-.040	- .500	↓	-.075	-.040	-.039	- .238
	1-2P		-.019±	.363i	-.885±	.346i	-.027	- .513	↓	.063	-.041±	.251i	.197
	1-2N		.1	-.097	-.894±	.541i	-.027	- .513	↓	.063	-.041±	.251i	.197
	1-3P		.024±	.441i	-.930±	.358i	-.004	- .536	↓	.350	-.044±	.432i	1.07
	1-3N		.040±	.157i	-.931±	.568i	-.004	- .536	↓	.350	-.044±	.432i	1.07
	2-2P		.021±	.38 i	-.48	-1.37	-.027	- .513	-.460	.063	-.041±	.251i	.197
	4-2P		.074±	.370i	-.297	-1.66	-.027	- .513	-.460	.063	-.041±	.251i	.197
	19-P		.101±	.444i	-.465	- .808	-.040	- .500	-.460	-.075	-.040	-.039	- .238
	19-N		.100	-.200	-.478±	.078i	-.040	- .500	↓	-.075	-.040	-.039	- .238
	19-2P		.102±	.440i	-.467	- .809	-.027	- .513	↓	.063	-.041±	.251i	.197
	19-2N		.104	-.183	-.489±	.085i	-.027	- .513	↓	.063	-.041±	.251i	.197
	19-3P		.101±	.421i	-.472	- .801	-.004	-..536	↓	.350	-.044±	.432i	1.07
	19-3N		.077	-.106	-.514±	.085i	-.004	- .536	↓	.350	-.044±	.432i	1.07
	8-P		.032±	.336i	-.218	-1.65	-.040	- .250	-.232	-.072	-.040	-.039	- .227
	8-2P		.028±	.353i	-.196	-1.67	-.015	- .276	↓	.206	-.041±	.251i	.635
	8-2N		-.152±	.125i	.099	-1.59	-.015	- .276	↓	.206	-.041±	.251i	.635
	11-1P		.043±	.352i	-.827	-1.06	-.034	-1.01	-.919	-.008	-.041±	.251i	- .024
	14-P		.10 ±	.302i	-.398	-1.60	-.040	-1.00	-.919	-.077	-.04	-.039	- .242
	14-1N		-.149±	.162i	.106	-1.60	-.034	-1.01	↓	-.008	-.041±	.251i	- .024
	14-2P		.10 ±	.380i	-.349	-1.66	-.022	-1.02	↓	.133	-.044±	.432i	.413

TABLE II (V) (CONT'D)

Group	Conf.		Δ λ_1	Δ λ_2	Δ λ_3	Δ λ_4	$N\frac{\theta}{\delta_e}(s)$ λ_1	$N\frac{\theta}{\delta_e}(s)$ λ_2	$N\frac{u}{\delta_e}(s)$ λ_1	$N\frac{\dot{h}}{\delta_e}(s)$ λ_1	$N\frac{w}{\delta_e}(s)$ λ_1	$N\frac{w}{\delta_e}(s)$ λ_2	$\frac{\dot{h}}{u}\Big\vert_{\delta_{ess}}$
V	EFFECT OF NON-ZERO $Z_{\delta e}/M_{\delta e}$ ON SELECTED CONFIGURATIONS (CONFIGURATION 1-2 WITH AND WITHOUT PITCH SAS)												
	1-21		-.010±	.194i	- .886±	.476i	-.026	-.485	-.432	.079	-.038±	.244i	.239
	1-22		-.010±	.194i	- .886±	.476i	-.025	0.456	-.402	.100	-.035±	.238i	.290
	R1-21		-.088	-.308	-1.04±	1.03i	-.026	-.485	-.434	.078	-.039±	.252i	.239
	R1-22		-.096	-.276	-1.03±	1.01i	-.025	-.456	-.406	.096	-.036±	.253i	.290
NB	δ_e TRANSFER FUNCTIONS FOR R1-21 AND R1-22 ARE FURTHER SHAPED AS SHOWN IN FIG. 3.												
VI	EFFECT OF NON-ZERO $M_{\delta T}/Z_{\delta T}$ ON CONFIGURATIONS 2-2												
	2-21		-.015±	.145i	- .504	-1.26	-.027	-.513	-.460	.063	-.041±	.251i	.197
	2-22		↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
	2-23		↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓

VI (CONT'D)			$\frac{\theta}{Z_{\delta_T}\delta_{T_{ss}}}$
	2-21		-.0127
	2-2		-.0061
	2-22		.0006
	2-23		.0072

TABLE III   Pilots' Comments

The pilots' comments are arranged in the sequence of Tables I and II.

	Flight 60-1	Flight 129-1
CONFIGURATION	1	1
FLIGHT NUMBER	60-1	129-1
PILOT	A	A
PILOT-RATING	4	4
WIND (knots)	5	8
WIND SHEAR	SMALL	NEGLIGIBLE
EXTERNAL TURBULENCE	LIGHT	NEGLIGIBLE
CHARACTERISTIC ROOTS	-.02 / -.04 / -.86± / .481	-.02 / -.04 / -.86± / .481

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

Flight 60-1:

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.34 (rad/sec^2)/in		$Z_{\delta T}$ = 11.9 (ft/sec^2)/in	
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

Flight 129-1:

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.25 (rad/sec^2)/in		$Z_{\delta T}$ = 11.9 (ft/sec^2)/in	
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

Flight 60-1:

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	MODERATE	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	+10, -5 knots			±200 fpm		

COMMENTS: THE STRONG DEPENDENCE OF AIRSPEED ON PITCH ATTITUDE MAKES FOR A DIFFICULT AIRSPEED HOLDING TASK EVEN WITH THIS FAIRLY GOOD MODEL.

Flight 129-1:

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	SLIGHT	MODERATE	NONE	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	+10, -5 knots			O K fpm		

COMMENTS: PITCH ATTITUDE VARIED CONTINUOUSLY WITH SMALL OUT-OF-TRIM ON ELEVATOR AND WITH TURBULENCE. MODERATE PITCH TRIM REQUIRED TO COMPENSATE FOR CHANGES OF DESCENT RATE. INCREASING AIRSPEED APPEARED TO PITCH THE NOSE DOWN. ALL THE ABOVE FACTORS CONTRIBUTED TO AIRSPEED PROBLEMS.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	Flight 60-1 AMPLITUDE	PERIOD	DAMPING	Flight 129-1 AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO			ZERO		
HEAVE	ZERO			ZERO		

	Flight 60-1 SOURCE	DEGREE	Flight 129-1 SOURCE	DEGREE
EXCITATION				
CONTROL				

COMMENTS

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 60-1	Flight 129-1
CHANGE REQUIRED:	SMALL	NEGLIGIBLE
EASE OF COMPENSATION	SLIGHT DIFFICULTY	NO DIFFICULTY

COMMENTS:

5 FLIGHT PATH CONTROL

Flight 60-1:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	MODERATE	SLIGHT	SLIGHT	SLIGHT
PRECISION	GOOD	GOOD	FAIR	GOOD	GOOD	GOOD

Flight 129-1:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	SLIGHT	SLIGHT	SLIGHT	SLIGHT	MODERATE
PRECISION	GOOD	FAIR	FAIR	FAIR	FAIR	POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500 (Flight 60-1); — (Flight 129-1)

COMMENTS:

Flight 60-1: THE AIRSPEED CONTROL CAUSED ENOUGH PROBLEMS TO REQUIRE A GREATER CONCENTRATION THAN DESIRED. HAD TO DESCEND AT 1200 F.P.M. FOR A WHILE DURING THE MIDDLE PORTION OF THE APPROACH AND THIS FELT UNCOMFORTABLE.

Flight 129-1: DIFFICULTY PROBABLY DUE TO BEING SLIGHTLY RUSTY ON CROSS-CHECK.

6 BREAKOUT AND FLARE

	Flight 60-1	Flight 129-1
EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY	NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR	GOOD

COMMENTS:

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT — Flight 60-1: NONE

9 LEAST OBJECTIONABLE FEATURES

Flight 129-1: ALL CHANGES TAKE PLACE SLOWLY AND WITH MODERATE CONCENTRATION CAN BE CONTAINED WELL ENOUGH.

10 MOST OBJECTIONABLE FEATURES

Flight 129-1: SEE SECTION #2.

11 MISCELLANEOUS

	Flight 30-2	Flight 21-2
CONFIGURATION	I	I
FLIGHT NUMBER	30-2	21-2
PILOT	C	D
PILOT-RATING	3	3
WIND (knots)	10	CALM
WIND SHEAR	SMALL	NEGLIGIBLE
EXTERNAL TURBULENCE	LIGHT	LIGHT
CHARACTERISTIC ROOTS	-.02, -.04, -.86 ± .48i	-.02, -.04, -.86 ± .48i

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

Flight 30-2:

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E} = 0.39$ (rad/sec²)/in		$Z_{\delta T} = 11.9$ (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

Flight 21-2:

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E} = 0.39$ (rad/sec²)/in		$Z_{\delta T} = 11.9$ (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

Flight 30-2:

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	NONE	NONE	NONE
MAXIMUM UNDESIRED FLUCTUATIONS	+5, -10 knots			±100 fpm		

Flight 21-2:

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	SLIGHT	SLIGHT	NONE	NONE	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	±5 knots			±200 fpm		

COMMENTS

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	Flight 30-2 AMPLITUDE	PERIOD	DAMPING	Flight 21-2 AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO			SMALL → ZERO		
HEAVE	ZERO			SMALL → ZERO		

	Flight 30-2 SOURCE	DEGREE	Flight 21-2 SOURCE	DEGREE
EXCITATION:				
CONTROL:				

COMMENTS:

Flight 21-2: GENERALLY REASONABLE CONFIGURATION, SLIGHT P.I.O. TENDENCIES, SOME OVERCONTROL BUT NOT MUCH.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 30-2	Flight 21-2
CHANGE REQUIRED	NEGLIGIBLE	MODERATE
EASE OF COMPENSATION	SLIGHT DIFFICULTY	SLIGHT/MODERATE DIFFICULTY

COMMENTS:

Flight 30-2: GAINED HEIGHT AND LOST UP TO 10 KNOTS AIRSPEED ON TURNS. SMALL AMOUNT OF POWER ADDED IN TURNS. CONTROL OF AIRSPEED IS MAJOR PREOCCUPATION.

Flight 21-2: DIFFICULTY DUE TO LAG IN SENSING NEED FOR POWER.

5 FLIGHT PATH CONTROL

Flight 30-2:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	SLIGHT	SLIGHT	SLIGHT	MODERATE
PRECISION						

Flight 21-2:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	SLIGHT	SLIGHT	>SLIGHT	>SLIGHT
PRECISION						

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

COMMENTS:

Flight 21-2: BEHIND THE AIRCRAFT NEAR MINIMUM ALTITUDE - OK UNTIL LAST 100 FT. OR SO.

6 BREAKOUT AND FLARE

	Flight 30-2	Flight 21-2
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	POOR

COMMENTS

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

Flight 30-2: NONE

Flight 21-2: NONE

9 LEAST OBJECTIONABLE FEATURES

Flight 21-2: SEEMS EASY TO CONTROL ATTITUDE, AND POWER REQUIREMENTS WERE RELATIVELY MINOR. REASONABLE PRECISION OF CONTROL WITH MODERATE PILOT EFFORT.

10 MOST OBJECTIONABLE FEATURES

Flight 30-2: CONSTANT ATTENTION REQUIRED TO CONTROL AIRSPEED, PARTICULARLY IF VARIATIONS EXCEED 5 KNOTS.

Flight 21-2: LAG BEHIND TALAR WHEN ATTEMPTING CLOSE CONTROL NEAR MINIMUM ALTITUDE.

11 MISCELLANEOUS

Flight 21-2: MAYBE I AM STILL OVERCONTROLLING WHEN TALAR SENSITIVITY IS HIGH NEAR TOUCHDOWN.

CONFIGURATION	I	WIND (knots)	5
FLIGHT NUMBER	36-1	WIND SHEAR	NEGLIGIBLE
PILOT	B	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	4B/C		

CHARACTERISTIC ROOTS

-.02	-.04	-.86 ±	j.481

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta e}$ = 0.30	(rad/sec²)/in	$Z_{\delta T}$ = -11.9	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	>SLIGHT	>SLIGHT	NONE	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	+10, -6		knots	-		fpm

COMMENTS

DIFFICULTY DUE TO CROSS-CHECK; THE INCREASED ATTITUDE STIFFNESS REQUIRED A SLIGHTLY NEW CONTROL TECHNIQUE FOR PITCH ATTITUDE AND AIRSPEED. SPEED CONTROL COULD PROBABLY BE IMPROVED WITH PRACTICE.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	SMALL	LONG	LOW
HEAVE	SMALL	LONG	LOW

	SOURCE	DEGREE
EXCITATION	UNKNOWN	HARDLY
CONTROL	NOT ATTEMPTED.	

COMMENTS

ONLY SENSED THIS A COUPLE OF TIMES - USUALLY NOT SEEN.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED	NEGLIGIBLE	
EASE OF COMPENSATION	NO	DIFFICULTY

COMMENTS

OK - GOOD.

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	SLIGHT	NONE	SLIGHT	NONE
PRECISION	GOOD	GOOD	FAIR/GOOD	GOOD	FAIR/GOOD	GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: O.K.

COMMENTS

SPEED INTERACTION WITH RATE OF CLIMB CAUSED SLIGHT CONTROL DIFFICULTY - SEE SECTION 7.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	VERY SLIGHT	DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	

COMMENTS

OK - SAFE.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

WHEN SPEED IS OTHER THAN 90 KNOTS, HAVE TO THINK HOW THIS AFFECTS EXISTING DESCENT RATE AND WHAT WILL HAPPEN TO THE LATTER WHEN SPEED IS CORRECTED TO 90 KNOTS.

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE.

9 LEAST OBJECTIONABLE FEATURES

10 MOST OBJECTIONABLE FEATURES

FAIRLY SENSITIVE TO VERTICAL [illegible] CHANGE, BUT NOT NOISY.

11 MISCELLANEOUS

HARD TO TRIM ATTITUDES - SUSPECT THAT EITHER ELEVATOR SENSITIVITY OR TRIM RATE TOO HIGH. RESPONSE TO RAPID ELEVATOR PULSES AND STEPS GOOD. [illegible] POSSIBLY [illegible]

CONFIGURATION		WIND (knots)	
FLIGHT NUMBER		WIND SHEAR	
PILOT		EXTERNAL TURBULENCE	
PILOT-RATING			

CHARACTERISTIC ROOTS

ELEVATOR		THRUST LEVER	
$M_{\delta e}$ =	(rad/sec²)/in	$Z_{\delta T}$ =	(ft/sec²)/in
Initial	Final	Initial	Final

Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
VMC	IMC	IMC	VMC	IMC	IMC
OUT	OUT	IN	OUT	OUT	IN
		knots			fpm

AMPLITUDE	PERIOD	DAMPING

SOURCE	DEGREE

DIFFICULTY

Intercept & initial track		Intermediate track		Final track	
Glide path	Localizer	Glide path	Localizer	Glide path	Localizer

DIFFICULTY

	Flight 69-1	Flight 74-2
CONFIGURATION	2L	2L
FLIGHT NUMBER	69-1	74-2
PILOT	A	B
PILOT-RATING	3	4B
WIND (knots)	5	CALM
WIND SHEAR	> SMALL	NEGLIGIBLE
EXTERNAL TURBULENCE	NEGLIGIBLE	NEGLIGIBLE
CHARACTERISTIC ROOTS	-.01, -.04, -.5, -1.24	-.01, -.04, -.5, -1.24

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR Initial	ELEVATOR Final	THRUST LEVER Initial	THRUST LEVER Final
CONTROL SENSITIVITY (69-1)	$M_{\delta E}$ = 0.3 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
RESPONSE (69-1)	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY
CONTROL SENSITIVITY (74-2)	$M_{\delta E}$ = 0.3 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
RESPONSE (74-2)	SATISFACTORY	SATISFACTORY	SLIGHTLY SMALL	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

Flight 69-1

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	NONE	SLIGHT	NONE	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	±5 knots			0 K		fpm

COMMENTS

Flight 74-2

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	NONE	NONE	NONE	NONE	NONE
MAXIMUM UNDESIRED FLUCTUATIONS	±7 knots			0 K		fpm

APPARENT LOW HEIGHT RATE DAMPING - NEED TO WAIT FOR ANGLE OF ATTACK AND RATE OF CLIMB TO SETTLE DOWN.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	69-1 AMPLITUDE	69-1 PERIOD	69-1 DAMPING	74-2 AMPLITUDE	74-2 PERIOD	74-2 DAMPING
PITCH	ZERO			ZERO		
HEAVE	ZERO			ZERO		

	69-1 SOURCE	69-1 DEGREE	74-2 SOURCE	74-2 DEGREE
EXCITATION				
CONTROL				

COMMENTS

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	69-1	74-2
CHANGE REQUIRED	SMALL	NEGLIGIBLE
EASE OF COMPENSATION	NO DIFFICULTY	NO DIFFICULTY

COMMENTS

5 FLIGHT PATH CONTROL

Flight 69-1

	Intercept & initial track Glide path	Intercept & initial track Localizer	Intermediate track Glide path	Intermediate track Localizer	Final track Glide path	Final track Localizer
DIFFICULTY	NONE	SLIGHT	SLIGHT	MODERATE	SLIGHT	MODERATE
PRECISION	GOOD	FAIR	FAIR	POOR	GOOD	FAIR

Flight 74-2

	Intercept & initial track Glide path	Intercept & initial track Localizer	Intermediate track Glide path	Intermediate track Localizer	Final track Glide path	Final track Localizer
DIFFICULTY	NONE	NONE	NONE	NONE	< 400 FT. SLIGHT	SLIGHT
PRECISION	GOOD	GOOD	GOOD	GOOD	FAIR/GOOD	FAIR/GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: (69-1) — ; (74-2) 300

COMMENTS

69-1: DIFFICULTY DUE TO THIS BEING THE FIRST EVALUATION OF THE DAY WITH THE WIND SHEAR AND DIRECTION NOT HAVING BEEN PREDETERMINED.

74-2: HEIGHT LIMIT BECAUSE OF POOR OVERSHOOT CAPABILITY IN RESPONSE TO THRUST.
DIFFICULTY DUE TO: 1) TALAR - HIGH SENSITIVITY
2) BEING EARLY IN MORNING

6 BREAKOUT AND FLARE

	69-1	74-2
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	FAIR

COMMENTS

74-2: SPEED DROPPED TO 45 KNOTS DURING TRANSITION FROM IMC TO VMC. DIFFICULT TO REGAIN SPEED. TRANSITION AND FLARE NOT TOO GOOD BECAUSE OF RUSTINESS AND EARLY MORNING CONSTITUTION.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

69-1: [illegible] THESE CHARACTERISTICS SEEMED MORE BOTHERSOME THAN PREVIOUSLY SINCE A LARGE SIDESLIP ANGLE SEEMED TO RESULT FROM A SMALL RUDDER DISPLACEMENT. THE HEADING [illegible]

74-2: NONE

9 LEAST OBJECTIONABLE FEATURES

69-1: [illegible]

74-2: GOOD PITCH RESPONSE TO TURBULENCE. GOOD ATTITUDE STABILITY AND SPEED HOLD.

10 MOST OBJECTIONABLE FEATURES

69-1: SOMEWHAT TOO MUCH ATTENTION REQUIRED TO MAINTAIN HEADING ON APPROACH.

74-2: THE HEIGHT RATE DAMPING APPEARED TO BE LOWER THAN IDEAL, BUT THE NECESSARY LEAD COULD BE LEARNED EASILY.

11 MISCELLANEOUS

74-2: ELEVATOR FORCES SEEMED HIGH FOR ME TODAY (FIRST FLIGHT FOR [illegible] WEEKS).

	Flight 118-2	Flight 88-3
CONFIGURATION	3L	3L
FLIGHT NUMBER	118-2	88-3
PILOT	A	A
PILOT RATING	5	8½
WIND (knots)	5	10-15
WIND SHEAR	SMALL	NEGLIGIBLE
EXTERNAL TURBULENCE	NEGLIGIBLE	LIGHT

CHARACTERISTIC ROOTS

118-2	0	-.04	-.30	-1.45
88-3	0	-.04	-.1	-1.45

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

Flight 118-2:

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E} = 0.3$ (rad/sec²)/in		$Z_{\delta T} = 11.9$ (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

Flight 88-3:

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E} = 0.34$ (rad/sec²)/in		$Z_{\delta T} = 11.9$ (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

Flight 118-2:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	SLIGHT	MODERATE	NONE	NONE	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	+5, -10 knots			0 K fpm		

Flight 88-3:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	GREAT	GREAT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	+13, -10 knots			3 K fpm		

COMMENTS

118-2: TURBULENCE RESPONSE IN PITCH ATTITUDE WAS MAIN PROBLEM. TOO MUCH CONCENTRATION REQUIRED TO HOLD AIRSPEED ON APPROACH.

88-3: ENORMOUS CHANGES IN PITCH ATTITUDE WITH SMALL ELEVATOR INPUTS.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

Flight 118-2:

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

Flight 88-3:

	AMPLITUDE	PERIOD	DAMPING
PITCH			
HEAVE			

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

88-3: FELT LIKE A STRAIGHT DIVERGENCE WHICH COULD BE DISASTROUS AFTER A MOMENT OF DIVERSION FROM THE TASK.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	118-2	88-3
CHANGE REQUIRED	NEGLIGIBLE	SMALL
EASE OF COMPENSATION	NO DIFFICULTY	NO DIFFICULTY

COMMENTS:

5. FLIGHT PATH CONTROL

Flight 118-2:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	MODERATE	MODERATE
PRECISION	FAIR	FAIR	FAIR	FAIR		POOR

Flight 88-3:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	MODERATE	SLIGHT	MODERATE	SLIGHT	MODERATE
PRECISION	FAIR	FAIR/GOOD	FAIR	POOR	FAIR	POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 118-2: 500; 88-3: 800

COMMENTS

118-2: THE EXPECTED WIND SHEAR DID NOT MATERIALIZE AND WE ENDED UP TO ONE SIDE OF THE LOCALIZER.

88-3: HAD TO BREAK FIRST APPROACH OFF AT 500 FT. DUE TO CONFLICTING TRAFFIC. SECOND STARTED FROM 800' AND WAS QUITE RUSHED.

6. BREAKOUT AND FLARE

	118-2	88-3
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	GOOD

COMMENTS:

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT — 118-2: NONE; 88-3: SMALL

9. LEAST OBJECTIONABLE FEATURES — 118-2: HEIGHT CONTROL GOOD.; 88-3: SEE SECTIONS #2, 3.

10. MOST OBJECTIONABLE FEATURES — 118-2: TURBULENCE RESPONSE IN PITCH.

11. MISCELLANEOUS

CONFIGURATION	3L	WIND(knots)	3
FLIGHT NUMBER	56-1	WIND SHEAR	SMALL
PILOT	B	EXTERNAL TURBULENCE	
PILOT-RATING	7½D		

CHARACTERISTIC ROOTS: 0, -.04 | -.3 | -1.45

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	SLIGHTLY GREAT	TOO GREAT	SLIGHTLY SMALL	SLIGHTLY SMALL

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	±5 knots			fpm		

COMMENTS

DIFFICULTY IN AIRSPEED CONTROL DUE TO PITCH INSTABILITY, AND IN VERTICAL VELOCITY CONTROL TO WIND SHEAR.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION:		
CONTROL:		

COMMENTS

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED:	NEGLIGIBLE
EASE OF COMPENSATION	NO DIFFICULTY

COMMENTS

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	NONE	NONE	SLIGHT	SLIGHT
PRECISION	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

COMMENTS

TRACKED IMC TO 100'.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD

COMMENTS

'RIGHT IN THE SLOT' - GOOD POSITIONING FOR TOUCHDOWN EXCEPT THAT SPEED WAS LOST IN FLARE BECAUSE OF THE GREATER STRETCH REQUIRED FROM 100 FT.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

NONE

9 LEAST OBJECTIONABLE FEATURES

HEIGHT CONTROL NOT TOO BAD IN PRESENCE OF TURBULENCE AND REAL WIND SHEAR.

10 MOST OBJECTIONABLE FEATURES

1) PITCH INSTABILITY - TOO MUCH ATTENTION TO ATTITUDE CONTROL WAS REQUIRED.
2) PITCH ATTITUDE UPSETS DUE TO TURBULENCE.

11 MISCELLANEOUS

COULD HAVE REDUCED ELEVATOR SENSITIVITY, BUT IT WAS MORE LIKE A LOW PITCH DAMPING PROBLEM. COULD BE RATED 7 WITH REDUCED SENSITIVITY.

CONFIGURATION	4	WIND (knots)	
FLIGHT NUMBER	18-3	WIND SHEAR	MODERATE
PILOT	A	EXTERNAL TURBULENCE	LIGHT
PILOT-RATING	5		

CHARACTERISTIC ROOTS

+.02	-.04	-.19	-1.58

CONFIGURATION	4	WIND (knots)	8
FLIGHT NUMBER	16-2	WIND SHEAR	>SMALL
PILOT	B	EXTERNAL TURBULENCE	>LIGHT
PILOT-RATING	7½		

CHARACTERISTIC ROOTS

+.02	-.04	-.19	-1.58

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.39 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.39 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	TOO GREAT	NOT ASSESSABLE	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	MODERATE	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	± 3 knots			0 K fpm		

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	SLIGHT	MODERATE	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	-20, +5 knots			fpm		

COMMENTS:

A GENERAL PROBLEM OF NOT BEING ABLE TO SELECT AND HOLD THE PITCH ATTITUDE TO MAINTAIN A DESIRED AIRSPEED.

DIFFICULTY IN SPEED CONTROL DUE TO TURBULENCE AND LEARNING CROSS-CHECK.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	AMPLITUDE	PERIOD	DAMPING
PITCH	SMALL	MEDIUM	LOW
HEAVE			

	SOURCE	DEGREE
EXCITATION:		
CONTROL:		

	SOURCE	DEGREE
EXCITATION:	UNKNOWN	
CONTROL:		

COMMENTS:

OSCILLATION APPARENT ON INITIAL TAKE-OVER BUT WAS NOT NOTICED AFTER FIRST 5 MINUTES.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED:	MODERATE	SMALL
EASE OF COMPENSATION	SLIGHT DIFFICULTY	NO DIFFICULTY

COMMENTS

DURING THE TURN TO THE LOCALIZER ABOUT THE RIGHT AMOUNT OF THRUST WAS APPLIED IN ANTICIPATION OF LOSS OF ALTITUDE. ON ROLLING OUT, HOWEVER, THE CORRECTION WAS REMOVED TOO LATE, AFTER THE AIRCRAFT HAD CLIMBED 300 FT.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
PRECISION	GOOD	FAIR	GOOD	FAIR	GOOD	FAIR

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	SLIGHT	SLIGHT	SLIGHT	SLIGHT
PRECISION	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE
IF GREATER THAN 200 FEET

COMMENTS

THE WIND SHEAR REQUIRED MUCH ATTENTION TO LOCALIZER TRACKING. HEADING WAS AFFECTED MUCH MORE THAN NORMAL BY TURBULENCE.

CROSS-CHECK WEAK ON PITCH ATTITUDE: TURBULENCE AND/OR CONTROL OFF-CENTRES RESULTED IN DIFFICULTY IN MAINTAINING DESIRED ATTITUDE. SPEED CONTROL GENERALLY POOR ON THIS APPROACH (SPEED LOW 45-55 KTS) PRIMARY TASK WAS GLIDE SLOPE TRACKING.

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	GOOD

COMMENTS:

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

MODERATE/SMALL. SEE SECTION 5.

NONE

9. LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES

INITIAL PITCH PIO REQUIRED LOW GAIN ON PITCH ATTITUDE CONTROL – HENCE POOR SPEED CONTROL.

11. MISCELLANEOUS

ONE NEEDS TO NOTICE ERRORS WHILE THEY ARE SMALL AND TO MAKE SMALL CORRECTIONS. THIS RESULTS IN GOOD TRACKING.

CONFIGURATION [illegible] WIND (knots) 10
FLIGHT NUMBER [illegible] WIND SHEAR SMALL
PILOT [illegible] EXTERNAL TURBULENCE LIGHT
PILOT RATING 7[illegible]

CHARACTERISTIC ROOTS

[illegible]	-.14	-.19	-1.55

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.39 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	NONE	NONE	NONE	NONE	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	[illegible] knots			[illegible] fpm		

COMMENTS

STICK BACK GIVES DOWNWARD ACCELERATION, [illegible] PITCH ATTITUDE DIVERGES WITH STICK STEP INPUT. [illegible]

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

SUDDEN ELEVATOR INPUTS [illegible] DAMPED OUT.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED	MODERATE/SMALL
EASE OF COMPENSATION	SLIGHT MODERATE DIFFICULTY

COMMENTS

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	NONE	SLIGHT	NONE	SLIGHT	SLIGHT
PRECISION		GOOD		GOOD		GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET [illegible]

COMMENTS

WIND SHEAR: 400-600 FPM DESCENT [illegible] SLOPE UNTIL 500 FT. [illegible] 400 FT [illegible] SOME SPEED CONTROL PROBLEMS ON APPROACH 40-50 KNOTS IN EARLY STAGES, 60 KNOTS BELOW 500 FT, [illegible].

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR/GOOD

COMMENTS

DIFFICULTY DUE TO BEING HIGH AT BREAKOUT, [illegible] FOR TOUCHDOWN.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT NONE.

9 LEAST OBJECTIONABLE FEATURES

10 MOST OBJECTIONABLE FEATURES

PITCH ATTITUDE [illegible] WITH ELEVATOR INPUTS, [illegible] CONSTANT AT [illegible].

11 MISCELLANEOUS

[illegible]

CONFIGURATION 4 WIND (knots) CALM
FLIGHT NUMBER 23-7 WIND SHEAR >SMALL
PILOT 3 EXTERNAL TURBULENCE LIGHT
PILOT RATING 7'

CHARACTERISTIC ROOTS

+.02	-.04	-.19	-1.58

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.39 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY		SATISFACTORY	

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	>SLIGHT	NONE	NONE	NONE
MAXIMUM UNDESIRED FLUCTUATIONS	±10 knots			[illegible] fpm		

COMMENTS

PITCH ATTITUDE APPEARS TO DIVERGE WITH ELEVATOR INPUT, BUT NOT AS BADLY AS CONFIGURATION 4. DISPLAY MUST BE MONITORED CLOSELY, AND ELEVATOR KEPT CENTRED.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

[illegible] INTO A PIO AT 500 FT. THERE IS POTENTIAL FOR LOSS OF CONTROL DURING MODERATELY TIGHT TRACKING.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED	MODERATE/SMALL
EASE OF COMPENSATION	SLIGHT DIFFICULTY

COMMENTS

PROBABLY EASY TO LEARN - NOT A FACTOR FOR FLARE AND TOUCHDOWN.

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	NONE	SLIGHT	NONE	SLIGHT	SLIGHT
PRECISION		GOOD		GOOD		FAIR/GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET 500

COMMENTS

[illegible] CONTROL REQUIRED AND USED BELOW 500 FT INDUCED MODEL INSTABILITY PROBLEMS.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	POOR/FAIR

COMMENTS

[illegible] AT BREAKOUT - NOTED A SLIGHTLY LOWER THAN DESIRABLE VERTICAL SPEED RESPONSE TO THRUST INPUTS. SENSED POSSIBILITY OF GETTING INTO THRUST/ELEVATOR PIO WHILE ADJUSTING RATE OF DESCENT JUST PRIOR TO TOUCHDOWN.

7 CONTROL TECHNIQUE

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT NONE.

9 LEAST OBJECTIONABLE FEATURES

10 MOST OBJECTIONABLE FEATURES

[illegible] INCIPIENT PITCH INSTABILITY AT 500 FT. [illegible] PITCH RESPONSE TO ELEVATOR.

11 MISCELLANEOUS

RATING [illegible] PIO POTENTIAL, OTHERWISE WOULD BE 7 BECAUSE OF PITCH RESPONSE TO ELEVATOR.

	Flight 23-1	Flight 23-3
CONFIGURATION	4	4
FLIGHT NUMBER	23-1	23-3
PILOT	D	D
PILOT-RATING	7+	3
WIND (knots)	CALM	CALM
WIND SHEAR	MODERATE	SMALL
EXTERNAL TURBULENCE	LIGHT	NEGLIGIBLE
CHARACTERISTIC ROOTS	+.02, -.04, -.19, -1.58	+.02, -.04, -.19, -1.58

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

Flight	ELEVATOR $M_{\delta E}$ = 0.39 (rad/sec²)/in Initial	ELEVATOR Final	THRUST LEVER $Z_{\delta T}$ = 11.9 (ft/sec²)/in Initial	THRUST LEVER Final
CONTROL SENSITIVITY / RESPONSE (23-1)	TOO SMALL	TOO GREAT	SATISFACTORY	SATISFACTORY
CONTROL SENSITIVITY / RESPONSE (23-3)	SLIGHTLY SMALL	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (23-1)	>SLIGHT	>SLIGHT	MODERATE	SLIGHT	SLIGHT	>SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (23-1)	±10 knots			±200 fpm		
DIFFICULTY (23-3)	NONE	NONE	SLIGHT	NONE	NONE	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (23-3)	±7 knots			O.K. fpm		

COMMENTS

23-1: VERY SLUGGISH PITCH RESPONSE. NOT POSSIBLE TO ASSESS FINAL ATTITUDE TO A GIVEN INPUT.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE (23-1)	PERIOD (23-1)	DAMPING (23-1)	AMPLITUDE (23-3)	PERIOD (23-3)	DAMPING (23-3)
PITCH	ZERO			ZERO		
HEAVE	ZERO			ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

23-1: THIS CONFIGURATION APPEARS TO HAVE LOW FREQUENCY SHORT-PERIOD CHARACTERISTICS; HENCE PILOT TENDS TO OVERDRIVE IT TO GET INITIAL RESPONSE AND, AS A CONSEQUENCE OVERSHOOTS, i.e. LOW FREQUENCY PIO.

23-3: MODERATE PITCH RESPONSE - NO PARTICULAR P.I.O. TENDENCY. SEEMS SLIGHTLY SLUGGISH.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	23-1	23-3
CHANGE REQUIRED	VERY SMALL	VERY SMALL
EASE OF COMPENSATION	NO DIFFICULTY	NO DIFFICULTY

COMMENTS

5. FLIGHT PATH CONTROL

	Intercept & initial track Glide path	Intercept & initial track Localizer	Intermediate track Glide path	Intermediate track Localizer	Final track Glide path	Final track Localizer
DIFFICULTY (23-1)	NONE	NONE	SLIGHT	SLIGHT	SLIGHT	MODERATE
PRECISION (23-1)	GOOD	GOOD	GOOD	FAIR	FAIR	POOR
DIFFICULTY (23-3)	NONE	>SLIGHT	NONE	NONE	SLIGHT	>SLIGHT
PRECISION (23-3)	GOOD	GOOD	GOOD	GOOD	GOOD	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

COMMENTS

23-1: SPENT TOO MUCH TIME CONTROLLING PITCH TO MAINTAIN AIRSPEED AND CONSEQUENTLY GOT BEHIND THE LOCALIZER TRACKING TASK. LARGE SIDESTEP MANOEUVRE REQUIRED TO LINE UP WITH RUNWAY.

6 BREAKOUT AND FLARE

	23-1	23-3
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	POOR	FAIR GOOD

COMMENTS:

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

23-1: NONE

23-3: NONE

9 LEAST OBJECTIONABLE FEATURES

23-1: HEIGHT CONTROL.

23-3: GOOD HEIGHT CONTROL - LITTLE POWER ACTIVITY.

10 MOST OBJECTIONABLE FEATURES

23-1: ATTITUDE CONTROL - SLUGGISH INITIAL RESPONSE AND OVERCONTROL TENDENCY. LARGE PITCH ATTITUDE FLUCTUATIONS NOT ACCEPTABLE.

23-3: SLIGHTLY SLUGGISH PITCH RESPONSE - FAIRLY LARGE PITCH ATTITUDE EXCURSIONS IN TURBULENCE.

11 MISCELLANEOUS

23-1: IN TURBULENCE, WORKLOAD IS HIGH IN ORDER TO ATTAIN REASONABLE PERFORMANCE.

23-3: GENERALLY GOOD PERFORMANCE IN ALL PHASES OF TASK EXCEPT SOME ERRORS IN LOCALIZER TRACKING RIGHT NEAR MINIMUMS.

CONFIGURATION 4L FLIGHT NUMBER 119-1 PILOT A PILOT-RATING 7

WIND (knots) 5 WIND SHEAR SMALL EXTERNAL TURBULENCE LIGHT

CHARACTERISTIC ROOTS: -.02 | -.04 | -.19 | -1.58

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.30 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	MODERATE	GREAT	NONE	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	±10 knots			±200 fpm		

COMMENTS: DIFFICULTY DUE TO OSCILLATORY CHARACTERISTICS WHEN I.M.C.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	MODERATE	MEDIUM	LOW
HEAVE			

	SOURCE	DEGREE
EXCITATION:	ELEVATOR, TURBULENCE	EASILY
CONTROL	ELEVATOR	EFFECTIVE

COMMENTS: UNDER IMC CONDITIONS THERE SEEMED TO BE A MODERATE FREQUENCY LIGHTLY DAMPED MOTION THAT KEPT THE NOSE BUSY - THE TURBULENCE CONTRIBUTED TO THIS ACTIVITY, NOT PRESENT VMC.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: NEGLIGIBLE

EASE OF COMPENSATION: NO DIFFICULTY

COMMENTS: THIS PORTION OF THE TASK WENT SMOOTHLY AS WELL COMPARED WITH THE PART THAT FOLLOWED.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	MODERATE	SLIGHT	MODERATE	MODERATE	MODERATE	MODERATE
PRECISION	FAIR	FAIR	POOR	POOR	[illegible]	POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500

COMMENTS: DIFFICULTY DUE TO OSCILLATORY CHARACTERISTICS AND DUE TO ANTICIPATING A WIND SHEAR WHICH DID NOT MATERIALIZE.

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: NO DIFFICULTY

PRECISION OF ATTAINING TOUCHDOWN POINT: GOOD

COMMENTS:

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE

9. LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES

OSCILLATORY CHARACTERISTICS.

11. MISCELLANEOUS

CONFIGURATION 4L FLIGHT NUMBER 121-1 PILOT C PILOT RATING 6

WIND (knots) 10 WIND SHEAR SMALL EXTERNAL TURBULENCE LIGHT

CHARACTERISTIC ROOTS: -.02 | -.04 | -.19 | -1.58

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.30 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	TOO SMALL	TOO GREAT	TOO SMALL	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	MODERATE	SLIGHT	MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	±10 knots			fpm		

COMMENTS: LOST 400 FT HEIGHT TURNING ONTO BASE LEG DUE TO LONGITUDINAL VELOCITY CHANGES.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION:		
CONTROL		

COMMENTS: NO UNDERLYING SHORT PERIOD PITCH OR HEAVE MOTION DETECTABLE.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED:

EASE OF COMPENSATION: DIFFICULTY

COMMENTS: NEGLIGIBLE CHANGE REQUIRED IF VELOCITY HELD CONSTANT. OTHERWISE THRUST CHANGES REQUIRED TO COMPENSATE FOR AIRSPEED CHANGES.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	MODERATE	SLIGHT	SLIGHT	NONE	MODERATE	SLIGHT
PRECISION	POOR	FAIR	FAIR	FAIR	FAIR	GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 150

COMMENTS: POOR INITIAL PERFORMANCE DUE TO HEIGHT LOSS ON BASE LEG. NECESSARY TO MAKE LARGE ATTITUDE CORRECTIONS TO OFFSET SPEED VARIATIONS PLUS LARGE THROTTLE MOVEMENTS. SPEED FELL TO 50 KNOTS ON FINAL.

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: MODERATE DIFFICULTY

PRECISION OF ATTAINING TOUCHDOWN POINT: FAIR

COMMENTS: DIFFICULTY DUE TO NECESSITY FOR MAKING EVEN LARGER CORRECTIONS WHEN VMC TO RECOVER SPEED.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER: AIRSPEED CONTROLLED WITH ELEVATOR, BUT THROTTLE USED TO COMPENSATE FOR SPEED CHANGES AS WELL AS TO CONTROL VERTICAL SPEED.

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE

9. LEAST OBJECTIONABLE FEATURES

NO UNPLEASANT OSCILLATORY CHARACTERISTICS DETECTABLE.

10. MOST OBJECTIONABLE FEATURES

LARGE THRUST CORRECTIONS WITH SPEED VARIATION. DIFFICULTY IN ATTAINING PRECISE SPEED CONTROL.

11. MISCELLANEOUS

SOME EXTERNAL TURBULENCE BELOW 1000 FT. CHANGE OF SPEED, I.E., 80 TO 70 KNOTS, DIFFICULT TO ACCOMPLISH WITH PRECISION AND TAKES TOO LONG.

CONFIGURATION 5L
FLIGHT NUMBER 90-1
PILOT A
PILOT-RATING 9

WIND (knots) 10
WIND SHEAR SMALL
EXTERNAL TURBULENCE NEGLIGIBLE

CHARACTERISTIC ROOTS

+.09	-.04	-.15	-1.74

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	GREAT	GREAT	SLIGHT	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	-10, +5 knots			0 K fpm		

COMMENTS

THE NOSE WAS IN CONSTANT MOTION DUE TO AN ENORMOUS STEADY STATE RESPONSE TO CONTROL INPUTS AND TO THE TURBULENCE. THE VERTICAL RESPONSE TO ELEVATOR INPUTS ACCENTUATED THE SEVERITY OF THIS MOTION. A MOMENT'S DIVERSION COULD BE CATASTROPHIC.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

STRAIGHT DIVERGENCE.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: NEGLIGIBLE
EASE OF COMPENSATION: NO DIFFICULTY

COMMENTS:

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	SLIGHT	SLIGHT	SLIGHT	MODERATE
PRECISION	GOOD	GOOD	FAIR	FAIR	FAIR	POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 1000

COMMENTS

SEE SECTION #2. I WAS WORKING SO HARD ON AIRSPEED CONTROL THAT HEADING WENT FOR A CROP, WE GOT OFF TO THE RIGHT AND REQUIRED QUITE A STRENUOUS 'S' TURN.

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: GREAT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: POOR

COMMENTS

A PITCH PIO OCCURRED AS THE AIRCRAFT WAS LEVELLED.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

9. LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES

11. MISCELLANEOUS

CONFIGURATION
FLIGHT NUMBER
PILOT
PILOT-RATING

WIND (knots)
WIND SHEAR
EXTERNAL TURBULENCE

CHARACTERISTIC ROOTS

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = (rad/sec²)/in		$Z_{\delta T}$ = (ft/sec²)/in	
Initial	Final	Initial	Final

Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
VMC	IMC	IMC	VMC	IMC	IMC
OUT	OUT	IN	OUT	OUT	IN
knots			fpm		

AMPLITUDE	PERIOD	DAMPING

SOURCE	DEGREE

DIFFICULTY

Intercept & initial track		Intermediate track		Final track	
Glide path	Localizer	Glide path	Localizer	Glide path	Localizer

DIFFICULTY

CONFIGURATION	6	WIND(knots)	10
FLIGHT NUMBER	14-3	WIND SHEAR	SMALL
PILOT	A	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	4½		

CHARACTERISTIC ROOTS

-.03	-.04	-.86 ±	.48i

CONFIGURATION	6	WIND (knots)	5-10
FLIGHT NUMBER	45-1	WIND SHEAR	VERY SMALL
PILOT	B	EXTERNAL TURBULENCE	SLIGHT
PILOT-RATING	5C		

CHARACTERISTIC ROOTS

-.03	-.04	-.86 ±	0.48i

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.39	(rad/sec²)/in	$Z_{\delta T}$ = 7.4	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = 0.3	(rad/sec²)/in	$Z_{\delta T}$ = 11.9	(ft/sec²)/in
Initial	Final	Initial	Final
SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	-5,+10		knots	OK		fpm

COMMENTS:

Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
VMC	IMC	IMC	VMC	IMC	IMC
OUT	OUT	IN	OUT	OUT	IN
SLIGHT	SLIGHT	SLIGHT	V. SLIGHT	V. SLIGHT	V. SLIGHT
±10		knots			fpm

DIFFICULTY DUE TO PITCH TRIM CHANGES WITH THRUST CHANGES.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	SMALL	SHORT	MODERATE
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION	ELEVATOR	EASILY
CONTROL	ELEVATOR	EFFECTIVE

COMMENTS: A SHORT PERIOD JOSTLE RESULTS FROM ELEVATOR INPUTS WHICH GOES THROUGH ABOUT 2-3 CYCLES BEFORE STOPPING

AMPLITUDE	PERIOD	DAMPING
ZERO		
ZERO		

SOURCE	DEGREE

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED	MODERATE	
EASE OF COMPENSATION	SLIGHT	DIFFICULTY

COMMENTS:

SOME	
SLIGHT	DIFFICULTY

NO REAL PROBLEM

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	SLIGHT	NONE	SLIGHT	NONE	SLIGHT	NONE
PRECISION	FAIR	GOOD	FAIR	GOOD	FAIR	GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 200

COMMENTS: STAYED SLIGHTLY BELOW GLIDE PATH ON THIS APPROACH AND HAD NO DIFFICULTY IN KEEPING THE GLIDE PATH NEEDLE ON SCALE AND RECOVERING THE GLIDE PATH JUST BEFORE REACHING 200 FT A.G.L.

Intercept & initial track		Intermediate track		Final track	
Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
NONE	NONE	NONE	NONE	NONE	NONE
GOOD	GOOD	GOOD	GOOD	FAIR/GOOD	FAIR/GOOD

OK

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	SLIGHT	DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR	

COMMENTS: THE AIRSPEED FELL OFF SOMEWHAT FASTER THAN I HAD PLANNED - PROBABLY DUE TO A LITTLE OVERCONTROL AND DUE TO THE OVERSHOOT CHARACTERISTICS.

NO	DIFFICULTY
GOOD	

NICE STEADY STATE DESCENT RATE SET UP FOR TOUCH-DOWN, BUT NOT REALLY CERTAIN THAT I HAD PRECISE CONTROL OVER RATE OF DESCENT AT TOUCHDOWN.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE

NONE

9 LEAST OBJECTIONABLE FEATURES

GOOD (SATISFACTORY) PITCH ATTITUDE STABILITY.

10 MOST OBJECTIONABLE FEATURES

REFER TO SECTION #3

INTERACTION BETWEEN THRUST AND PITCH - EVERY SIGNIFICANT POWER CHANGE REQUIRES NEW PITCH ATTITUDE TRIM - NOTICEABLE EVEN FOR RELATIVELY RAPID POWER CHANGES ON APPROACH.

11 MISCELLANEOUS

$M_{\delta E}$ CHANGED FROM 0.59 to 0.39

OCCASIONAL LARGE PITCH UPSETS - TURBULENCE?

CONFIGURATION 6 | WIND (knots) 15-20
FLIGHT NUMBER 40-7 | WIND SHEAR MODERATE
PILOT D | EXTERNAL TURBULENCE MODERATE
PILOT-RATING 3

CHARACTERISTIC ROOTS

-.03	-.04	-.86 ±	.48i

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.30	(rad/sec²)/in	$Z_{\delta T}$ = 7.4	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	SLIGHT	SLIGHT	NONE	SLIGHT	>SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	±5		knots	±200		fpm

COMMENTS: TROUBLE ONLY NEAR GROUND - PROBABLY DUE TO WIND SHEAR.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	SMALL	MEDIUM	MODERATE
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED:	MODERATE	
EASE OF COMPENSATION	MODERATE	DIFFICULTY

COMMENTS: PILOT IS BEHIND THE AIRPLANE - AIRSPEED AND VERTICAL SPEED BUILDS UP BEFORE ACTION IS TAKEN - THEN OVERCONTROLS.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	NONE	NONE	SLIGHT	SLIGHT	MODERATE	MODERATE
PRECISION	GOOD	GOOD	FAIR	FAIR	POOR	POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET [ ]

COMMENTS: DIFFICULTY PROBABLY DUE TO WIND SHEAR

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	NO	DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	

COMMENTS:

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE

9. LEAST OBJECTIONABLE FEATURES: GOOD DAMPING IN PITCH - IAS STABLE.

10. MOST OBJECTIONABLE FEATURES: QUITE A BIT OF THROTTLE MANIPULATION TO MAINTAIN GLIDE PATH.

11. MISCELLANEOUS

CONFIGURATION | WIND (knots)
FLIGHT NUMBER | WIND SHEAR
PILOT | EXTERNAL TURBULENCE
PILOT-RATING

CHARACTERISTIC ROOTS

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ =	(rad/sec²)/in	$Z_{\delta T}$ =	(ft/sec²)/in
Initial	Final	Initial	Final

Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
VMC	IMC	IMC	VMC	IMC	IMC
OUT	OUT	IN	OUT	OUT	IN
		knots			fpm

AMPLITUDE	PERIOD	DAMPING

SOURCE	DEGREE

	DIFFICULTY

Intercept & initial track		Intermediate track		Final track	
Glide path	Localizer	Glide path	Localizer	Glide path	Localizer

	DIFFICULTY

	Flight 74-1	Flight 87-1
CONFIGURATION	7L	7L
FLIGHT NUMBER	74-1	87-1
PILOT	A	A
PILOT RATING	5	5
WIND (knots)	5	10
WIND SHEAR	SMALL	NEGLIGIBLE
EXTERNAL TURBULENCE	NEGLIGIBLE	NEGLIGIBLE
CHARACTERISTIC ROOTS	-.013, -.04, -.25, -1.49	-.013, -.04, -.25, -1.49

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY: ELEVATOR $M_{\delta E}$ = 0.3 (rad/sec²)/in; THRUST LEVER $Z_{\delta T}$ = 8.9 (ft/sec²)/in

RESPONSE	Elevator Initial	Elevator Final	Thrust Lever Initial	Thrust Lever Final
Flight 74-1	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY
Flight 87-1	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (74-1)	SLIGHT	MODERATE	MODERATE	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (74-1)	±10 knots			±300 fpm		
DIFFICULTY (87-1)	MODERATE	MODERATE	MODERATE	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (87-1)	±10 knots			OK fpm		

COMMENTS

74-1: DURING VMC FLIGHT THE SPEED CONTROL WAS RELATIVELY EASY, BUT ON GOING UNDER THE HOOD THE NOSE SEEMED TO WANDER. THIS BECAME MORE OF A PROBLEM WITH TURBULENCE - HENCE THE AIRSPEED CONTROL BECAME DIFFICULT.

87-1: THE NOSE WOULD NOT STAY WHERE IT WAS PUT AND VERY SMALL ELEVATOR DISPLACEMENTS CAUSED CONSTANT CREEP.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE (74-1)	PERIOD (74-1)	DAMPING (74-1)	AMPLITUDE (87-1)	PERIOD (87-1)	DAMPING (87-1)
PITCH	ZERO			ZERO		
HEAVE	ZERO			ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	74-1	87-1
CHANGE REQUIRED	MODERATE	SMALL
EASE OF COMPENSATION	MODERATE DIFFICULTY	NO DIFFICULTY

COMMENTS:

74-1: A FAIR AMOUNT OF POWER WAS REQUIRED DURING THE TURNS BUT THIS WOULD PROBABLE BECOME EASY TO ANTICIPATE WITH EXPERIENCE.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY (74-1)	SLIGHT	SLIGHT	MODERATE	SLIGHT	SLIGHT	MODERATE
PRECISION (74-1)	FAIR	FAIR	FAIR	FAIR	FAIR	POOR
DIFFICULTY (87-1)	NONE	NONE	MODERATE	MODERATE	SLIGHT	MODERATE
PRECISION (87-1)	GOOD	GOOD	POOR	POOR	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500 (74-1); 500 (87-1)

COMMENTS

74-1: WE WENT HIGH ON THE GLIDE PATH AT ABOUT 1000' AGL - PROBABLY BECAUSE OF THE GREAT CONCENTRATION REQUIRED FOR AIRSPEED CONTROL. THE MAJORITY OF THE APPROACH PRESENTED A HIGH WORKLOAD, BUT THE LAST 700 FT OR SO WORKED OUT VERY WELL.

87-1: DIFFICULTY DUE TO ANTICIPATING A REQUIREMENT TO CHANGE HEADING TO COUNTERACT A WIND SHEAR WHICH DID NOT MATERIALIZE UNTIL THE LAST 400-500 FT. AIRSPEED CONTROL REQUIRED TOO MUCH ATTENTION.

6. BREAKOUT AND FLARE

	74-1	87-1
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	POOR

COMMENTS:

87-1: ADDED TOO MUCH POWER AND STARTED TO CLIMB.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT SMALL

9. LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES

11. MISCELLANEOUS

	Flight 74-4	Flight 86-2
CONFIGURATION	7L	7L
FLIGHT NUMBER	74-4	86-2
PILOT	B	C
PILOT RATING	4.5	3
WIND (knots)	0	15
WIND SHEAR	NEGLIGIBLE	SMALL
EXTERNAL TURBULENCE	NEGLIGIBLE	MODERATE BELOW 1300'
CHARACTERISTIC ROOTS	-.013 / -.04 / -.15 / -1.49	-.013 / -.04 / -.25 / -1.49

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	Flight 74-4	Flight 86-2
CONTROL SENSITIVITY – ELEVATOR	$M_{\delta E} = 0.3$ (rad/sec²)/in	$M_{\delta E} = 0.3$ (rad/sec²)/in
CONTROL SENSITIVITY – THRUST LEVER	$Z_{\delta T} = -8.9$ (ft/sec²)/in	$Z_{\delta T} = 8.9$ (ft/sec²)/in
RESPONSE – Elevator Initial	SATISFACTORY	SATISFACTORY
RESPONSE – Elevator Final	SATISFACTORY	SATISFACTORY
RESPONSE – Thrust lever Initial	SATISFACTORY	SATISFACTORY
RESPONSE – Thrust lever Final	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (h)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (74-4)	NONE	SLIGHT	SLIGHT	V.SLIGHT	V.SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (74-4)	+5,-10 knots			±200 fpm		
DIFFICULTY (86-2)	SLIGHT	SLIGHT	SLIGHT	NONE	NONE	NONE
MAXIMUM UNDESIRED FLUCTUATIONS (86-2)	+8,-5 knots			fpm		

COMMENTS

Flight 74-4: NOT POSITIVE OF REASON FOR DIFFICULTY. RECOGNIZED NEED FOR ATTITUDE CHANGES TO ADJUST SPEED, BUT DIFFICULT TO DO SO - COULD BE DUE TO HIGHER THAN DESIRABLE CONTROL FORCES.

Flight 86-2: SLOW DEPARTURE FROM DESIRED SPEED NOT IMMEDIATELY APPARENT AND HENCE VARIATIONS INDICATED ABOVE.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	Flight 74-4			Flight 86-2		
	AMPLITUDE	PERIOD	DAMPING	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO			SMALL	SHORT	HIGH
HEAVE	ZERO			ZERO		

	Flight 74-4		Flight 86-2	
	SOURCE	DEGREE	SOURCE	DEGREE
EXCITATION			ELEVATOR	HARDLY
CONTROL			NOT ATTEMPTED	

COMMENTS

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 74-4	Flight 86-2
CHANGE REQUIRED	SMALL	NEGLIGIBLE
EASE OF COMPENSATION	NO DIFFICULTY	DIFFICULTY

COMMENTS

Flight 86-2: THRUST NEEDS INDISTINGUISHABLE FROM THOSE OF LEVEL FLIGHT.

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY (74-4)	NONE	NONE	SLIGHT	SLIGHT	SLIGHT	SLIGHT
PRECISION (74-4)	GOOD	GOOD	GOOD	FAIR	FAIR	FAIR
DIFFICULTY (86-2)	NONE	NONE	NONE	NONE	SLIGHT	SLIGHT
PRECISION (86-2)	GOOD	GOOD	GOOD	GOOD	FAIR	GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

COMMENTS

Flight 74-4: DIFFICULTY DUE TO WIND EFFECTS AND TIGHTER CONTROL OF GLIDESLOPE.

Flight 86-2: ONSET OF EXTERNAL TURBULENCE WAS MARKED BELOW 1300' AGL. PERFORMANCE IN TRACKING REMAINED GOOD BECAUSE OF GOOD MODEL CHARACTERISTICS.

6 BREAKOUT AND FLARE

	Flight 74-4	Flight 86-2
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR/GOOD	GOOD

COMMENTS

Flight 74-4: DIFFICULTY IN MAINTAINING SPEED IN LOWER PORTION OF GLIDESLOPE AND THROUGH FLARE - GENERALLY LOW ON SPEED. MADE A CORRECTION BUT PROBABLY SHOULD HAVE MOVED IT BIT SOON.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

Flight 74-4: NONE

Flight 86-2: NONE. LATERAL STICK FORCES COMPATIBLE WITH LONGITUDINAL ONES.

9 LEAST OBJECTIONABLE FEATURES

Flight 74-4: GOOD IN TURBULENCE, REASONABLE ATTITUDE STABILITY.

Flight 86-2: NO UNEXPECTED LONGITUDINAL OR HEAVE RESPONSES.

10 MOST OBJECTIONABLE FEATURES

11 MISCELLANEOUS

Flight 74-4: SOME WIND EFFECTS NOTICEABLE. ELEVATOR FORCES SLIGHTLY TOO HIGH. MY DIFFICULTY IN MAKING SPEED ADJUSTMENTS MIGHT BE HELPED BY REDUCING THE ELEVATOR FORCE GRADIENT.

Flight 86-2: GOOD MODEL WITH GENERALLY PLEASANT CHARACTERISTICS. SLIGHT DIFFICULTY IN MAINTAINING PRECISE SPEED ON CIRCUIT, BUT SPEED CONTROL BETTER DURING APPROACH.

	Left	Right
CONFIGURATION	8	8
FLIGHT NUMBER	92-1	118-L
PILOT	A	A
PILOT-RATING	3	7
WIND (knots)	5	5
WIND SHEAR		LIGHT
EXTERNAL TURBULENCE		NEGLIGIBLE

CHARACTERISTIC ROOTS

Left	0	-.04	-.17	-1.56
Right	0	-.04	-.17	-1.58

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY (Left)	$M_{\delta E} = 0.3$ (rad/sec²)/in		$Z_{\delta T} = 8.9$ (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE (Left)	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY
CONTROL SENSITIVITY (Right)	$M_{\delta E} = 0.3$ (rad/sec²)/in		$Z_{\delta T} = 8.9$ (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE (Right)	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE (Left)	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (Left)	SLIGHT	SLIGHT	MODERATE	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (Left)	+10,0 knots			OK fpm		
TURBULENCE (Right)	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (Right)	SLIGHT	MODERATE	GREAT	SLIGHT	MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS (Right)	+15,-10 knots			±300 fpm		

COMMENTS

Right: THE PITCH ATTITUDE CHANGED RAPIDLY WITH SMALL CONTROL INPUTS. A MODERATE CHANGE IN LIFT ACCOMPANIED AIRSPEED CHANGES MAKING FOR BOTH AN AIRSPEED AND VERTICAL SPEED CONTROL PROBLEM. TURBULENCE BOUNCED THE NOSE AROUND MODERATELY.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE (Left)	PERIOD (Left)	DAMPING (Left)	AMPLITUDE (Right)	PERIOD (Right)	DAMPING (Right)
PITCH	ZERO			ZERO		
HEAVE	ZERO			ZERO		

	SOURCE (Left)	DEGREE (Left)	SOURCE (Right)	DEGREE (Right)
EXCITATION				
CONTROL				

COMMENTS

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Left	Right
CHANGE REQUIRED	NEGLIGIBLE	SMALL
EASE OF COMPENSATION	NO DIFFICULTY	NO DIFFICULTY

COMMENTS

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY (Left)	NONE	SLIGHT	SLIGHT	SLIGHT	MODERATE	SLIGHT
PRECISION (Left)	FAIR	FAIR	FAIR	FAIR	FAIR	FAIR
DIFFICULTY (Right)	MODERATE	SLIGHT	GREAT	MODERATE	GREAT	SLIGHT
PRECISION (Right)	POOR	FAIR	VERY POOR	FAIR	POOR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE (IF GREATER THAN 200 FEET): Left: 500; Right: 800

COMMENTS

Left: TO STAY ON THE GLIDE PATH, THE RATE OF DESCENT FROM APPROXIMATELY 700' TO 200 FT HAD TO BE INCREASED TO AS MUCH AS 1400 F.P.M. THIS REQUIREMENT WAS ANTICIPATED FROM THE PREVIOUS APPROACH AND WAS COPED WITH ADEQUATELY. WITHOUT THIS PRIOR KNOWLEDGE, APPROACH WOULD HAVE HAD TO HAVE BEEN ABORTED.

Right: SEE SECTION #2. WIND SHEAR ALSO CAUSED SOME DIFFICULTY IN DIRECTION.

6 BREAKOUT AND FLARE

	Left	Right
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	GOOD

COMMENTS:

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT — Left: NONE; Right: SMALL

9 LEAST OBJECTIONABLE FEATURES

Left: THE TURBULENCE DID NOT SEEM TO HAVE BEEN A FACTOR - IT WAS NOT REALLY NOTICEABLE.

10 MOST OBJECTIONABLE FEATURES

Right: SEE SECTION #2

11 MISCELLANEOUS

Left: $M_{\delta E}$ WAS CHANGED FROM .59 TO .3 AND $Z_{\delta T}$ FROM 4.5 TO 8.9. BOTH PRESET SENSITIVITIES WERE FAR FROM OPTIMUM.

	Flight 25-2	Flight 49-1
CONFIGURATION	8	8
FLIGHT NUMBER	25-2	49-1
PILOT	B	B
PILOT-RATING	5½	6C
WIND (knots)	10	
WIND SHEAR	SMALL	
EXTERNAL TURBULENCE	MODERATE	
CHARACTERISTIC ROOTS	0, -.04, -.17, -1.58	0, -.04, -.17, -1.58

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY (25-2)	$M_{\delta E}$ = 0.39 (rad/sec²)/in		$Z_{\delta T}$ = 7.4 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE (25-2)	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY
CONTROL SENSITIVITY (49-1)	$M_{\delta E}$ = 0.59 (rad/sec²)/in		$Z_{\delta T}$ = 4.5 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE (49-1)	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (25-2)	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (25-2)	-12+5 knots			fpm		
DIFFICULTY (49-1)	SLIGHT	SLIGHT	SLIGHT	MODERATE	MODERATE	
MAXIMUM UNDESIRED FLUCTUATIONS (49-1)	±8 knots			fpm		

COMMENTS

25-2: DIFFICULTY DUE TO CROSS-CHECK AND LEARNING.

49-1: STRANGE HEAVE CHARACTERISTICS NOT APPRECIATED UNTIL FINAL APPROACH WHEN IT APPEARED THAT PROBLEM WAS DUE TO AN APPARENT LOW HEIGHT RATE DAMPING. I JUST COULD NOT GET THE PRECISE DESCENT RATE NEEDED.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE (25-2)	PERIOD	DAMPING	AMPLITUDE (49-1)	PERIOD	DAMPING
PITCH	ZERO			ZERO		
HEAVE	ZERO			ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS:

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	25-2	49-1
CHANGE REQUIRED:	MODERATE	SOME
EASE OF COMPENSATION	SLIGHT DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS:

25-2: LEARNING

49-1: I WAS UNABLE TO ATTRIBUTE THE THRUST REQUIREMENT DIRECTLY TO A BANK ANGLE EFFECT.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY (25-2)	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
PRECISION (25-2)	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD
DIFFICULTY (49-1)	SLIGHT	SLIGHT	MODERATE	SLIGHT	>SLIGHT	>SLIGHT
PRECISION (49-1)	FAIR	FAIR	POOR	FAIR	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 25-2: O.K.; 49-1: 500

COMMENTS:

49-1: I HAD NOT LEARNED THE CONTROL OF DESCENT RATE - WENT HIGH, THEN HIGHER EVEN THOUGH THRUST WAS STILL BEING REDUCED. FINALLY CORRECTED WITH A DESCENT RATE OF 1500 F.P.M. RECOVERED GLIDESLOPE AT END WITH LOTS OF THRUST LEAD BUT DO NOT LIKE LARGE DESCENT RATE AND THRUST REQUIREMENTS NEAR GROUND.

6 BREAKOUT AND FLARE

	25-2	49-1
EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY	SLIGHT/MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR/GOOD	GOOD

COMMENTS:

25-2: NEEDED 1 TO 2 SECONDS TO FIND THE LANDING AREA AFTER BREAKOUT - BRIGHT SUN AND RED MARKERS AGAINST SNOW.

49-1: DIFFICULTY POSSIBLY DUE TO THRUST LAG.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT — 25-2: NONE; 49-1: NONE

9 LEAST OBJECTIONABLE FEATURES

25-2: LIKE A HELICOPTER - NEED MORE ATTENTION TO PITCH ATTITUDE THAN I GAVE IT.

49-1: TURBULENCE NOT A FACTOR, PITCH ATTITUDE STABILITY REASONABLE.

10. MOST OBJECTIONABLE FEATURES

25-2: PITCH ATTITUDE MONITORING IS TOO MUCH OF A REQUIREMENT. IF CROSS-CHECK IS LOST MOMENTARILY 10 TO 15 KNOTS AIRSPEED CHANGE RESULTS.

11 MISCELLANEOUS

49-1: PILOT ASKED TO ASSESS THE EFFECT OF SIMULATION OF PILOT STATION REMOVED FROM CENTRE OF GRAVITY.
COMMENT: FEELS BETTER THAN WITHOUT THIS TERM, BUT OSCILLATORY LOSS OF CONTROL POSSIBLE EQUALLY WITH EITHER.

	Configuration 8	Configuration 9
CONFIGURATION	8	9
FLIGHT NUMBER	L22-3	41-2
PILOT	C	D
PILOT RATING	7½	8½
WIND (knots)	5	15-20
WIND SHEAR	SMALL	SMALL
EXTERNAL TURBULENCE	LIGHT (SOME THERMALS)	LIGHT
CHARACTERISTIC ROOTS	0 / -.04 / -.17 / -1.58	-.024 / -.04 / -.116 / -1.66

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	Elevator control sensitivity	Elevator response: Initial	Elevator response: Final	Thrust lever control sensitivity	Thrust lever response: Initial	Thrust lever response: Final
Configuration 8	$M_{\delta E}$ = 0.3 (rad/sec²)/in	TOO SMALL	TOO GREAT	$Z_{\delta T}$ = 3.9 (ft/sec²)/in		TOO GREAT
Configuration 9	$M_{\delta E}$ = 0.34 (rad/sec²)/in	TOO SMALL	TOO GREAT	$Z_{\delta T}$ = 11.9 (ft/sec²)/in	TOO SMALL	TOO GREAT

2 EASE OF MAINTAINING DESIRED VELOCITIES

Configuration 8:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	MODERATE	SLIGHT	MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	±10 knots			fpm		

COMMENTS: VERY CLOSE ATTENTION REQUIRED IMC TO MAINTAIN GIVEN AIRSPEED. AS A RESULT CONTROL OF VERTICAL SPEED SUFFERED, PARTICULARLY ON DOWNWIND AND BASE LEG.

Configuration 9:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	GREAT	GREAT	MODERATE	GREAT	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	> ±10 knots			>300 fpm		

COMMENTS: DIFFICULTY DUE TO OVERCONTROL OF PITCH ATTITUDE AND THRUST. IT APPEARS THAT THE CONFIGURATION HAS NEGATIVE STATIC MARGIN AND COUPLING BETWEEN THRUST AND PITCH ATTITUDE. PILOT TENDS TO OVERDRIVE THE AIRCRAFT AND OVERCONTROLS TO THE POINT OF A P.I.O.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	Configuration 8: AMPLITUDE	PERIOD	DAMPING	Configuration 9: AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO			MODERATE		
HEAVE	ZERO			MODERATE		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS (Configuration 8): OSCILLATION UNNOTICEABLE UNLESS OBSCURED BY LIGHT EXTERNAL TURBULENCE.

COMMENTS (Configuration 9): RESPONSE CLOSED LOOP - SOME TENDENCY TO P.I.O. BUT MOSTLY PILOT NOTICES LARGE AMPLITUDE OVERSHOOTS OF PITCH ATTITUDE AND THRUST.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Configuration 8	Configuration 9
CHANGE REQUIRED	SMALL	LARGE/EXCESSIVE
EASE OF COMPENSATION	SLIGHT DIFFICULTY	GREAT DIFFICULTY

COMMENTS (Configuration 8): THROTTLE USED TO MAINTAIN CONSTANT ALTITUDE IN PRESENCE OF SPEED VARIATIONS.

COMMENTS (Configuration 9): DIFFICULTY PROBABLY DUE TO COUPLING BETWEEN IAS AND PITCH ATTITUDE. WHEN PILOT MAKES AN INPUT, HE CANNOT TELL WHAT THE FINAL RESPONSE WILL BE.

5 FLIGHT PATH CONTROL

	Intercept & initial track: Glide path	Localizer	Intermediate track: Glide path	Localizer	Final track: Glide path	Localizer
DIFFICULTY (Config. 8)	GREAT	SLIGHT	SLIGHT	SLIGHT	MODERATE	SLIGHT
PRECISION (Config. 8)	VERY POOR	FAIR	GOOD	GOOD	FAIR	FAIR
DIFFICULTY (Config. 9)	GREAT	GREAT	GREAT	GREAT	GREAT	GREAT
PRECISION (Config. 9)	VERY POOR	VERY POOR	VERY POOR	VERY POOR	VERY POOR	VERY POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

COMMENTS (Configuration 8): LOST HEIGHT TO 1500 FT ON BASE LEG. COULD NOT REGAIN 1900 FT DUE TO MANIFOLD PRESSURE FLUCTUATIONS IN PRESENCE OF TURBULENCE.

COMMENTS (Configuration 9): TOO MUCH ATTENTION REQUIRED TO CONTROL AIRSPEED THROUGHOUT APPROACH - CONTINUOUS OVERCONTROL. ALSO HAD POOR VISIBILITY AND TRAFFIC PROBLEMS WHICH DISTRACTED ME FROM TASK.

6 BREAKOUT AND FLARE

	Configuration 8	Configuration 9
EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY	SLIGHT/MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	POOR

COMMENTS (Configuration 8): VERY POSITIVE EFFORT REQUIRED TO KEEP SPEED UP WITH STICK AND TO REDUCE RATE OF DESCENT WITH THROTTLE

COMMENTS (Configuration 9): INDICATED AIRSPEED WAS TOO LOW.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

Configuration 8: DURING THE INTERMEDIATE TRACK, USED THROTTLE TO LEAD IN CHECKING SPEED DEPARTURES.

Configuration 9: COUPLING BETWEEN PITCH ATTITUDE AND RATE OF DESCENT SEEMED TO BE PRESENT. I HAD SO MUCH TROUBLE MAINTAINING AIRSPEED THAT IT WAS NOT POSSIBLE TO BE POSITIVE ABOUT THE EFFECTS OF THRUST CHANGES.

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

Configuration 9: SMALL: IT SEEMED THAT MAKING HEADING CHANGES WAS DIFFICULT BECAUSE OF THE GREAT DIFFICULTY IN CONTROLLING PITCH DURING TURNING MANOEUVRES.

9 LEAST OBJECTIONABLE FEATURES

10 MOST OBJECTIONABLE FEATURES

Configuration 9: PITCH ATTITUDE CONTROL, IAS CONTROL, POOR RATE OF DESCENT CONTROL.

11 MISCELLANEOUS

Configuration 8: V.M.C. FLIGHT RELATIVELY EASY COMPARED WITH I.M.C. REAL DIFFICULTY FIRST EXPERIENCED IN CHANGING AIRSPEED UNDER I.M.C.

Configuration 9: SOME PROBLEM PSYCHOLOGICALLY DUE TO WEATHER AND TRAFFIC INTERFERENCE.

CONFIGURATION	9	WIND (knots)	10
FLIGHT NUMBER	87-2	WIND SHEAR	NEGLIGIBLE
PILOT	A	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	6		

CHARACTERISTIC ROOTS | -.024 | -.040 | -.116 | -1.66 |

CONFIGURATION	9	WIND (knots)	10-15
FLIGHT NUMBER	38-2	WIND SHEAR	SMALL
PILOT	B	EXTERNAL TURBULENCE	LIGHT
PILOT-RATING	7½D		

CHARACTERISTIC ROOTS | +.024 | -.04 | -.116 | -1.66 |

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.3	(rad/sec²)/in	$Z_{\delta T}$ = 8.9	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.39	(rad/sec²)/in	$Z_{\delta T}$ = 11.9	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY		SATISFACTORY	TOO GREAT

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	GREAT	GREAT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	±10		knots	OK		f.p.m.

COMMENTS: DIFFICULTY DUE TO THE PITCH ATTITUDE NOT SETTLING DOWN IN RESPONSE TO A VERY SMALL INPUT BUT, INSTEAD, WANDERING IN THE DIRECTION OF THE INPUT.

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	>SLIGHT	>SLIGHT	>SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	+5, -15		knots			f.p.m.

DIFFICULTY DUE TO TURBULENCE UPSETTING PITCH ATTITUDE AND TO PITCH ATTITUDE INSTABILITY.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO			ZERO		
HEAVE	ZERO			ZERO		

	SOURCE	DEGREE	SOURCE	DEGREE
EXCITATION				
CONTROL				

COMMENTS

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED:	SMALL	SOME	
EASE OF COMPENSATION	NO DIFFICULTY		DIFFICULTY

COMMENTS: SOME THRUST COMPENSATION IS REQUIRED, BUT I AM NOT SURE OF THE CAUSE.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	NONE	NONE	SLIGHT	SLIGHT	SLIGHT	SLIGHT
PRECISION	GOOD	GOOD	FAIR	FAIR	FAIR	FAIR

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	SLIGHT	NONE	NONE	NONE	SLIGHT	SLIGHT
PRECISION	FAIR	GOOD	GOOD	GOOD	FAIR/GOOD	FAIR/GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: | | 300 |

COMMENTS: GREATER ATTENTION IS REQUIRED TO CONTROL PITCH ATTITUDE - THIS DEGRADES BOTH VERTICAL AND LATERAL TRACKING.

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	GOOD

COMMENTS: NOT SURE OF THRUST RESPONSE TO BE EXPECTED. RATE OF DESCENT AT TOUCHDOWN WAS SATISFACTORY, BUT WAS NOT POSITIVELY AND PRECISELY UNDER CONTROL.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT — NONE

9. LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES — AIRSPEED CONTROL QUITE DIFFICULT

PITCH ATTITUDE INSTABILITY - NOT ACCEPTABLE IN TURBULENCE. HEAVE CHARACTERISTICS A LITTLE CONFUSING FOR SOME UNKNOWN REASON.

11. MISCELLANEOUS

CONTROLLABILITY COULD BE IN QUESTION BECAUSE OF PITCH ATTITUDE DIVERGENCE - MOTION DISORIENTATION ETC.

	Flight 14-2	Flight 61-1
CONFIGURATION	10	10
FLIGHT NUMBER	14-2	61-1
PILOT	A	A
PILOT-RATING	8	7
WIND (knots)	10-15	10
WIND SHEAR	MODERATE	
EXTERNAL TURBULENCE	NEGLIGIBLE	
CHARACTERISTIC ROOTS	-.02 | -.04 | -.865± | .4761	-.02 | -.04 | -.865± | .4761

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY:

Flight	ELEVATOR		THRUST LEVER	
14-2	$M_{\delta E}$ = 0.3 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
61-1	$M_{\delta E}$ = 0.25 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
RESPONSE	Initial	Final	Initial	Final
14-2	SLIGHTLY GREAT	TOO GREAT	SATISFACTORY	TOO SMALL
61-1	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (14-2)	MODERATE	GREAT	GREAT	SLIGHT	SLIGHT	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS (14-2)	+15.0 knots			+200.0 fpm		
DIFFICULTY (61-1)	MODERATE	GREAT	GREAT	SLIGHT	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS (61-1)	±10 knots			±200 fpm		

COMMENTS

14-2: THE FINAL RESPONSE TO ELEVATOR INPUTS WAS TOO GREAT AND TOO MUCH ATTENTION WAS REQUIRED TO HOLD PITCH ATTITUDE. THE TURBULENCE ALSO DISTURBED PITCH ATTITUDE TOO MUCH.

61-1: DIFFICULTY DUE TO PITCH OSCILLATION WHICH REQUIRED MUCH TOO MUCH CONCENTRATION ON PITCH ATTITUDE.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	Flight	AMPLITUDE	PERIOD	DAMPING
PITCH	14-2	LARGE	MEDIUM	LOW
HEAVE	14-2	ZERO		
PITCH	61-1	MODERATE	MEDIUM	LOW
HEAVE	61-1	ZERO		

	Flight	SOURCE	DEGREE
EXCITATION:	14-2	ELEVATOR, TURBULENCE	EASILY
CONTROL:	14-2	ELEVATOR	INEFFECTIVE
EXCITATION:	61-1	ELEVATOR, TURBULENCE	EASILY
CONTROL:	61-1	ELEVATOR	AGGRAVATING

COMMENTS

14-2: THIS DID NOT SEEM TO BE AN OPEN LOOP OSCILLATION BUT RATHER A PIO IN PITCH.

61-1: OSCILLATION CONTINUOUSLY BEING EXCITED.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	14-2	61-1
CHANGE REQUIRED:	SMALL	SMALL
EASE OF COMPENSATION:	NO DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS:

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY (14-2)	MODERATE	NONE	MODERATE	MODERATE	GREAT	MODERATE
PRECISION (14-2)	POOR	GOOD	POOR	FAIR	VERY POOR	POOR
DIFFICULTY (61-1)	SLIGHT	NONE	SLIGHT	NONE	SLIGHT	NONE
PRECISION (61-1)	FAIR	GOOD	FAIR	GOOD	FAIR	GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

COMMENTS

14-2: THE THRUST LEVER HAD TO BE PULLED BACK CONTINUOUSLY ON APPROACH TO TRY TO KEEP THE AIRCRAFT GOING DOWN. THERE WAS A FAIR WIND SHEAR CAUSING MOVEMENT TO THE RIGHT OF LOCALIZER AT LOW ALTITUDE.

6. BREAKOUT AND FLARE

	14-2	61-1
EASE OF ARRESTING RATE OF DESCENT	GREAT DIFFICULTY	SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	VERY POOR	FAIR

COMMENTS:

14-2: TOO HIGH ON GLIDE PATH AT BREAKOUT

61-1: THIS PORTION WENT SURPRISINGLY WELL IN LIGHT OF UNDESIRABLE PITCH CHARACTERISTICS.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT — NONE

9. LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES

11. MISCELLANEOUS

14-2: THRUST LEVER DISPLACEMENTS TOO LARGE.

61-1: MADE TWO ATTEMPTS WITH TALAR LOCALIZER AT 090° AND ENDED UP MUCH TOO HIGH ON EACH. - CHANGED TALAR TO 220° AND A THIRD APPROACH WAS MADE SUCCESSFULLY. THIS ILLUSTRATES THE IMPORTANCE OF GOOD WIND INFORMATION FOR AIRCRAFT OF THIS TYPE. 1400 F.P.M. DOWN REQUIRED WITH TAIL WIND AND STILL NOT RECOVERING GLIDESLOPE.

	Flight 52-1	Flight 55-1
CONFIGURATION	10	10
FLIGHT NUMBER	52-1	55-1
PILOT	B	B
PILOT-RATING	7½C	5C
WIND (knots)	CALM	
WIND SHEAR	?	MODERATE
EXTERNAL TURBULENCE		MODERATE
CHARACTERISTIC ROOTS	-.02, -.04, -.865 ± j .4761	-.02, -.04, -.865 ± j .4761

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY: ELEVATOR $M_{\delta E}$ = 0.25 (rad/sec²)/in; THRUST LEVER $Z_{\delta T}$ = 15.0 (ft/sec²)/in

RESPONSE	Elevator Initial	Elevator Final	Thrust Lever Initial	Thrust Lever Final
Flight 52-1	SATISFACTORY	SATISFACTORY	SATISFACTORY	NOT ASSESSABLE
Flight 55-1	SATISFACTORY	SATISFACTORY	SATISFACTORY	TOO SMALL

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (52-1)	SLIGHT	SLIGHT	MODERATE	SLIGHT	SLIGHT	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS (52-1)	+20, -5 knots			-300 fpm		
DIFFICULTY (55-1)	SLIGHT	>SLIGHT	MODERATE	SLIGHT	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS (55-1)	+15, -10 knots			+300 fpm		

COMMENTS

52-1: DIFFICULTY MAINLY ON APPROACH FOR SOME UNKNOWN REASON

55-1: DIFFICULTY IN VERTICAL SPEED CONTROL DUE TO LOW THRUST LEVER SENSITIVITY. IT TAKES A LONG TIME TO SETTLE DOWN TO WHAT IS TOO SMALL A VALUE

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH (52-1)	ZERO		
HEAVE (52-1)	ZERO		
PITCH (55-1)	ZERO		
HEAVE (55-1)	ZERO		

	SOURCE	DEGREE
EXCITATION:		
CONTROL:		

COMMENTS

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 52-1	Flight 55-1
CHANGE REQUIRED	SMALL	NEGLIGIBLE
EASE OF COMPENSATION:	NO DIFFICULTY	NO DIFFICULTY

COMMENTS

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY (52-1)	NONE	NONE	SLIGHT	NONE	GREAT	>SLIGHT
PRECISION (52-1)	GOOD	FAIR	FAIR		VERY POOR	FAIR
DIFFICULTY (55-1)	NONE	NONE	FAIR	NONE	>MODERATE	NONE
PRECISION (55-1)	GOOD	GOOD	FAIR	GOOD	VERY POOR	

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 600 (52-1); (55-1 blank)

COMMENTS

52-1: GLIDESLOPE OK TO 800 FT., THEN GOT HIGHER AND HIGHER SUDDENLY — REDUCING POWER HAD NO EFFECT

55-1: DIFFICULTY COULD BE DUE TO WIND SHEAR

6 BREAKOUT AND FLARE

	Flight 52-1	Flight 55-1
EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY	MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	POOR

COMMENTS:

52-1: UNCERTAIN OF THRUST LEVER CHARACTERISTICS

55-1: DIFFICULTY DUE TO GETTING HIGH ON APPROACH

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

55-1: SPEED UNINTENTIONALLY HIGH ON APPROACH. PROBABLY DUE TO PUTTING NOSE DOWN WHEN THRUST LEVER DOES NOT PRODUCE DESIRED RATE OF DESCENT.

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE

9 LEAST OBJECTIONABLE FEATURES

55-1: TURBULENCE RESPONSE NOT BAD — BETTER IN PITCH THAN IN HEAVE

10 MOST OBJECTIONABLE FEATURES

52-1: SOME PITCH ATTITUDE UPSETS IN TURBULENCE
PITCH ATTITUDE LOOSE — MILDLY UNSTABLE.
VERTICAL SPEED CONTROL VERY POOR (UNABLE TO GET DOWN)

55-1: PITCH ATTITUDE DIVERGENCE

11. MISCELLANEOUS

52-1: DID TWO APPROACHES AND UNINTENTIONALLY GOT HIGH ON BOTH OF THEM

55-1: POSSIBLE WIND SHEAR ON APPROACH. RATING ASSUMES THAT A COMBINATION OF WIND SHEAR AND LEARNING DEFICIENCY WAS RESPONSIBLE FOR NOT BEING ABLE TO GET DOWN ON GLIDESLOPE ON APPROACH.

CONFIGURATION	10		WIND (knots)	5
FLIGHT NUMBER	48-3		WIND SHEAR	MODERATE
PILOT	C		EXTERNAL TURBULENCE	MODERATE
PILOT-RATING	6			

CHARACTERISTIC ROOTS

-.02	-.04	-.865±	.475i

CONFIGURATION	10		WIND (knots)	CALM
FLIGHT NUMBER	20-1		WIND SHEAR	NEGLIGIBLE
PILOT	D		EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	3 TO 4			

CHARACTERISTIC ROOTS

-.02	-.04	-.865±	.476i

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.25	(rad/sec²)/in	$Z_{\delta T}$ = 15.0	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	SATISFACTORY	TOO SMALL	TOO SMALL

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.3	(rad/sec²)/in	$Z_{\delta T}$ = 15.0	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	TOO GREAT	TOO SMALL	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	+10 to 15		knots	?		fpm

COMMENTS: DIFFICULTY ONLY NOTICEABLE ON FINAL APPROACH WHEN UNABLE TO STAY DOWN ON GLIDESLOPE. SPEED FLUCTUATIONS OCCURRED DURING THIS PHASE

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	MODERATE	NONE	NONE	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	±10		knots	±300		fpm

COMMENTS: CONSTANT ATTENTION TO PITCH ATTITUDE REQUIRED BOTH WITH AND WITHOUT TURBULENCE.
WITHOUT TURBULENCE SPEED FLUCTUATIONS ±3 KNOTS.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	SMALL	MEDIUM	MODERATE
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION:	ELEVATOR	HARDLY
CONTROL:	ELEVATOR	EFFECTIVE

COMMENTS:

	AMPLITUDE	PERIOD	DAMPING
PITCH	SMALL	MEDIUM	MODERATE
HEAVE	SMALL	MEDIUM	HIGH

	SOURCE	DEGREE
EXCITATION:		
CONTROL:		

COMMENTS: NOT OSCILLATORY BUT, WHEN MAKING RAPID, MODERATE TO LARGE PITCH INPUTS, SOME TENDENCY TO OVERCONTROL DEVELOPED. THIS CREATED A SLIGHT PIO WHICH COULD BE ELIMINATED BY THE PILOT REDUCING HIS GAIN

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 48-3	Flight 20-1
CHANGE REQUIRED:	NEGLIGIBLE	SMALL
EASE OF COMPENSATION:	NO DIFFICULTY	NO DIFFICULTY

COMMENTS:

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	SLIGHT	NONE	MODERATE	SLIGHT	GREAT	MODERATE
PRECISION	FAIR	GOOD	GOOD	GOOD	VERY POOR	POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500

COMMENTS: UNABLE TO GET DOWN ON TO GLIDESLOPE ON FINAL APPROACH. (NB. MODERATE VERTICAL WIND SHEAR.) TO STEEPEN DESCENT, ALLOWED NOSE TO DROP AND SPEED INCREASE TO 70 KNOTS. RELUCTANT TO PULL THRUST LEVER FAR ENOUGH WHEN RATE OF DESCENT ALREADY 1000 FT/MIN.

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	NONE	SLIGHT	MODERATE	MODERATE	MODERATE	MODERATE
PRECISION	GOOD	GOOD	POOR	POOR	VERY POOR	VERY POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET:

COMMENTS: MOST IF NOT ALL DIFFICULTY PROBABLY DUE TO LACK OF PILOT'S PROFICIENCY. OVERCONTROLLED AS TALAR SENSITIVITY INCREASED NEAR END OF APPROACH.

6 BREAKOUT AND FLARE

	Flight 48-3	Flight 20-1
EASE OF ARRESTING RATE OF DESCENT	MODERATE DIFFICULTY	NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	VERY POOR	POOR

COMMENTS: OVERSHOT. WOULD HAVE HAD GREATER DIFFICULTY AT 200 FT DUE TO HIGH RATE OF DESCENT

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE: NOT CONSCIOUS OF ANY DISHARMONY IF PRESENT.

NONE

9 LEAST OBJECTIONABLE FEATURES: UNTIL FINAL PART OF APPROACH, WOULD HAVE RATED MODEL AS QUITE GOOD

POWER MANIPULATION IS A MINOR REQUIREMENT

10 MOST OBJECTIONABLE FEATURES: DIFFICULTY IN FOLLOWING FINAL GLIDESLOPE OVERRIDING IN ARRIVING AT RATING

NEED TO PAY CLOSE ATTENTION TO ATTITUDE. NOT POSSIBLE TO TRIM PRECISELY AND TO FLY HANDS OFF

11 MISCELLANEOUS: THRUST LEVER DISPLACEMENTS TOO LARGE. UNCERTAIN WHETHER PRESENCE OF WIND SHEAR AGGRAVATED ABOVE PROBLEM

TURBULENCE CAUSES SUBSTANTIAL INCREASE IN PILOT'S WORKLOAD. I AM NOT SURE MY PROFICIENCY IS YET UP SUFFICIENTLY FOR EVALUATIONS. RATING IS TENTATIVE.
NOTE: THIS WAS THE PILOT'S FIRST EVALUATION.

	Flight 69-2	Flight 95-3
CONFIGURATION	11L	11L
FLIGHT NUMBER	69-2	95-3
PILOT	A	B
PILOT-RATING	7	7C
WIND (knots)		10
WIND SHEAR	SMALL/MODERATE	SMALL
EXTERNAL TURBULENCE	NEGLIGIBLE	LIGHT

CHARACTERISTIC ROOTS				
Flight 69-2	-.013	-.04	-.733	-1.0
Flight 95-3	-.013	-.04	-.733	-1.0

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.25 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	TOO GREAT	SATISFACTORY	TOO SMALL

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.2 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	SATISFACTORY	SLIGHTLY SMALL	SLIGHTLY SMALL

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	SLIGHT	GREAT	NONE	SLIGHT	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	±8 knots			±200 fpm		

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	+10, -5 knots			fpm		

COMMENTS:

(69-2) THE TURBULENCE AND LARGE PITCH ATTITUDE RESPONSE TO ELEVATOR CAUSED MUCH TOO MUCH PITCH ATTITUDE ACTIVITY AND HENCE A REAL AIRSPEED CONTROL PROBLEM. TOO MUCH CONCENTRATION ON THIS ASPECT WAS REQUIRED AND HEADING CONTROL BECAME WEAK

(95-3) PITCH CHARACTERISTICS REQUIRE CLOSE ATTENTION TO PITCH ATTITUDE

3. RESIDUAL OSCILLATORY CHARACTERISTICS

		AMPLITUDE	PERIOD	DAMPING
69-2	PITCH	ZERO		
69-2	HEAVE	ZERO		
95-3	PITCH	SMALL	LONG (≈12 SEC.)	ZERO
95-3	HEAVE			

		SOURCE	DEGREE
69-2	EXCITATION:		
69-2	CONTROL:		
95-3	EXCITATION:	UNKNOWN	SLIGHT
95-3	CONTROL:	ELEVATOR	EFFECTIVE

COMMENTS

(95-3) BOTHERSOME DURING TIGHT PITCH AND AIRSPEED TRACKING EXERCISES

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	69-2	95-3
CHANGE REQUIRED	SMALL	SMALL
EASE OF COMPENSATION	NO DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS:

(95-3) DIFFICULTY DUE TO PITCH CHARACTERISTICS BEING EITHER UNSTABLE OR BARELY OSCILLATORY WITH ZERO DAMPING.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY: (69-2)	SLIGHT	SLIGHT	MODERATE	MODERATE	SLIGHT	GREAT
PRECISION (69-2)	FAIR	FAIR	POOR	POOR	FAIR	VERY POOR
DIFFICULTY: (95-3)	NONE	NONE	SLIGHT	SLIGHT	SLIGHT	SLIGHT
PRECISION (95-3)	GOOD	GOOD	GOOD	FAIR	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500 (69-2); 300 (95-3)

COMMENTS:

(69-2) SEE SECTION #2. I STARTED TO GET WELL ABOVE THE GLIDEPATH DURING THE INTERMEDIATE PORTION AND HAD TO SELECT ABOUT 1300 F.P.M. DOWN WHICH WAS UNCOMFORTABLE. AT AND JUST BEFORE BREAKOUT THE LOCALIZER WAS HARD RIGHT AND THE GLIDEPATH SLIGHTLY LOW. HIGH WORKLOAD ON BOTH G.P. AND LOC.

(95-3) PITCH CHARACTERISTICS DEMAND MOST ATTENTION — LOCALIZER TRACKING SUFFERS. ALWAYS SEEM TO GO HIGH AT BREAKOUT WHEN BLIND LOWERED.

6. BREAKOUT AND FLARE

	69-2	95-3
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	FAIR

COMMENTS:

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

(69-2) SMALL; THE WEATHERCOCK STABILITY SEEMS WEAK WHEN A SMALL RUDDER INPUT IS MADE.

(95-3) VERY SMALL

9. LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES

(95-3) PITCH CHARACTERISTICS — APPARENT OSCILLATION SOMETIMES ADDS TO YOUR CORRECTING CONTROL INPUT TO GIVE TOO LARGE A CORRECTION. THE LONG PERIOD OF THE OSCILLATION IS SUCH AS TO NOT ALLOW ANTICIPATION OF THIS EFFECT AND THEREBY TO GET CAUGHT.

11. MISCELLANEOUS

(95-3) NOTE: NO ARTIFICIAL TURBULENCE WAS INTRODUCED DURING THIS EVALUATION.

CONFIGURATION	11	WIND(knots)	10
FLIGHT NUMBER	37-2	WIND SHEAR	?
PILOT	B	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	7		

CHARACTERISTIC ROOTS: -.013 | -.04 -.733 | -1.0

CONFIGURATION		WIND(knots)	
FLIGHT NUMBER		WIND SHEAR	
PILOT		EXTERNAL TURBULENCE	
PILOT-RATING			

CHARACTERISTIC ROOTS: | | | |

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.3	(rad/sec²)/in	$Z_{\delta T}$ = 15.0	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE:	TOO GREAT	NOT ASSESSABLE	SATISFACTORY	SATISFACTORY

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ =	(rad/sec²)/in	$Z_{\delta T}$ =	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE:				

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	SLIGHT	MODERATE	NONE	NONE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	+10, -15		knots			fpm

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY						
MAXIMUM UNDESIRED FLUCTUATIONS			knots			fpm

COMMENTS: DIFFICULTY DUE TO PITCH ATTITUDE UPSETS BY TURBULENCE. POOR DESCENT-RATE CONTROL ON APPROACH — POSSIBLY DUE TO WIND SHEAR.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

	AMPLITUDE	PERIOD	DAMPING
PITCH			
HEAVE			

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED:

EASE OF COMPENSATION: DIFFICULTY

COMMENTS: NOT SURE OF REQUIREMENTS. THRUST CHANGES APPEAR TO AFFECT PITCH ATTITUDE — NO PROBLEM.

CHANGE REQUIRED:

EASE OF COMPENSATION: DIFFICULTY

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	NONE	NONE	NONE	NONE	MODERATE	SLIGHT
PRECISION	GOOD	GOOD	GOOD	GOOD	POOR	FAIR/GOOD

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:						
PRECISION						

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500

COMMENTS: NOT SURE OF CAUSE OF DIFFICULTY POSSIBLY SHEAR

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: SLIGHT DIFFICULTY

PRECISION OF ATTAINING TOUCHDOWN POINT: FAIR

COMMENTS: NOT SURE OF CAUSE OF DIFFICULTY

DIFFICULTY

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

9 LEAST OBJECTIONABLE FEATURES

10 MOST OBJECTIONABLE FEATURES

SENSITIVE TO TURBULENCE, MUCH ATTENTION REQUIRED TO PITCH ATTITUDE. RATHER RAPID RESPONSE TO ELEVATOR.

11 MISCELLANEOUS

LARGE RESPONSE TO ELEVATOR INPUTS ONLY NOTICEABLE WHEN ELEVATOR STEPS APPLIED PURPOSELY. CHARACTERISTICS LIKE A HELICOPTER. TURBULENCE RATING D TO E.

	Flight 85-2	Flight 121-1
CONFIGURATION	12L	12L
FLIGHT NUMBER	85-2	121-1
PILOT	A	A
PILOT RATING	8½	8
WIND (knots)		10
WIND SHEAR	NEGLIGIBLE	MODERATE
EXTERNAL TURBULENCE	NEGLIGIBLE	NEGLIGIBLE
CHARACTERISTIC ROOTS	0, -.04, -.369, -1.38	0, -.04, -.369, -1.38

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY: ELEVATOR $M_{\delta E}$ = [illegible].25 (rad/sec²)/in; THRUST LEVER $Z_{\delta T}$ = 15.0 (ft/sec²)/in

RESPONSE	Elevator Initial	Elevator Final	Thrust Lever Initial	Thrust Lever Final
Flight 85-2	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY
Flight 121-1	SATISFACTORY	TOO GREAT	SATISFACTORY	TOO SMALL

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (85-2)	MODERATE	GREAT	GREAT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (85-2)	±10 knots			OK fpm		
DIFFICULTY (121-1)	SLIGHT	SLIGHT	GREAT	NONE	SLIGHT	>MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS (121-1)	±10 knots			200 fpm		

COMMENTS

FANTASTIC ATTITUDE CHANGES TAKE PLACE QUITE RAPIDLY WITH SMALL CONTROL INPUTS; HENCE CONSTANT ATTENTION REQUIRED TO MAINTAIN AIRSPEED. THE TURBULENCE ALSO BUMPS THE NOSE AND HEAVES THE AIRCRAFT INACCEPTABLY.

PITCH ATTITUDE CONTROL WAS MUCH TOO SENSITIVE WHEN TURBULENCE WAS BOUNCING THE NOSE AROUND. ON FIRST APPROACH 1300F.P.M. WAS REQUIRED TO HOLD GLIDE PATH ON SECOND APPROACH POWER HAD TO BE BLED OFF TO 48%.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH (85-2)	LARGE	LONG	ZERO/NEGATIVE
HEAVE (85-2)			
PITCH (121-1)	MODERATE	MEDIUM	MODERATE
HEAVE (121-1)	ZERO		

	SOURCE	DEGREE
EXCITATION (85-2)	ELEVATOR, TURBULENCE	EASILY
CONTROL (85-2)	ELEVATOR	EFFECTIVE
EXCITATION (121-1)	ELEVATOR, TURBULENCE	EASILY
CONTROL (121-1)	ELEVATOR	INEFFECTIVE

COMMENTS

IT APPEARED, BY A SPECIFIC TEST THAT THERE WAS A ZERO OR NEGATIVELY DAMPED OSCILLATION, BUT THIS SHOWED UP IN PRACTICE AS A STRAIGHT PITCH DIVERGENCE.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 85-2	Flight 121-1
CHANGE REQUIRED	SMALL	NEGLIGIBLE
EASE OF COMPENSATION	NO DIFFICULTY	NO DIFFICULTY

COMMENTS

5. FLIGHT PATH CONTROL

	Intercept & initial track Glide path	Intercept & initial track Localizer	Intermediate track Glide path	Intermediate track Localizer	Final track Glide path	Final track Localizer
DIFFICULTY (85-2)						
PRECISION (85-2)						
DIFFICULTY (121-1)	MODERATE	SLIGHT	MODERATE	SLIGHT	GREAT	GREAT
PRECISION (121-1)	POOR	FAIR	POOR	FAIR	POOR	VERY POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 800 (85-2); 800 (121-1)

COMMENTS:

ALL PHASES OF TRACKING WERE OK, BUT I WAS WORKING MUCH TOO HARD ON AIRSPEED CONTROL.

ASSESSMENT FOR SECOND APPROACH. APPROXIMATELY 1000 F.P.M. WERE REQUIRED TO MAINTAIN GLIDEPATH. THE AIRSPEED CONTROL WAS POOR AND THIS ADDED TO THE VERTICAL SPEED PROBLEMS. LITTLE TIME WAS LEFT FOR LOCALIZER MONITORING AND HEADING WANDERED.

6 BREAKOUT AND FLARE

	Flight 85-2	Flight 121-1
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	GOOD

COMMENTS:

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: SMALL: AS ON ALL MODELS, THE HEADING CHANGE WITH SMALL OUT-OF-TRIM ON RUDDER WAS TOO LARGE

9 LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES

THE UNSTEADINESS IN PITCH BECAME QUITE INTOLERABLE WHEN THE TURBULENCE WAS INTRODUCED.

TURBULENCE AND PITCH ATTITUDE CONTROL. POWER CHANGES WITH DESCENT RATE.

11. MISCELLANEOUS

APPROACH PHASE WAS REPEATED WITH TALAR LOCALIZER REORIENTED 80° INTO WIND.

CONFIGURATION	12L	WIND (knots)	5
FLIGHT NUMBER	55-3	WIND SHEAR	SMALL
PILOT	B	EXTERNAL TURBULENCE	MODERATE
PILOT RATING	7D		X(SLIGHT TAIL WIND)

CHARACTERISTIC ROOTS

0	-.04	-.369	-1.38

CONFIGURATION	13L	WIND (knots)	5
FLIGHT NUMBER	62-1	WIND SHEAR	MODERATE
PILOT	A	EXTERNAL TURBULENCE	LIGHT
PILOT RATING	7		

CHARACTERISTIC ROOTS

+.026	-.04	-.212	-1.57

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = .15 (rad/sec²)/in		$Z_{\delta T}$ = 15 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	TOO GREAT	TOO SMALL	TOO SMALL

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.25 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	>SLIGHT	>SLIGHT	>SLIGHT	>SLIGHT	>SLIGHT	>SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	±6 knots			±200 fpm		

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	MODERATE	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	±5 knots			±200 fpm		

COMMENTS

DIFFICULTY DUE TO:
LOW THRUST LEVER SENSITIVITY? QUITE RESPONSIVE TO TURBULENCE, SLOW TO SETTLE DOWN TO FINAL RATE OF DESCENT AFTER THRUST INPUTS?

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	SMALL/MODERATE	LONG	
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION	UNKNOWN	EASILY
CONTROL	ELEVATOR	EFFECTIVE

	AMPLITUDE	PERIOD	DAMPING
PITCH	MODERATE	MEDIUM	LOW
HEAVE			

	SOURCE	DEGREE
EXCITATION	ELEVATOR, TURBULENCE	EASILY
CONTROL	ELEVATOR	EFFECTIVE

COMMENTS

I CANNOT BE POSITIVE THAT THE OSCILLATION IS THERE — COULD BE LOW PITCH DAMPING, HIGH ELEVATOR SENSITIVITY PROBLEM.

THE LIGHTLY DAMPED OSCILLATION IN PITCH WAS THE MOST OUTSTANDING FEATURE OF THIS MODEL. CONTINUOUS ATTENTION WAS REQUIRED TO MAINTAIN PITCH ATTITUDE BUT, AFTER A WHILE THE AIRSPEED CONTROL SEEMED TO BE RELATIVELY EASY. — PERHAPS BECAUSE THE MOTION WAS PREDICTABLE?

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED	NEGLIGIBLE	NEGLIGIBLE
EASE OF COMPENSATION	NO DIFFICULTY	NO DIFFICULTY

COMMENTS

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	NONE	SLIGHT	SLIGHT
PRECISION	GOOD	GOOD	FAIR	GOOD	FAIR	FAIR

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	MODERATE	SLIGHT	SLIGHT	GREAT	MODERATE
PRECISION	FAIR	POOR	FAIR	FAIR	VERY POOR	POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: [ ] / 500

COMMENTS

ON FINAL TRACK, PROBLEM WAS DUE TO WIND SHEAR.

EVERYTHING WAS SORTED OUT WITH 800F.P.M. RATE OF DESCENT IN INTERMEDIATE PORTION. THEN, TO MAINTAIN GLIDEPATH 1000 F.P.M. BECAME INADEQUATE AND WE ENDED UP MUCH TOO HIGH TO COMPLETE THE APPROACH. THE WIND SOCK SHOWED ABOUT 5 KNOTS CROSSWIND.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY	GREAT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	VERY POOR

COMMENTS

NOT POSITIVE OF THRUST CONTROL OVER RATE OF DESCENT. AT TOUCHDOWN, RATE OF DESCENT WAS CERTAINLY OK.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

NONE. MODERATE REAL TURBULENCE. HAD TO TRIM RUDDER TWICE. LATERAL DIRECTIONAL CHARACTERISTICS CERTAINLY NOTICEABLE.

9 LEAST OBJECTIONABLE FEATURES

10 MOST OBJECTIONABLE FEATURES

PITCH INSTABILITY. RESPONSIVE IN PITCH AND HEAVE TO TURBULENCE.

11 MISCELLANEOUS

ELEVATOR CONTROL SENSITIVITY REDUCED FROM 0.25 TO 0.15 BECAUSE CONTROL WOULD BE IN DOUBT FOR STEP INPUTS AT HIGHER LEVEL (VERY LARGE PITCH RATE RESPONSE).

CONFIGURATION	14	WIND(knots)	10-15
FLIGHT NUMBER	18-1	WIND SHEAR	MODERATE
PILOT	A	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	6		

CHARACTERISTIC ROOTS

+.031	-.04	-.20	-1.58

CONFIGURATION	14	WIND (knots)	15
FLIGHT NUMBER	40-3	WIND SHEAR	
PILOT	D	EXTERNAL TURBULENCE	
PILOT-RATING	7½		

CHARACTERISTIC ROOTS

+.031	-.04	-.20	-1.58

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E} = 0.3$ (rad/sec²)/in		$Z_{\delta T} = 15.0$ (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E} = 0.3$ (rad/sec²)/in		$Z_{\delta T} = 15.0$ (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	TOO GREAT	SATISFACTORY	TOO GREAT

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	MODERATE	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	3 TO 5 knots			OK fpm		

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	>MODERATE	SLIGHT	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	±10 knots			±200 fpm		

COMMENTS

THE FINAL RESPONSE TO ELEVATOR IS TOO GREAT. THE PITCH ATTITUDE CONTINUOUSLY JOSTLES AS A RESULT OF ELEVATOR AND TURBULENCE MAKING FOR A HIGH PITCH WORKLOAD.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	MODERATE	MEDIUM	LOW
HEAVE			

	SOURCE	DEGREE
EXCITATION:	ELEVATOR, TURBULENCE	EASILY
CONTROL	ELEVATOR	EFFECTIVE

	AMPLITUDE	PERIOD	DAMPING
PITCH	MODERATE	MEDIUM	NEGATIVE
HEAVE	SMALL	LONG	MODERATE

	SOURCE	DEGREE
EXCITATION:	ELEVATOR, TURBULENCE	EASILY
CONTROL	ELEVATOR	EFFECTIVE

COMMENTS

THE OSCILLATORY CHARACTERISTICS ARE ALL CLOSED LOOP-PIO. OPEN LOOP THE RESONSE WAS TYPICAL OF NEGATIVE STATIC MARGIN CHARACTERISTICS.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED	NEGLIGIBLE	NEGLIGIBLE
EASE OF COMPENSATION	NO DIFFICULTY	NO DIFFICULTY

COMMENTS:

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	NONE	SLIGHT	NONE	MODERATE
PRECISION	FAIR	GOOD	FAIR	FAIR/GOOD	FAIR	VERY POOR

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	NONE	MODERATE	MODERATE	GREAT	GREAT
PRECISION	GOOD	GOOD	FAIR	FAIR	FAIR	VERY POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500

COMMENTS

DIFFICULTY DUE TO UNCOMFORTABLE PITCHING THAT IS DIFFICULT TO RESTRAIN.

HAD TO WORK VERY HARD — CONSTANT PILOT CONTROL INPUTS REQUIRED. SURPRISED AT THE PERFORMANCE.

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	MODERATE DIFFICULTY	NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	VERY POOR	VERY POOR

COMMENTS:

SEE SECTIONS #2 AND 5. THE PITCH ATTITUDE COULD NOT BE SELECTED ACCURATELY ENOUGH BEFORE THE TOUCHDOWN POINT TO ENSURE A LANDING. HOWEVER, WITHOUT ACTUALLY TOUCHING DOWN THIS IS DIFFICULT TO ASSESS.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE

NONE

9. LEAST OBJECTIONABLE FEATURES

RATE OF CLIMB CONTROL AND HEADING CONTROL OK.

10. MOST OBJECTIONABLE FEATURES: SEE SECTIONS #2, 5 AND 6.

ATTITUDE CONTROL — REQUIRED CONSTANT ATTENTION AND STRONG TENDENCY TO OVERCONTROL AND PIO.

11. MISCELLANEOUS

PERFORMANCE CAN BE ACHIEVED ie. REASONABLY GOOD PRECISION, BUT MUST WORK TOO HARD.

	Flight 125-1	Flight 58-1
CONFIGURATION	14L	14L
FLIGHT NUMBER	125-1	58-1
PILOT	B	C
PILOT-RATING	7E	6
WIND (knots)		5
WIND SHEAR		SMALL
EXTERNAL TURBULENCE		LIGHT (THERMAL ACTIVITY)
CHARACTERISTIC ROOTS	+.031 / -.04 / -.20 / -1.58	+.031 / -.04 / -.20 / -1.58

AIRCRAFT RESPONSE TO CONTROL INPUTS

		ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY		$M_{\delta E}$ = 0.25 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
		Initial	Final	Initial	Final
RESPONSE	Flight 125-1	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY
RESPONSE	Flight 58-1	SATISFACTORY	TOO GREAT	SATISFACTORY	NOT ASSESSABLE

2 EASE OF MAINTAINING DESIRED VELOCITIES

		Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION		VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE		OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	Flight 125-1	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	Flight 125-1	±5 knots			fpm		
DIFFICULTY	Flight 58-1	MODERATE	MODERATE	MODERATE	SLIGHT	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	Flight 58-1	±10 knots			? fpm		

COMMENTS

Flight 125-1: DIFFICULTY DUE TO WEAK PITCHING OSCILLATION

Flight 58-1: LARGE FINAL RESPONSE TO LONGITUDINAL CONTROL INPUTS

3 RESIDUAL OSCILLATORY CHARACTERISTICS

		AMPLITUDE	PERIOD	DAMPING
PITCH	Flight 125-1	MODERATE/SMALL	LONG	ZERO
HEAVE	Flight 125-1	?		
PITCH	Flight 58-1	MODERATE	LONG	LOW
HEAVE	Flight 58-1	ZERO		

		SOURCE	DEGREE
EXCITATION	Flight 125-1	TURBULENCE + UNKNOWN	EASILY
CONTROL	Flight 125-1	ELEVATOR	EFFECTIVE
EXCITATION	Flight 58-1	ELEVATOR	EASILY
CONTROL	Flight 58-1	ELEVATOR	EFFECTIVE

COMMENTS

Flight 125-1: OSCILLATION ITSELF IS NOT VERY LARGE, BUT TURBULENCE EXCITES LARGE ATTITUDE EXCURSIONS

Flight 58-1: EFFECT IS TENDENCY TO DEPART FROM REQUIRED AIRSPEED BY TOO LARGE A MARGIN TO BE ACCEPTABLE. CLOSE AIRSPEED CONTROL DIFFICULT.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 125-1	Flight 58-1
CHANGE REQUIRED	SMALL	SMALL
EASE OF COMPENSATION	NO DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS

Flight 125-1: MUST MONITOR PITCH DURING TURNS

Flight 58-1: MAINTENANCE OF VERTICAL VELOCITY NO MORE DIFFICULT IN TURNS THAN IN LEVEL FLIGHT, ALTITUDE VARIATION IN VMC TASKS 100 FT.

5 FLIGHT PATH CONTROL

		Intercept & initial track		Intermediate track		Final track	
		Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	Flight 125-1	NONE	NONE	NONE	NONE	NONE	NONE
PRECISION	Flight 125-1	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD
DIFFICULTY	Flight 58-1	SLIGHT	SLIGHT	MODERATE	MODERATE	GREAT	MODERATE
PRECISION	Flight 58-1						

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

Flight 125-1: OK (IF IN POSITION)

Flight 58-1: 400

COMMENTS

Flight 125-1: ATTITUDE AND SPEED CONTROL MOST DIFFICULT. DRAWS ATTENTION AWAY FROM LOCALIZER TASK RESULTING IN SLIGHT 'S' TURNING.

Flight 58-1: WENT VMC AT 400 FT. SINCE HIGH ON GLIDEPATH AND WANTED TO ATTEMPT FLARE.

6 BREAKOUT AND FLARE

	Flight 125-1	Flight 58-1
EASE OF ARRESTING RATE OF DESCENT	VERY SLIGHT DIFFICULTY	MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	POOR

COMMENTS

Flight 125-1: THERE WAS A HINT OF HEAVE PIO TENDENCY NEAR GROUND WHILE TRYING TO STABILIZE PITCH.

Flight 58-1: FAILED TO CORRECT COMPLETELY FOR HIGH APPROACH.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

Flight 125-1: SPEED CONTROL TECHNIQUE IS TO MAKE LARGE PITCH ATTITUDE CORRECTIONS FOR A SHORT TIME.

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

Flight 125-1: NONE

Flight 58-1: SMALL. RELATIVELY HIGH LATERAL FORCES. LONGITUDINAL FORCES LOWER. LACK OF HARMONY NOTICEABLE.

9 LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES

Flight 125-1: PITCH OSCILLATION, PITCH DIVERGENCE (RATHER RAPID), VERY RESPONSIVE TO ARTIFICIAL TURBULENCE.

Flight 58-1: POOR CONTROL OF AIRSPEED AND POSSIBLY ALSO RATE OF DESCENT.

11 MISCELLANEOUS

Flight 125-1: UNSTABLE PITCHING MOMENT FROM HEAVE INPUTS APPEARED TO EXIST.

Flight 58-1: SLOPPY MODEL.

	Flight 105-1				Flight 52-3		
CONFIGURATION	15L	WIND (knots)	10	CONFIGURATION	15L	WIND (knots)	3
FLIGHT NUMBER	105-1	WIND SHEAR	SMALL	FLIGHT NUMBER	52-3	WIND SHEAR	SMALL/MODERATE
PILOT	A	EXTERNAL TURBULENCE	LIGHT	PILOT	B	EXTERNAL TURBULENCE	LIGHT/MODERATE
PILOT-RATING	8			PILOT-RATING	9½ S-F		

CHARACTERISTIC ROOTS

Flight 105-1	+.093	-.04	-.116	-1.73
Flight 52-3	-.093	-.04	-.116	-1.73

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR $M_{\delta E} = 0.25$ (rad/sec²)/in		THRUST LEVER $Z_{\delta T} = 15.0$ (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE (105-1)	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY
RESPONSE (52-3)	TOO GREAT		TOO SMALL	

CONTROL SENSITIVITY: as above (both flights).

2. EASE OF MAINTAINING DESIRED VELOCITIES

Flight 105-1:

	Longitudinal velocity (IAS)			Vertical velocity (h)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	MODERATE	GREAT	SLIGHT	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	±10 knots			±200 fpm		

COMMENTS: PITCH ATTITUDE CONTROL SLOPPY – STATICALLY DIVERGENT THE TURBULENCE CONTINUALLY DISTURBS THE PITCH ATTITUDE AND THE VERTICAL VELOCITY

Flight 52-3:

	Longitudinal velocity (IAS)			Vertical velocity (h)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	>SLIGHT	>SLIGHT	>SLIGHT	>SLIGHT	>SLIGHT	>SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	±8 knots			fpm		

COMMENTS: DIFFICULTY DUE TO PITCH EFFECTS ON AIRSPEED AND WIND SHEAR EFFECTS ON RATE OF DESCENT

3. RESIDUAL OSCILLATORY CHARACTERISTICS

Flight 105-1:

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

Flight 52-3:

	AMPLITUDE	PERIOD	DAMPING
PITCH	MODERATE	LONG (10-15 SECS)	ZERO/NEGATIVE
HEAVE			

	SOURCE	DEGREE
EXCITATION	UNKNOWN	EASILY
CONTROL	ELEVATOR	EFFECTIVE

COMMENTS: THE OSCILLATORY CHARACTERISTICS WERE VERY BOTHERSOME, DISORIENTATING AND DANGEROUS – ie. IF THE PHASING IS SUCH THAT OSCILLATION ADDS TO AN ELEVATOR INPUT, A VERY RAPID RESPONSE RESULTS.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 105-1	Flight 52-3
CHANGE REQUIRED	NEGLIGIBLE	VERY SMALL
EASE OF COMPENSATION	NO DIFFICULTY	VERY SLIGHT DIFFICULTY

COMMENTS

5. FLIGHT PATH CONTROL

Flight 105-1:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	MODERATE	SLIGHT	MODERATE	SLIGHT
PRECISION	FAIR	FAIR	FAIR	FAIR	POOR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500

COMMENTS: SO MUCH ATTENTION WAS REQUIRED FOR PITCH ATTITUDE CONTROL THAT HEADING AND AIRSPEED MAINTENANCE WENT FOR A CHOP

Flight 52-3:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
PRECISION	FAIR/GOOD	FAIR/GOOD	FAIR/GOOD	FAIR/GOOD	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE: NO IMC PERMITTED.

COMMENTS: DIFFICULT DUE TO UNSTABLE PITCH OSCILLATION AND TO THE GREAT SUSCEPTIBILITY TO TURBULENCE

6. BREAKOUT AND FLARE

	Flight 105-1	Flight 52-3
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	GREAT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	VERY POOR

COMMENTS (52-3): REASON FOR DIFFICULTY NOT KNOWN – THRUST APPLIED WITHOUT EFFECT. FIRST SHORT TOUCHDOWN TO DATE. PRECISION AT BREAKOUT NOT BAD – A BIT LOW – BUT UNABLE TO ARREST HIGH RATE OF DESCENT NEEDED IN WIND SHEAR.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: SMALL (105-1); NONE (52-3)

9. LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES

Flight 105-1: SLOPPY PITCH ATTITUDE CONTROL, TURBULENCE DISTURBANCE IN PITCH.

Flight 52-3: PITCH CHARACTERISTICS. INABILITY TO ARREST RATE OF DESCENT AT TOUCHDOWN. TURBULENCE UPSETS IN HEAVE AND PITCH

11. MISCELLANEOUS

Flight 52-3: THRUST LEVER SENSITIVITY WAS OK IN AIR BUT TOO LOW NEAR GROUND. INCIPIENT DISORIENTATION AS TALAR SENSITIVITY INCREASES AND CONTROL INPUT FREQUENCY INCREASES IN PRESENCE OF PITCH CHARACTERISTICS. HEAD WIND BECAME TAILWIND ON APPROACH.

CONFIGURATION	16L
FLIGHT NUMBER	117-1
PILOT	A
PILOT RATING	3
WIND (knots)	CALM
WIND SHEAR	SMALL
EXTERNAL TURBULENCE	NEGLIGIBLE

CHARACTERISTIC ROOTS

-.028	-.04	-.69 ±	.711

CONFIGURATION	16L
FLIGHT NUMBER	127-1
PILOT	B
PILOT RATING	3B
WIND (knots)	5
WIND SHEAR	NEGLIGIBLE
EXTERNAL TURBULENCE	NEGLIGIBLE

CHARACTERISTIC ROOTS

-.028	-.04	-.69 ±	.711

AIRCRAFT RESPONSE TO CONTROL INPUTS

Flight 117-1:

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.25	(rad/sec²)/in	$Z_{\delta T}$ = 11.9	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

Flight 127-1:

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.25	(rad/sec²)/in	$Z_{\delta T}$ = 11.9	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

Flight 117-1:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	SLIGHT	MODERATE	NONE	NONE	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	+5, -10		knots	±100		fpm

COMMENTS SOMEWHAT TOO MUCH ATTENTION REQUIRED TO KEEP THE NOSE IN POSITION TO RETAIN THE AIRSPEED. AIRSPEED, IN MANY CASES, FALLS OFF ABOUT 10 KNOTS AT ABOUT 400-500 FT AGL, — PROBABLY DUE TO DECREASING WIND.

Flight 127-1:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	NONE	NONE	NONE	NONE	NONE
MAXIMUM UNDESIRED FLUCTUATIONS	±3		knots			fpm

3 RESIDUAL OSCILLATORY CHARACTERISTICS

Flight 117-1:

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

Flight 127-1:

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 117-1	Flight 127-1
CHANGE REQUIRED	NEGLIGIBLE	SMALL
EASE OF COMPENSATION	NO DIFFICULTY	NO DIFFICULTY

COMMENTS

5 FLIGHT PATH CONTROL

Flight 117-1:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	SLIGHT	NONE	SLIGHT	SLIGHT	SLIGHT
PRECISION		FAIR	GOOD	FAIR	FAIR	FAIR

Flight 127-1:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	NONE	NONE	NONE	NONE
PRECISION	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

Flight 127-1: O.K.

COMMENTS THE ONLY PROBLEM WAS THE WIND SHEAR WHICH REQUIRED ABOUT 20° OF HEADING CHANGE STARTING AT ABOUT 600 TO 700 FT AGL.

6 BREAKOUT AND FLARE

	Flight 117-1	Flight 127-1
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	FAIR/GOOD

COMMENTS

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT NONE

Flight 127-1: NONE

9 LEAST OBJECTIONABLE FEATURES

Flight 127-1: GOOD AMOUNT OF ATTITUDE STABILITY — EASY TO CONTROL YET ADEQUATELY STABLE. NOT VERY SENSITIVE TO TURBULENCE.

10 MOST OBJECTIONABLE FEATURES

11 MISCELLANEOUS

Flight 127-1: NOTICEABLE EFFECT OF POWER, CHANGES ON PITCH TRIM — BUT IS ACCEPTABLE. MAJOR EFFECT IS HAVING TO RETRIM ON GLIDE SLOPE INTERCEPT. THEREAFTER MINOR POWER CHANGES DO NOT NECESSARILY REQUIRE RETRIM, ALTHOUGH EFFECT MUST BE ANTICIPATED.

	Flight 117-2			Flight 116-1		
CONFIGURATION	17L	WIND (knots)	5	17L	WIND (knots)	5-10
FLIGHT NUMBER	117-2	WIND SHEAR	SMALL	116-1	WIND SHEAR	SMALL
PILOT	A	EXTERNAL TURBULENCE	NEGLIGIBLE	D	EXTERNAL TURBULENCE	MODERATE
PILOT-RATING	6			7D		

CHARACTERISTIC ROOTS

Flight				
117-2	-.013	-.04	-.50	-.89
116-1	-.013	-.04	-.50	-.89

AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.25 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE: (117-2)	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY
RESPONSE: (116-1)	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (117-2)	SLIGHT	MODERATE	GREAT	NONE	SLIGHT	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS (117-2)	+12, -8 knots			± 200 fpm		
DIFFICULTY (116-1)	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (116-1)	±5 knots			+400, -200 fpm		

COMMENTS:

(117-2) DIFFICULTY DUE TO PITCH ATTITUDE WANDER WHICH KEPT THE AIRSPEED CHANGING (SEE SECTION 3).

(116-1) ACHIEVED 1500 F.P.M. RATE OF DESCENT UNINTENTIONALLY.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH (117-2)	SMALL	LONG	LOW
HEAVE (117-2)	ZERO		
PITCH (116-1)	ZERO		
HEAVE (116-1)	ZERO		

	SOURCE	DEGREE
EXCITATION: (117-2)	ELEVATOR	EASILY
CONTROL: (117-2)	ELEVATOR	EFFECTIVE
EXCITATION: (116-1)		
CONTROL: (116-1)		

COMMENTS

(117-2) A LOW FREQUENCY WANDER IN PITCH FELT AS IF IT WOULD DIVERGE IF LEFT ALONE. THIS KEPT THE NOSE ACTIVE AND PRODUCED A VERY HIGH WORKLOAD IN PITCH.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	117-2	116-1
CHANGE REQUIRED	NEGLIGIBLE	SMALL
EASE OF COMPENSATION:	NO DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS:

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY (117-2)	NONE	NONE	MODERATE	SLIGHT	MODERATE	SLIGHT
PRECISION (117-2)	GOOD	GOOD	FAIR	FAIR	FAIR	FAIR
DIFFICULTY (116-1)	SLIGHT	MODERATE	SLIGHT	SLIGHT	MODERATE	MODERATE
PRECISION (116-1)	FAIR	POOR	FAIR	FAIR	POOR	POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: (117-2) 500; (116-1) 400

COMMENTS:

(117-2) THE LACK OF GOOD AIRSPEED CONTROL RESULTED IN A CHANGING REQUIREMENT FOR RATE OF DESCENT, THE WIND SHEAR OF APPROXIMATELY 30° CAUSED A SLIGHT PROBLEM.

(116-1) PERFORMANCE NOT GOOD ENOUGH FOR LOWER BREAKOUT HEIGHT. OVERSHOT ON LOCALIZER INTERCEPT, DIFFICULTY DUE TO HEIGHT CONTROL, TURBULENCE, ENGINE POWER SURGES.

6 BREAKOUT AND FLARE

	117-2	116-1
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	FAIR

COMMENTS:

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT NONE

9 LEAST OBJECTIONABLE FEATURES

10 MOST OBJECTIONABLE FEATURES

(116-1) (1) HEIGHT CONTROL DIFFICULT IN THE PRESENCE OF SIMULATOR ENGINE POWER LIMITATIONS.

(2) PITCH DIVERGENCE.

11. MISCELLANEOUS

CONFIGURATION 18
FLIGHT NUMBER 15-3
PILOT A
PILOT-RATING 8½
WIND(knots) 5-10
WIND SHEAR NEGLIGIBLE
EXTERNAL TURBULENCE NEGLIGIBLE

CHARACTERISTIC ROOTS	-.034	-.04	-.49±	.875i

CONFIGURATION 18
FLIGHT NUMBER 37-1
PILOT B
PILOT-RATING 7
WIND(knots) 8
WIND SHEAR ?
EXTERNAL TURBULENCE LIGHT

CHARACTERISTIC ROOTS	-.034	-.04	-.49±	.875i

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = .20 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	NOT ASSESSABLE	SATISFACTORY	SATISFACTORY

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = .2 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	V.M.C.	I.M.C.	I.M.C.	V.M.C.	I.M.C.	I.M.C.
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	GREAT	GREAT	SLIGHT	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	-10,+5 knots			±200 fpm		

COMMENTS

A CONSTANT MODERATE FREQUENCY PITCH OSCILLATION, WHICH IS PROBABLY PILOT INDUCED, KEEPS THE PITCH ATTITUDE MOVING. THE TURBULENCE EXCITES THIS AND THE HEAVING DUE TO TURBULENCE IS LARGER THAN WITH ANY OTHER MODEL TO DATE. THE WORST PART OF THE TURBULENCE HOWEVER, LIES WITH THE DIRECTIONAL DISTURBANCES CAUSED DURING LOCALIZER TRACKING.

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	V.M.C.	I.M.C.	I.M.C.	V.M.C.	I.M.C.	I.M.C.
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	SLIGHT	SLIGHT	NONE	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	±10 knots			±300 fpm		

NOT SURE OF REASON FOR DIFFICULTY. MAY BE THAT WITH RATE OF DESCENT CONTROL ON GLIDE PATH NEAR BOTTOM WAS DUE TO A WIND SHEAR PROBLEM. 500F.P.M. TO HOLD AT TOP BUT, ALTHOUGH CONTINUOUSLY REDUCING THRUST AT BOTTOM (800 FT.), CORRECTION WAS NOT LARGE ENOUGH TO MAINTAIN GLIDE SLOPE.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	MODERATE	MEDIUM	LOW
HEAVE			

	SOURCE	DEGREE
EXCITATION	ELEVATOR AND TURBULENCE	EASILY
CONTROL	ELEVATOR	INEFFECTIVE

COMMENTS

SEE #2

	AMPLITUDE	PERIOD	DAMPING
PITCH			
HEAVE			

	SOURCE	DEGREE
EXCITATION		
CONTROL		

THERE WAS A TRACE OF A PITCH/HEAVE OSCILLATION — PERHAPS PARTLY PILOT INDUCED WITH THRUST LEVER AND ELEVATOR.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: SMALL
EASE OF COMPENSATION: NO DIFFICULTY
COMMENTS:

CHANGE REQUIRED: SOME
EASE OF COMPENSATION: NO DIFFICULTY

NOT A FACTOR IN RATING.

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	MODERATE	MODERATE	GREAT	GREAT
PRECISION						

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500

COMMENTS

SEE SECTION #2

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	NONE	NONE	MODERATE	SLIGHT
PRECISION	GOOD	GOOD	GOOD	GOOD	FAIR/GOOD	GOOD

THE REASON FOR DIFFICULTY IS NOT CLEAR BUT MAY HAVE BEEN DUE TO WIND SHEAR OR POWER/PITCH ATTITUDE INTERACTION, WE WENT HIGH TOWARDS THE END.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: GOOD
COMMENTS:

EASE OF ARRESTING RATE OF DESCENT: SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: FAIR/GOOD

GLIDE SLOPE INDICATION WAS FULL DEFLECTION HIGH AT BREAKOUT — I CAME OUT AT 300 FT. TO ACCOMPLISH TRANSITION. EVEN SO I WAS ABLE TO PRETTY WELL CONTROL THE TOUCHDOWN POINT AND RATE OF DESCENT.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: MODERATE. SEE #2. THE YAWING MAY HAVE BEEN DUE TO POWER CHANGES RATHER THAN TO TURBULENCE

NONE

9 LEAST OBJECTIONABLE FEATURES

TURBULENCE RATING 8

10 MOST OBJECTIONABLE FEATURES

(1) LARGE INTERACTION BETWEEN THRUST LEVER AND PITCH ATTITUDE.
(2) RELATIVELY LOOSE IN PITCH — ONE NEEDS TO MONITOR PITCH ATTITUDE, ESPECIALLY IF THRUST LEVER CHANGES ARE GOING ON SIMULTANEOUSLY.

11 MISCELLANEOUS

THE RATING COULD HAVE BEEN 6 IF IT HAD NOT BEEN FOR GOING HIGH ON GLIDE SLOPE, THE REASON FOR WHICH I AM NOT CERTAIN.

CONFIGURATION	LB	WIND (knots)	5
FLIGHT NUMBER	125-2	WIND SHEAR	SMALL
PILOT	C	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT RATING	5		

CONFIGURATION		WIND (knots)	
FLIGHT NUMBER		WIND SHEAR	
PILOT		EXTERNAL TURBULENCE	
PILOT RATING			

CHARACTERISTIC ROOTS

-.034	-.04	-.49±	.8751

CHARACTERISTIC ROOTS

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.2 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	TOO SMALL	TOO GREAT	SATISFACTORY	SATISFACTORY

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = (rad/sec²)/in		$Z_{\delta T}$ = (ft/sec²)/in	
Initial	Final	Initial	Final

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	MODERATE	SLIGHT	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	10 knots			fpm		

Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
VMC	IMC	IMC	VMC	IMC	IMC
OUT	OUT	IN	OUT	OUT	IN
knots			fpm		

COMMENTS: CHANGES OF SPEED DIFFICULT TO ACCOMPLISH WITH PRECISION.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

AMPLITUDE	PERIOD	DAMPING

	SOURCE	DEGREE
EXCITATION		
CONTROL		

SOURCE	DEGREE

COMMENTS:

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED	SMALL	
EASE OF COMPENSATION:	MODERATE DIFFICULTY	DIFFICULTY

COMMENTS: THRUST DEMANDS OBSCURED BY EFFECT OF SPEED VARIATIONS.

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	MODERATE	SLIGHT	MODERATE	SLIGHT	MODERATE	SLIGHT
PRECISION	POOR	GOOD	POOR	GOOD	FAIR	GOOD

Intercept & initial track		Intermediate track		Final track	
Glide path	Localizer	Glide path	Localizer	Glide path	Localizer

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

COMMENTS: TRACKING ON INTERMEDIATE PORTION QUITE GOOD, BUT SPEED WAS HIGH (70 KNOTS). DIFFICULT TO GET ESTABLISHED ON GLIDE PATH WITH CORRECT SPEED.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	

COMMENTS

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE

9 LEAST OBJECTIONABLE FEATURES: NO NOTICEABLE OSCILLATORY TENDENCIES.

10 MOST OBJECTIONABLE FEATURES: DIFFICULT TO CHANGE SPEED WITH PRECISION, BUT SPEED CHANGES HAVE CONSIDERABLE EFFECT ON THRUST REQUIREMENTS. MORE OF A PROBLEM IMC THAN VMC.

11 MISCELLANEOUS: THRUST LEVER DISPLACEMENTS POSSIBLY A BIT LARGER THAN NECESSARY. ELEVATOR TRIM RATE TOO SLOW.

CONFIGURATION	19	WIND (knots)	10
FLIGHT NUMBER	6-2	WIND SHEAR	
PILOT	A	EXTERNAL TURBULENCE	ZERO
PILOT-RATING	7		

CHARACTERISTIC ROOTS: -.018 | -.04 | -.50± | .0581

CONFIGURATION	19	WIND (knots)	10-15
FLIGHT NUMBER	14-1	WIND SHEAR	SMALL
PILOT	A	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	7½		

CHARACTERISTIC ROOTS: -.018 | -.04 | -.50± | .0581

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY:

RESPONSE:

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = .2 (rad/sec²)/in		$Z_{\delta T}$ = 7.4 (ft/sec²)/in	
Initial	Final	Initial	Final
SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = .20 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
Initial	Final	Initial	Final
SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	-	GREAT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	±8 knots			fpm		

COMMENTS: THE PITCH CONTROL IS VERY POSITIVE AND CAUSED OVERCONTROLLING IN PITCH ATTITUDE. TURBULENCE HAS A MODERATE EFFECT ON BOTH PITCH AND HEAVE.

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	GREAT	GREAT	NONE	SLIGHT	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	±10 knots			±200 fpm		

THE PITCH ATTITUDE HAD A WAY OF WANDERING RATHER UNPREDICTABLY — ALTHOUGH THERE WAS A PERIODIC CHARACTERISTIC, IT WAS DIFFICULT TO PREDICT WHEN FACED WITH OTHER PARTS OF THE TASK.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

	AMPLITUDE	PERIOD	DAMPING
PITCH	LARGE	MEDIUM	LOW
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION	δ_E, δ_T, TURBULENCE	EASILY
CONTROL	ELEVATOR	INEFFECTIVE

SEE SECTION #2.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: MODERATE

EASE OF COMPENSATION: SLIGHT DIFFICULTY

COMMENTS

CHANGE REQUIRED: SMALL

EASE OF COMPENSATION: NO DIFFICULTY

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:			MODERATE	MODERATE		
PRECISION			POOR	POOR		

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET:

COMMENTS: PITCH ATTITUDE DIFFICULT TO SETTLE ON AND HENCE THE AIRSPEED AND REQUIRED RATE OF DESCENT VARY.

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	SLIGHT	NONE	GREAT	MODERATE	GREAT	MODERATE
PRECISION	FAIR	GOOD	POOR	GOOD	VERY POOR	FAIR

500

THE GLIDE PATH GOT AWAY AT ABOUT 500 FT. A.G.L., PROBABLY DUE TO THE HIGH WORKLOAD IN TRYING TO KEEP AIRSPEED.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: NO DIFFICULTY

PRECISION OF ATTAINING TOUCHDOWN POINT: GOOD

COMMENTS: WE WERE LOW ON THE GLIDE PATH AND BREAKOUT AND HENCE HAD LOTS OF TIME TO DRAG IT IN TO THE LANDING TOUCHDOWN POINT.

EASE OF ARRESTING RATE OF DESCENT: GREAT DIFFICULTY

PRECISION OF ATTAINING TOUCHDOWN POINT: VERY POOR

BROKE OUT WELL ABOVE GLIDE PATH EVEN THOUGH THE RATE OF DESCENT HAD BEEN AT OR CLOSE TO 1000 F.P.M. FROM 500 FT. A.G.L. TOO MUCH ATTENTION WAS REQUIRED TO DIVE-OFF HEIGHT AND THE OSCILLATORY PITCH ATTITUDE MADE FOR A VERY INSECURE FEELING IN PITCH.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: SMALL

NONE

9 LEAST OBJECTIONABLE FEATURES

10 MOST OBJECTIONABLE FEATURES

SEE SECTION #2

11 MISCELLANEOUS

THE ELEVATOR CONTROL FORCES WERE HIGH AND THOSE OF THE RUDDER LOW.

CONFIGURATION	19	WIND(knots)	5
FLIGHT NUMBER	115-1	WIND SHEAR	NEGLIGIBLE
PILOT	B	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	7½		

CHARACTERISTIC ROOTS: -.015 | -.04 | -.50± | .05ai

CONFIGURATION	19	WIND(knots)	15
FLIGHT NUMBER	39-1	WIND SHEAR	MODERATE
PILOT	C	EXTERNAL TURBULENCE	MODERATE
PILOT-RATING	4		

CHARACTERISTIC ROOTS: -.018 | -.04 | -.50± | .0581

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY:
RESPONSE:

ELEVATOR $M_{\delta E}$ = -.2 (rad/sec²)/in Initial	Final	THRUST LEVER $Z_{\delta T}$ = 11.9 (ft/sec²)/in Initial	Final
SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

ELEVATOR $M_{\delta E}$ = -.2 (rad/sec²)/in Initial	Final	THRUST LEVER $Z_{\delta T}$ = 11.9 (ft/sec²)/in Initial	Final
SATISFACTORY	SATISFACTORY	SATISFACTORY	

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	±8 knots			fpm		

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	MODERATE	SLIGHT	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	±10 knots			? fpm		

COMMENTS: DIFFICULTY DUE TO UNDERLYING PITCHING OSCILLATION WHICH GIVES CONTINUOUS ATTITUDE UPSETS.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	SMALL	LONG (8 TO 10 SECS)	[illegible]
HEAVE			

	AMPLITUDE	PERIOD	DAMPING
PITCH			
HEAVE			

	SOURCE	DEGREE
EXCITATION	UNKNOWN	EASILY
CONTROL	ELEVATOR	EFFECTIVE

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS: SIMILAR TO CONFIGURATION [illegible] EXCEPT [illegible] BECAUSE OF PITCHING MOMENTS DUE TO [illegible] ANGLE OF ATTACK, THE OSCILLATION COULD BE MORE OR LESS IN PHASE AS NOTED.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: — / SMALL
EASE OF COMPENSATION: DIFFICULTY / SLIGHT DIFFICULTY

COMMENTS: THE PERTINENT PROBLEM DURING TURNS IN [illegible] A MODEL CONTAINING PITCHING OSCILLATIONS IS THE MANNER IN WHICH THE OSCILLATION REVERSALS UNEXPECTEDLY [illegible] TO [illegible] FROM ELEVATOR INPUTS DURING [illegible] OF TURN, SOMETIMES SEVERAL SECONDS AFTER THE CONTROL [illegible]. THIS DEMANDS CLOSE MONITORING OF ATTITUDE [illegible] AND [illegible] MODERATELY [illegible] OF [illegible].

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	NONE	NONE	NONE	NONE
PRECISION	GOOD	GOOD	GOOD	GOOD	[illegible]	GOOD

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	MODERATE	NONE	SLIGHT	SLIGHT	SLIGHT	SLIGHT
PRECISION						

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: [illegible]

COMMENTS: ONLY [illegible] ATTITUDE [illegible]

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: SLIGHT DIFFICULTY / [illegible] DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: GOOD / FAIR

COMMENTS: [illegible] KNOTS IN AIRSPEED

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

9 LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES
(1) UNDERLYING PITCHING OSCILLATION
(2) [illegible] PITCHING MOMENT [illegible] ANGLE OF ATTACK
(3) PITCH INSTABILITY

[illegible] DIFFICULTY IN MAINTAINING SPEED CONTROL WITHIN ±10 KNOTS ON INSTRUMENT TASKS

11 MISCELLANEOUS

CONFIGURATION	19	WIND(knots)	5
FLIGHT NUMBER	122-1	WIND SHEAR	SMALL
PILOT	C	EXTERNAL TURBULENCE	LIGHT (LONGISH PERIOD THERMAL ACTIVITY NOTICEABLE)
PILOT-RATING	4		

CHARACTERISTIC ROOTS | -.016 | -.04 | -.50± | .0581 |

CONFIGURATION	19	WIND (knots)	CALM
FLIGHT NUMBER	21-3	WIND SHEAR	NEGLIGIBLE
PILOT	D	EXTERNAL TURBULENCE	LIGHT
PILOT-RATING	7		

CHARACTERISTIC ROOTS | -.018 | -.04 | -.50± | .0581 |

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.2 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	TOO SMALL	TOO GREAT	SATISFACTORY	SATISFACTORY

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = .2 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	TOO SMALL	TOO GREAT	TOO SMALL	TOO GREAT

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	±5 knots			fpm		

COMMENTS: QUITE GOOD PERFORMANCE OBTAINED, BUT REQUIRES CLOSE ATTENTION TO MAINTAIN REQUIRED SPEED.

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	>MODERATE	SLIGHT	SLIGHT	>MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	±10 knots			± 600 fpm		

COMMENTS: OSCILLATORY IN PITCH AND TENDENCY TO OVERCONTROL. THE INITIAL RESPONSE SEEMS TO BE SLOW SO THAT PILOT OVERDRIVES INITIALLY.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

	AMPLITUDE	PERIOD	DAMPING
PITCH	>MODERATE	MEDIUM	LOW
HEAVE	ZERO/SMALL	MEDIUM	MODERATE/HIGH

	SOURCE	DEGREE
EXCITATION	TURBULENCE ELEVATOR	EASILY MODERATELY
CONTROL	ELEVATOR	EFFECTIVE

COMMENTS: CLOSED LOOP PIO — HEIGHT CONTROL SEEMS OK, PITCH RESPONSE RATHER SLOW BUT NOT EXTREMELY SO.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED:	NEGLIGIBLE	SMALL
EASE OF COMPENSATION:	SLIGHT DIFFICULTY	NO DIFFICULTY

COMMENTS: SPEED VARIATIONS REQUIRE THROTTLE COMPENSATION TO MAINTAIN ALTITUDE.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	NONE	NONE	SLIGHT	SLIGHT
PRECISION	GOOD	GOOD	GOOD	GOOD	FAIR/GOOD	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

COMMENTS: CLOSE ATTENTION REQUIRED TO PREVENT SPEED VARIATIONS.

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	SLIGHT	SLIGHT	GREAT	GREAT
PRECISION						

COMMENTS: OVERCONTROL AS SENSITIVITY OF TALAR INCREASED.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY	NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	VERY POOR

COMMENTS: DIFFICULTY DUE TO NEED TO MAINTAIN SPEED WITH LONGITUDINAL CONTROL WHILE ARRESTING RATE OF DESCENT WITH THROTTLE.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER: ON INTERMEDIATE TRACK SOME ATTEMPT WAS MADE TO POSITION THE AIRCRAFT FORE AND AFT ON GLIDE PATH PRIMARILY USING THROTTLE. APPEARED TO BE SUCCESSFUL FOR SMALL CORRECTIONS.

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE — NONE

9 LEAST OBJECTIONABLE FEATURES

POWER REQUIREMENTS SMALL

10 MOST OBJECTIONABLE FEATURES: RATHER TOO CLOSE ATTENTION REQUIRED TO AVOID SPEED VARIATIONS AND THEIR CONSEQUENT EFFECT ON VERTICAL SPEED.

VERY POOR PRECISION FROM 200 FT. A.G.L. TO TOUCHDOWN. STRONG TENDENCY TO OVERCONTROL ATTITUDE

11 MISCELLANEOUS: JUST POSSIBLE THAT EXTERNAL TURBULENCE AFFECTED RATING ADVERSELY BY A SMALL AMOUNT

MOST OF THE TASK WAS RATED UNSATISFACTORY — ACCEPTABLE BUT, ON FINAL APPROACH VMC, I WOULD HESITATE TO TRY AND LAND BECAUSE OF POOR ATTITUDE CONTROL.

CONFIGURATION	20	WIND (knots)	CALM
FLIGHT NUMBER	3-3	WIND SHEAR	-
PILOT	A	EXTERNAL TURBULENCE	ZERO
PILOT-RATING	9		

CHARACTERISTIC ROOTS

+.041	-.04	-.101	-.959

CONFIGURATION	20	WIND (knots)	10
FLIGHT NUMBER	83-2	WIND SHEAR	MODERATE
PILOT	A	EXTERNAL TURBULENCE	NEGLIGIBLE HIGH
PILOT-RATING	8		LIGHT LOW

CHARACTERISTIC ROOTS

+.041	-.04	-.101	-.959

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.2 (rad/sec^2)/in		$Z_{\delta T}$ = 7.4 (ft/sec^2)/in	
	Initial	Final	Initial	Final
RESPONSE	GOOD	TOO GREAT		

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.2 (rad/sec^2)/in		$Z_{\delta T}$ = 11.9 (ft/sec^2)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	TOO GREAT	SATISFACTORY	

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	MODERATE	GREAT	MODERATE	MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	-10 to +6 knots			fpm		

COMMENTS: DIFFICULTY DUE TO VERY SLOPPY PITCH ATTITUDE CONTROL. TURBULENCE HAD LARGE EFFECT ON PITCH AND A MODERATE EFFECT ON HEAVE

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	GREAT	GREAT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	-10 to +5 knots			OK fpm		

A SLIGHT OUT OF TRIM ON ELEVATOR RESULTED IN ENORMOUS PITCH ATTITUDE CHANGES. THE NOSE WAS IN CONSTANT MOTION AND VERY INTENSE CONCENTRATION WAS REQUIRED TO MAINTAIN AIRSPEED ON APPROACH.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	LARGE	MEDIUM	LOW
HEAVE			

	SOURCE	DEGREE
EXCITATION	ELEVATOR, TURBULENCE	EASILY
CONTROL	ELEVATOR	INEFFECTIVE

COMMENTS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

SIMPLE DIVERGENCE, A VERY SHORT PERIOD OF INATTENTION COULD RESULT IN ALARMINGLY LARGE PITCH ATTITUDE CHANGES.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: SMALL
EASE OF COMPENSATION: NO DIFFICULTY

COMMENTS:

SMALL
NO DIFFICULTY

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY			GREAT	MODERATE		
PRECISION			VERY POOR	POOR		

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET:

COMMENTS

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	MODERATE	SLIGHT	SLIGHT	MODERATE
PRECISION	FAIR	FAIR	POOR	FAIR	FAIR	POOR

700-800

SORTING OUT THE WIND AS A FUNCTION OF HEIGHT WAS A PROBLEM. APPROXIMATELY 20° OF HEADING CHANGE WAS REQUIRED FROM START TO FINISH.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: GREAT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: VERY POOR

COMMENTS: IT WAS IMPOSSIBLE TO SELECT THE DESIRED PITCH ATTITUDE FOR THE FLARE SINCE THE OSCILLATORY CHARACTERISTICS WERE VERY BOTHERSOME.

NO DIFFICULTY
GOOD

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: MODERATE, BECAUSE OF THE LIGHT BREAKOUT FORCE ON RUDDER

9 LEAST OBJECTIONABLE FEATURES

10 MOST OBJECTIONABLE FEATURES

11 MISCELLANEOUS: ELEVATOR AND RUDDER FORCES LOW.

WHEN THE RATE OF DESCENT INCREASED, THE NOSE SEEMED TO COME UP, INDICATING AN UNSTABLE PITCHING MOMENT WITH ANGLE OF ATTACK. THIS IN ITSELF WAS NOT OVERLY BOTHERSOME BUT PRESENTED A MINOR TRIM ANNOYANCE.

CONFIGURATION	20	WIND (knots)	5
FLIGHT NUMBER	124-2	WIND SHEAR	NEGLIGIBLE
PILOT	B	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	8D		

CHARACTERISTIC ROOTS

+.041	-.04	-.101	-.959

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.2	(rad/sec²)/in	$Z_{\delta T}$ = 11.9	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE	TOO GREAT	TOO GREAT	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	N
DIFFICULTY	MODERATE	MODERATE	MODERATE	SLIGHT	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	±8 knots			OK fpm		

COMMENTS

DIFFICULTY DUE TO UNDERLYING PHUGOID TYPE OF OSCILLATION WHICH FORCES ATTENTION TO PITCH AND HENCE SPEED.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	MODERATE	LONG	NEGATIVE OR ZERO
HEAVE	?	?	

	SOURCE	DEGREE
EXCITATION	UNKNOWN	EASILY
CONTROL	ELEVATOR	EFFECTIVE

COMMENTS

THERE IS A PITCH ATTITUDE INSTABILITY AS WELL.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED	
EASE OF COMPENSATION	DIFFICULTY

COMMENTS

THE MORE SIGNIFICANT FACTOR IS THAT PITCH INPUTS ARE REQUIRED IN THE TURN. THESE CAN LEAD TO A PIO TYPE OF TURN BECAUSE OF THE SUPERPOSITION OF THE OSCILLATORY CHARACTERISTICS AND THE RESPONSE TO CONTROL INPUTS. SIMILAR EFFECTS RESULT FROM THRUST INPUTS.

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	NONE	NONE	SLIGHT	SLIGHT
PRECISION	GOOD	GOOD	GOOD	GOOD	FAIR	GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE
IF GREATER THAN 200 FEET: OK BECAUSE GOOD TRACKING WAS ACHIEVED

COMMENTS

GLIDE PATH AND LOCALIZER CONTROL OK. SPEED CONTROL GAVE MODERATE DIFFICULTY INITIALLY.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD

COMMENTS

NEEDED TO PAY MORE THAN USUAL ATTENTION TO PITCH ATTITUDE IN ORDER TO MAINTAIN SPEED AFTER BREAKOUT

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

9 LEAST OBJECTIONABLE FEATURES

10 MOST OBJECTIONABLE FEATURES

PITCH OSCILLATION — APPROXIMATELY 10 SEC. PERIOD. PITCHING MOMENTS DUE TO THRUST INPUTS NOTICEABLE AND CAN ADD TO OR SUBTRACT FROM OSCILLATION.

11 MISCELLANEOUS

LARGE PITCH CHANGES CAN RESULT IMC UNLESS ATTITUDE CLOSELY MONITORED. RESPONSE TO ELEVATOR INPUTS TOO LARGE BECAUSE OF APPARENT PITCH ATTITUDE DIVERGENCE.

CONFIGURATION
FLIGHT NUMBER
PILOT
PILOT-RATING
WIND (knots)
WIND SHEAR
EXTERNAL TURBULENCE

CHARACTERISTIC ROOTS

	ELEVATOR		THRUST LEVER	
	$M_{\delta E}$ =	(rad/sec²)/in	$Z_{\delta T}$ =	(ft/sec²)/in
	Initial	Final	Initial	Final

Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
VMC	IMC	IMC	VMC	IMC	IMC
OUT	OUT	IN	OUT	OUT	IN
knots			fpm		

AMPLITUDE	PERIOD	DAMPING

SOURCE	DEGREE

DIFFICULTY

Intercept & initial track		Intermediate track		Final track	
Glide path	Localizer	Glide path	Localizer	Glide path	Localizer

DIFFICULTY

CONFIGURATION	RIL	WIND (knots)	10
FLIGHT NUMBER	69-3	WIND SHEAR	SMALL
PILOT	A	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	3		

CHARACTERISTIC ROOTS

-.04	-.38	-1.05±	1.061

CONFIGURATION	RIL	WIND (knots)	5
FLIGHT NUMBER	76-1	WIND SHEAR	NEGLIGIBLE
PILOT	B	EXTERNAL TURBULENCE	VERY LIGHT
PILOT-RATING	5C		

CHARACTERISTIC ROOTS

-.04	-.38	-1.05±	1.061

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY:
RESPONSE:

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = 0.34	(rad/sec²)/in	$Z_{\delta T}$ = 15.0	(ft/sec²)/in
Initial	Final	Initial	Final
SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = 0.34	(rad/sec²)/in	$Z_{\delta T}$ = 15.0	(ft/sec²)/in
Initial	Final	Initial	Final
SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	SLIGHT	SLIGHT	NONE	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	+5, -8 knots			O K fpm		

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	±3 knots			O K fpm		

COMMENTS:

GOOD MODEL. - AIRSPEED GOT A LITTLE LOW DURING LATTER PART OF APPROACH, BUT I FELT THAT THIS WAS A CROSS-CHECK PROBLEM, NOT A HANDLING QUALITIES PROBLEM.

ON FLARE, DID SLOW DOWN TO 50 KNOTS.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION:		
CONTROL		

	SOURCE	DEGREE
EXCITATION:		
CONTROL		

COMMENTS

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: NEGLIGIBLE
EASE OF COMPENSATION: NO DIFFICULTY

CHANGE REQUIRED: VERY SMALL
EASE OF COMPENSATION: NO DIFFICULTY

COMMENTS

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	NONE	NONE	NONE	NONE
PRECISION	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	NONE	NONE	V. SLIGHT	V. SLIGHT
PRECISION	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

O K

COMMENTS

HAD TO WORK HARDER BUT PERFORMANCE WAS GOOD. LOTS OF CONTROL ACTIVITY.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: GOOD

EASE OF ARRESTING RATE OF DESCENT: SLIGHT MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: FAIR-GOOD

COMMENTS

SPEED LOW DURING TRANSITION (50 KNOTS) - HAD TO PITCH NOSE DOWN AND REDUCE RATE OF DESCENT AT SAME TIME. I DID NOT HAVE PRECISE CONTROL OF RATE OF DESCENT AT TOUCHDOWN, SUSPECTED A SLIGHT TENDENCY TOWARDS A PITCH/HEAVE PIO AT TOUCHDOWN.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

NONE

9 LEAST OBJECTIONABLE FEATURES

NO RESPONSE TO TURBULENCE. AIRSPEED CONTROL GOOD EVEN THOUGH THE PITCH RESPONSE WAS NOT OF ATTITUDE COMMAND TYPE.

REASONABLE ATTITUDE AND SPEED STABILITY. LOW RESPONSE TO TURBULENCE.

10 MOST OBJECTIONABLE FEATURES

SOME PITCH UPSETS, PROBABLY DUE TO UNCONSCIOUS CONTROL INPUTS.

11 MISCELLANEOUS

VIBRATION ENVIRONMENT WITH SUN BEHIND CAUSED A HIGHER LEVEL OF PHYSIOLOGICAL CONCERN AND ACTIVITY. - COULD LEAD TO A DISORIENTATION TENDENCY IN SOME CIRCUMSTANCES BUT, IN MY CASE, JUST MADE ME WANT TO GET TASK OVER WITH. DESPITE THIS, TRACKING PERFORMANCE WAS QUITE GOOD.

	Flight 71-3		Flight 91-1	
CONFIGURATION	R1-2L		R1-2L	
FLIGHT NUMBER	71-3		91-1	
PILOT	A		B	
PILOT-RATING	3		4B	
WIND (knots)			10-15	
WIND SHEAR			>SMALL	
EXTERNAL TURBULENCE			LIGHT	

CHARACTERISTIC ROOTS				
Flight 71-3	-.08	-.34	-1.06 ±	1.05i
Flight 91-1	-.05	-.34	-1.06 ±	1.05i

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY:

	ELEVATOR		THRUST LEVER	
Flight 71-3	$M_{\delta E}$ = 0.34	(rad/sec²)/in	$Z_{\delta T}$ = 15.0	(ft/sec²)/in
Flight 91-1	$M_{\delta E}$ = 0.34	(rad/sec²)/in	$Z_{\delta T}$ = 15.0	(ft/sec²)/in

RESPONSE:

	Elevator Initial	Elevator Final	Thrust Lever Initial	Thrust Lever Final
Flight 71-3	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY
Flight 91-1	TOO GREAT	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
Flight 71-3 DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
Flight 71-3 MAXIMUM UNDESIRED FLUCTUATIONS	±5 knots			±100 fpm		
Flight 91-1 DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
Flight 91-1 MAXIMUM UNDESIRED FLUCTUATIONS	±7 knots			fpm		

COMMENTS

Flight 71-3: THE PITCH ATTITUDE HOLDING COULD HAVE BEEN MORE FIRM TO ALLEVIATE THIS ASPECT OF THE WORKLOAD.

Flight 91-1: DIFFICULTY DUE TO: (1) CROSS-CHECK, (2) THERE APPEARED TO BE A LONG PERIOD SPEED OSCILLATION, BUT IT WAS PROBABLY PILOT INDUCED, (3) HEIGHT CONTROL, PROBABLY DUE TO WIND EFFECTS.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	Flight 71-3 AMPLITUDE	PERIOD	DAMPING	Flight 91-1 AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO			ZERO		
HEAVE	ZERO			ZERO		

	SOURCE	DEGREE
EXCITATION:		
CONTROL:		

COMMENTS

Flight 91-1: THERE APPEARED TO BE A LONG PERIOD SPEED OSCILLATION - PROBABLY PILOT INDUCED.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 71-3	Flight 91-1
CHANGE REQUIRED:	MODERATE	VERY SMALL
EASE OF COMPENSATION	NO DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS

5 FLIGHT PATH CONTROL

	Intercept & initial track Glide path	Intercept & initial track Localizer	Intermediate track Glide path	Intermediate track Localizer	Final track Glide path	Final track Localizer
Flight 71-3 DIFFICULTY	NONE	NONE	SLIGHT	SLIGHT	SLIGHT	SLIGHT
Flight 71-3 PRECISION	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD
Flight 91-1 DIFFICULTY	NONE	NONE	SLIGHT	NONE	SLIGHT	SLIGHT
Flight 91-1 PRECISION	GOOD	GOOD	FAIR/GOOD	FAIR/GOOD	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

Flight 91-1: O.K.

COMMENTS

Flight 71-3: THIS WAS THE BEST APPROACH OF THE THREE MODELS (8-2PL, 7-2L) FLOWN ON THIS FLIGHT. THE TURBULENCE DID NOT UPSET THE PITCH ATTITUDE AND HENCE AIRSPEED WAS QUITE GOOD.

Flight 91-1: DIFFICULTY DUE TO BEING THE FIRST MODEL FLOWN IN A STRONG WIND GRADIENT.

6 BREAKOUT AND FLARE

	Flight 71-3	Flight 91-1
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	GOOD

COMMENTS:

Flight 91-1: HAD TO SET RATE OF DESCENT AND HOLD IT TO TOUCHDOWN - FELT I COULD GET A SLIGHT HEAVE PIO IF I USED COLLECTIVE TO ARREST PRECISELY.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

Flight 71-3: SMALL

Flight 91-1: NONE, LOCALIZER 'S' TURNING BELOW 700 FT.

9 LEAST OBJECTIONABLE FEATURES

Flight 91-1: GOOD PITCH STABILITY, BUT INITIAL RESPONSE TOO FAST i.e. TIME CONSTANT IN PITCH A LITTLE TOO SHORT - COULD LEARN TO LIKE IT THOUGH.

10 MOST OBJECTIONABLE FEATURES

Flight 91-1: RATE OF DESCENT TRACKING NEEDS SOME PRACTICE - APPARENT LOW HEIGHT RATE DAMPING?

11 MISCELLANEOUS

Flight 91-1: NO SIGNIFICANT TURBULENCE EFFECTS.

	Flight 62-1		Flight 51-1
CONFIGURATION	R1-3L		R1-3L
FLIGHT NUMBER	62-1		51-1
PILOT	A		D
PILOT RATING	5½		8
WIND (knots)			CALM
WIND SHEAR	SMALL		NEGLIGIBLE
EXTERNAL TURBULENCE	LIGHT		NEGLIGIBLE
CHARACTERISTIC ROOTS	-.21 ± .11, -1.06 ± 1.031		-.21 ± .11, -1.06 ± 1.031

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

Flight 62-1:

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

Flight 51-1:

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.25 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	TOO GREAT	TOO SMALL	TOO GREAT

2 EASE OF MAINTAINING DESIRED VELOCITIES

Flight 62-1:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	MODERATE	SLIGHT	SLIGHT	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	± 8 knots			± 300 fpm		

COMMENTS: AS THE AIRSPEED DECREASES, A RATE OF DESCENT BUILDS BUT THERE IS NOT THE IMMEDIATE 'BOTTOM FALLING OUT' FEELING OF SOME MODELS.

Flight 51-1:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	MODERATE	SLIGHT	MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	± 10 knots			± 300-500 fpm		

COMMENTS: DIFFICULTY DUE TO BEING ON BACKSIDE OF POWER REQUIRED CURVE.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

Flight 62-1:

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS:

Flight 51-1:

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO	MEDIUM	HIGH
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS: PITCH DYNAMICS WERE GOOD.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 62-1	Flight 51-1
CHANGE REQUIRED	SMALL	MODERATE
EASE OF COMPENSATION	SLIGHT DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS (62-1): OK AS LONG AS AIRSPEED IS HELD.

COMMENTS (51-1): AIRSPEED CONTROL WAS REASONABLY GOOD IN TURNS BECAUSE PITCH DYNAMICS WERE GOOD.

5 FLIGHT PATH CONTROL

Flight 62-1:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	SLIGHT	NONE	MODERATE	SLIGHT
PRECISION	GOOD	GOOD	FAIR	GOOD	POOR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 300-400

COMMENTS: DURING THE FINAL STAGES (APPROX. 500 FT.) OF THE APPROACH, THE AIRSPEED INCREASED TO AROUND 68 KNOTS AND THE RATE OF DESCENT DECREASED LEAVING US HIGH ON THE GLIDE PATH.

Flight 51-1:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	> SLIGHT	> SLIGHT	MODERATE	MODERATE	GREAT	GREAT
PRECISION	FAIR	FAIR	POOR	POOR	VERY POOR	VERY POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET:

COMMENTS: AS PILOT'S GAIN INCREASES NEAR FINAL PORTION OF APPROACH, HE OVERCONTROLS AND HENCE I.A.S. AND VERTICAL VELOCITY EXCURSIONS INCREASE. THIS LEADS TO LARGE AND FREQUENT POWER INPUTS.

6 BREAKOUT AND FLARE

	Flight 62-1	Flight 51-1
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	FAIR

COMMENTS (51-1): AIRSPEED, HOWEVER, WAS LOW.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

(51-1): COUPLED AIRSPEED AND POWER BUT NOT TOO SUCCESSFULLY.

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

9 LEAST OBJECTIONABLE FEATURES

(51-1): GOOD PITCH DYNAMICS.

10 MOST OBJECTIONABLE FEATURES

(62-1): TOO MUCH COUPLING BETWEEN AIRSPEED AND VERTICAL SPEED.

(51-1): PRECISE CONTROL OF AIRSPEED AND VERTICAL SPEED NOT POSSIBLE ON FINAL APPROACH - LARGE THRUST INPUTS REQUIRED.

11 MISCELLANEOUS

CONFIGURATION A1-3L
FLIGHT NUMBER 101-3
PILOT B
PILOT-RATING 4½C

WIND (knots) 10
WIND SHEAR SMALL
EXTERNAL TURBULENCE LIGHT

CHARACTERISTIC ROOTS

-.21 ±	.11	-1.06 ±	1.031

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	± 4 knots			± 200 fpm		

COMMENTS

DIFFICULTY DUE TO HEIGHT RESPONSE TO CONTROL INPUTS BEING A LITTLE SLOW. ALSO SOME NORMAL FORCE DUE TO AIRSPEED CHANGES.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED	SMALL	
EASE OF COMPENSATION	SLIGHT	DIFFICULTY

COMMENTS

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
PRECISION	FAIR	FAIR	FAIR	FAIR	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: OK

COMMENTS

BROKE OUT AT 150 FT. REASON FOR DIFFICULTY UNKNOWN. SPEED CONTROL NOT AS GOOD AS MIGHT HAVE BEEN EXPECTED WITH THIS LARGE AMOUNT OF ATTITUDE STABILITY. PERHAPS SPEED CHANGES WERE DUE TO THRUST INPUTS.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	SLIGHT	DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR/GOOD	

COMMENTS:

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE

9 LEAST OBJECTIONABLE FEATURES

GOOD PITCH STABILITY BUT TOO GOOD (TIME CONSTANT TOO SHORT AND GEARING OF STICK TO PITCH ATTITUDE TOO HIGH).

10 MOST OBJECTIONABLE FEATURES

NOTICEABLE PITCHING MOMENT DUE TO THRUST CHANGES (I THINK THAT AFTER SEEING MODEL AP-3 THAT THE SPEED AND HEIGHT CONTROL PROBLEMS ON DESCENT WERE LARGELY DUE TO THIS).

11 MISCELLANEOUS

ELEVATOR CONTROL FORCES HIGH FOR THIS LEVEL OF PITCH STABILITY - DIFFICULT TO CHANGE PITCH ATTITUDE AND HENCE SPEED.

CONFIGURATION
FLIGHT NUMBER
PILOT
PILOT RATING

WIND (knots)
WIND SHEAR
EXTERNAL TURBULENCE

CHARACTERISTIC ROOTS

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = (rad/sec²)/in		$Z_{\delta T}$ = (ft/sec²)/in	
Initial	Final	Initial	Final

Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
VMC	IMC	IMC	VMC	IMC	IMC
OUT	OUT	IN	OUT	OUT	IN
knots			fpm		

AMPLITUDE	PERIOD	DAMPING

SOURCE	DEGREE

	DIFFICULTY

Intercept & initial track		Intermediate track		Final track	
Glide path	Localizer	Glide path	Localizer	Glide path	Localizer

	DIFFICULTY

	Flight 61-2	Flight 48-1
CONFIGURATION	R4	R4
FLIGHT NUMBER	61-2	48-1
PILOT	A	C
PILOT-RATING	3	3
WIND (knots)	5	15
WIND SHEAR	NEGLIGIBLE	NEGLIGIBLE
EXTERNAL TURBULENCE	LIGHT	MODERATE
CHARACTERISTIC ROOTS	-.04 / -.62 / -1.06± 1.06 i	-.04 / -.62 / -1.06± 1.06 i

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR (61-2)		THRUST LEVER (61-2)		ELEVATOR (48-1)		THRUST LEVER (48-1)	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in		$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ - 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

Flight 61-2:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	knots			fpm		

Flight 48-1:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	±5 knots			± 300 fpm		

COMMENTS:

Flight 48-1: DEVELOPED SINK RATE ON TURNING ON TO LOCALIZER - RATHER SLOW TO CORRECT WHILE MAINTAINING AIRSPEED

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE (61-2)	PERIOD (61-2)	DAMPING (61-2)	AMPLITUDE (48-1)	PERIOD (48-1)	DAMPING (48-1)
PITCH	ZERO			ZERO		HIGH
HEAVE	ZERO			ZERO		

	SOURCE (61-2)	DEGREE (61-2)	SOURCE (48-1)	DEGREE (48-1)
EXCITATION				
CONTROL:				

COMMENTS:

Flight 48-1: NO NOTICEABLE LONGITUDINAL OSCILLATORY BEHAVIOUR

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 61-2	Flight 48-1
CHANGE REQUIRED	NEGLIGIBLE	MODERATE
EASE OF COMPENSATION:	NO DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS

Flight 48-1: DIFFICULTY TO DETECT EARLY ANY SINK TENDENCY

5. FLIGHT PATH CONTROL

Flight 61-2:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	NONE	SLIGHT	NONE	SLIGHT	>MODERATE	SLIGHT
PRECISION		GOOD		GOOD	VERY POOR	GOOD

Flight 48-1:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	SLIGHT	SLIGHT	SLIGHT	SLIGHT	MODERATE	SLIGHT
PRECISION	FAIR	FAIR	GOOD	GOOD	FAIR	GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: Flight 61-2: 500; Flight 48-1: —

COMMENTS

Flight 61-2: I THINK THAT I BECAME OVER CONFIDENT SINCE THE MODEL HAD BEEN SO PLEASANT AND, AT AROUND 500 ft., I LOST THE GLIDE PATH AND WENT TOO HIGH FOR A COMFORTABLE APPROACH TO THE TOUCH DOWN POINT

6. BREAKOUT AND FLARE

	Flight 61-2	Flight 48-1
EASE OF ARRESTING RATE OF DESCENT	MODERATE DIFFICULTY	NONE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	POOR	GOOD

COMMENTS:

Flight 61-2: SEE SECTION # 5

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

Flight 61-2: NONE

Flight 48-1: SMALL: DIFFICULT TO ASSESS, BUT TENDENCY TO UNDERBANK WHEN MAKING LARGE HEADING CHANGES.

9. LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES

Flight 48-1: PROBABLY CONSIDERABLE LACK OF HARMONY BETWEEN LONGITUDINAL AND LATERAL/DIRECTIONAL CONTROLS

11. MISCELLANEOUS

Flight 61-2: THIS IS THE FIRST MODEL THAT I HAVE FELT AS THOUGH I REALLY COULD LEARN TO FLY AND LIKE.

Flight 48-1: ELEVATOR FORCES WERE TOO HIGH AND DISPLACEMENTS TOO SMALL. COMPARATIVELY PLEASANT MODEL BUT STILL REQUIRES CONSIDERABLE CONCENTRATION TO FLY TASK WITH PRECISION.

	Flight 38-1	Flight 40-1
CONFIGURATION	R4L	R4L
FLIGHT NUMBER	38-1	40-1
PILOT	B	D
PILOT-RATING	3C	3½
WIND (knots)	10-15	15-20
WIND SHEAR		MODERATE
EXTERNAL TURBULENCE		MODERATE

CHARACTERISTIC ROOTS

Flight				
38-1	-.04	-.52	1.06±	1.06i
40-1	-.04	-.62	1.06±	1.06i

AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY / RESPONSE:

Flight	ELEVATOR		THRUST LEVER	
38-1	$M_{\delta E}$ = 0.39 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
	SLIGHTLY GREAT	SATISFACTORY	SATISFACTORY	SATISFACTORY
40-1	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
	SATISFACTORY	SATISFACTORY	SLIGHTLY SMALL	SLIGHTLY GREAT

2 EASE OF MAINTAINING DESIRED VELOCITIES

Flight 38-1

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	NONE	NONE	NONE	NONE	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	±5 knots			±200 fpm		

COMMENTS: NOTICEABLE RESPONSE IN HEAVE TO TURBULENCE - DID NOT ATTEMPT TO CONTROL RATE OF DESCENT FOR TURBULENCE UPSETS. THE ±200 fpm FIGURE IS NOT MEANINGFUL.

Flight 40-1

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	>MODERATE	SLIGHT	> SLIGHT	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	+8, -10 knots			±100 fpm		

COMMENTS: ATTITUDE CONTROL POOR DUE TO LACK OF PILOT PROFICIENCY. OVER-CONTROL IN POWER

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	Flight 38-1			Flight 40-1		
	AMPLITUDE	PERIOD	DAMPING	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO			SMALL	MEDIUM	MODERATE
HEAVE	ZERO			ZERO		

	Flight 38-1		Flight 40-1	
	SOURCE	DEGREE	SOURCE	DEGREE
EXCITATION				
CONTROL				

COMMENTS: (40-1) NO PIO TENDENCY

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 38-1	Flight 40-1
CHANGE REQUIRED	NEGLIGIBLE	MODERATE
EASE OF COMPENSATION	NONE DIFFICULTY	MODERATE DIFFICULTY

COMMENTS: (40-1) DIFFICULTY DUE TO OVERCONTROL

5 FLIGHT PATH CONTROL

Flight		Intercept & initial track		Intermediate track		Final track	
		Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
38-1	DIFFICULTY	NONE	NONE	NONE	NONE	SLIGHT	SLIGHT
38-1	PRECISION	GOOD	GOOD	GOOD	GOOD	FAIR/GOOD	FAIR/GOOD
40-1	DIFFICULTY	NONE	NONE	SLIGHT	SLIGHT	GREAT	GREAT
40-1	PRECISION	GOOD	GOOD	FAIR	FAIR	POOR	POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: (38-1) OK

COMMENTS:

(38-1) FIRST MODEL OF DAY - POSSIBLE WIND SHEAR BUT THIS WAS NOT A FACTOR IN THE RATING

(40-1) DIFFICULTY PROBABLY DUE TO PILOT'S LOW PROFICIENCY COUPLED WITH HIGH WIND AND WIND SHEAR

6 BREAKOUT AND FLARE

	Flight 38-1	Flight 40-1
EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY	NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR/GOOD	FAIR

COMMENTS: (38-1) SEEMED TO PIO A BIT IN THE FLARE WITH RESPECT TO THRUST LEVER AND HEIGHT.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: (38-1) NONE; (40-1) NONE

9 LEAST OBJECTIONABLE FEATURES

(38-1) STATICALLY STABLE - NOT AS MUCH ATTENTION REQUIRED TO PITCH ATTITUDE

(40-1) GOOD DAMPING ALL AXES.

10 MOST OBJECTIONABLE FEATURES

(38-1) MODERATE TURBULENCE RESPONSE BUT NOT BAD. SOME PITCH ATTITUDE UPSETS NOTICED WITH TURBULENCE BUT NOT DIFFICULT TO CONTROL. HEAVE UPSETS FROM THE TURBULENCE WERE, FOR THE MOST PART, RIDDEN OUT WITH LITTLE, BUT SOME ATTEMPT, TO CONTROL WITH THRUST LEVER.

(40-1) OVERCONTROL TENDENCY BELOW 500 Ft. PROBABLY PILOT PROFICIENCY IS STILL LOW.

11 MISCELLANEOUS

(38-1) ELEVATOR TRIM RATE TOO FAST.

(40-1) OVERALL IT WAS NOT A BAD CONFIGURATION. I GUESS MOST OF THE POOR PERFORMANCE CAN BE BLAMED ON PILOT PROFICIENCY. (NOTE, THE PILOT HAD NOT FLOWN ON THIS PROJECT FOR 17 DAYS.)

	Flight 79-1	Flight 80-2
CONFIGURATION	A4L	A4L
FLIGHT NUMBER	79-1	80-2
PILOT	A	B
PILOT-RATING	5	5½B
WIND (knots)	CALM	5
WIND SHEAR	NEGLIGIBLE	
EXTERNAL TURBULENCE	NEGLIGIBLE	
CHARACTERISTIC ROOTS	-.04, -.62, 1.06 ± 1.06i	-.04, -.62, 1.06 ± 1.06i

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY / RESPONSE (Flight 79-1):

ELEVATOR $M_{\delta E}$ = 0.34 (rad/sec²)/in		THRUST LEVER $Z_{\delta T}$ = 15.0 (ft/sec²)/in	
Initial	Final	Initial	Final
SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

CONTROL SENSITIVITY / RESPONSE (Flight 80-2):

ELEVATOR $M_{\delta E}$ = 0.34 (rad/sec²)/in		THRUST LEVER $Z_{\delta T}$ = 15.0 (ft/sec²)/in	
Initial	Final	Initial	Final
		SATISFACTORY	

2 EASE OF MAINTAINING DESIRED VELOCITIES

Flight 79-1:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	SLIGHT	MODERATE	NONE	NONE	NONE
MAXIMUM UNDESIRED FLUCTUATIONS	+8, -5 knots			O K fpm		

COMMENTS: ON THE THIRD APPROACH, THE TURBULENCE SEEMED TO BE MORE OF A PROBLEM, AND THIS RESULTED IN AIRSPEED EXCURSIONS.

Flight 80-2:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	NONE	NONE	NONE	NONE	NONE
MAXIMUM UNDESIRED FLUCTUATIONS	5 knots			GOOD fpm		

3 RESIDUAL OSCILLATORY CHARACTERISTICS

Flight 79-1:

	AMPLITUDE	PERIOD	DAMPING
PITCH	SMALL	SHORT	LOW
HEAVE			

	SOURCE	DEGREE
EXCITATION	ELEVATOR, TURBULENCE	MODERATELY
CONTROL		

COMMENTS: THE TURBULENCE GAVE BUMPS THAT SEEMED TO START A FEW CYCLES OF THE OSCILLATION GOING, BUT THE MOST SEVERE EXCITATION OCCURRED WHEN LEVELLING OFF AT THE END OF THE APPROACH. THIS IS A FEATURE THAT MAY BE LEARNABLE BUT IT WAS THE DECIDING FACTOR IN DE-RATING THE MODEL.

Flight 80-2:

	AMPLITUDE	PERIOD	DAMPING
PITCH	SMALL	SHORT	ZERO
HEAVE	MODERATE	SHORT	ZERO

	SOURCE	DEGREE
EXCITATION	ELEVATOR, THRUST LEVER	MODERATE
CONTROL	ELEVATOR, THRUST LEVER	AGGRAVATING

COMMENTS: COULD BE EXCITED IN THE LANDING AND FLARE MANOEUVRE.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 79-1	Flight 80-2
CHANGE REQUIRED	SMALL	NEGLIGIBLE
EASE OF COMPENSATION	NO DIFFICULTY	NO DIFFICULTY

COMMENTS

5. FLIGHT PATH CONTROL

Flight 79-1:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	SLIGHT	NONE	SLIGHT	SLIGHT
PRECISION	GOOD	GOOD	FAIR	GOOD	FAIR	GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: —

COMMENTS: ASSESSMENT ABOVE IS FOR LAST APPROACH.

Flight 80-2:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	> SLIGHT	NONE	NONE	NONE	NONE
PRECISION	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 300

COMMENTS: DIFFICULTY ON LOCALIZER DUE TO WIND SHEAR BUT, ONCE RECOGNIZED, IT CAUSED NO REAL PROBLEM - IT DID NOT AFFECT RATING. THE BREAKOUT HEIGHT WAS CHOSEN TO ENABLE GOOD STEADY STATE CONDITIONS TO BE ESTABLISHED FOR TOUCHDOWN.

6 BREAKOUT AND FLARE

	Flight 79-1	Flight 80-2
EASE OF ARRESTING RATE OF DESCENT	MODERATE DIFFICULTY	MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	VERY POOR	FAIR
COMMENTS	SEE SECTION #3.	P.I.O. TENDENCY DURING FLARE - HAD TO ESTABLISH A GLIDE PATH WHICH HAD A REASONABLE RATE OF DESCENT WHICH COULD THEN BE CARRIED RIGHT ON TO TOUCH DOWN. ATTEMPTS TO ARREST RATE OF DESCENT SHOULD NOT BE MADE.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

	Flight 79-1	Flight 80-2
EFFECT ON FINAL ASSESSMENT	SMALL	NONE.

9 LEAST OBJECTIONABLE FEATURES

Flight 79-1: THE PITCH ATTITUDE CONTROL WAS A GREAT HELP IN MAINTAINING AIRSPEED BUT IT WAS DEGRADED BY
(1) THE OSCILLATORY PROBLEMS,
(2) THE REQUIREMENT TO TRIM. THIS WAS NOT A REAL PROBLEM SINCE IT WAS LIKE TRIMMING AIRSPEED.

Flight 80-2: WORKLOAD ON DESCENT VERY LOW - GOOD PITCH ATTITUDE AND ANGLE OF ATTACK STABILITY EVEN IN TURBULENCE. BUT, I SUSPECT THAT LOOP IS TOO TIGHT ON ANGLE OF ATTACK.

10 MOST OBJECTIONABLE FEATURES

Flight 80-2: DEFINITE PIO TENDENCY NEAR GROUND AND SOME IN AIR FOR MODERATE SIZED, FAST INPUTS.

11 MISCELLANEOUS

Flight 79-1: MODEL WAS FLOWN TWICE WITH APPROACH HEADING OF 290 AND THEN WITH 040°.

Flight 80-2: SENSITIVITY ON ELEVATOR COULD BE REDUCED ~20%. VERY GOOD MODEL ON GLIDE PATH TESTS - GLIDE PATH RATING 3B BUT PIO TENDENCY NOT GOOD AS IT CAUSES AN ABNORMAL (BUT FEASIBLE) LANDING TECHNIQUE

	Flight 83-1		Flight 96-1	
CONFIGURATION	A4L	WIND (knots) 10	A4L	WIND (knots) 0
FLIGHT NUMBER	83-1	WIND SHEAR SMALL	96-1	WIND SHEAR NEGLIGIBLE
PILOT	B	EXTERNAL TURBULENCE LIGHT	C	EXTERNAL TURBULENCE NEGLIGIBLE
PILOT-RATING	4C		5	

CHARACTERISTIC ROOTS

Flight				
83-1	-.04	-.62	1.06 ±	1.061
96-1	-.04	-.62	1.06 ±	1.061

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE (83-1)	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY
RESPONSE (96-1)	TOO GREAT	SATISFACTORY	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (83-1)	NONE	NONE	NONE	NONE	NONE	NONE
MAXIMUM UNDESIRED FLUCTUATIONS (83-1)	± 8 knots			0 K fpm		
DIFFICULTY (96-1)	NONE	NONE	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (96-1)	-8, +2 knots			? fpm		

COMMENTS:

83-1: VERY GOOD FOR HOLDING VELOCITIES - SO GOOD THAT THE CROSSCHECK ON IAS WAS ALLOWED TO BECOME DEFICIENT AND IAS HOLDING ON GLIDE PATH WAS NOT AS GOOD AS EXPECTED.

96-1: SOME VELOCITY AND HEIGHT CHANGES DURING TURNS, OTHERWISE LITTLE PROBLEM.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH (83-1)	ZERO		
HEAVE (83-1)	ZERO		
PITCH (96-1)	SMALL	SHORT	LOW
HEAVE (96-1)	ZERO		

	SOURCE	DEGREE
EXCITATION (83-1)		
CONTROL (83-1)		
EXCITATION (96-1)	ELEVATOR, TURBULENCE	EASILY
CONTROL (96-1)	NOT ATTEMPTED	

COMMENTS

96-1: SMALL, LIGHTLY DAMPED PITCH OSCILLATION PREVENTS RAPID AND ACCURATE MANOEUVRING.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	83-1	96-1
CHANGE REQUIRED:	NEGLIGIBLE	SMALL
EASE OF COMPENSATION:	NO DIFFICULTY	MODERATE DIFFICULTY

COMMENTS:

96-1: GAINED HEIGHT IN TURNS AND LOST ≤ 10 KNOTS.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY (83-1)	NONE	NONE	NONE	NONE	NONE	NONE
PRECISION (83-1)	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD
DIFFICULTY (96-1)	NONE	SLIGHT	NONE	NONE	SLIGHT	SLIGHT
PRECISION (96-1)						

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

83-1: O K IF YOU CAN STAY ON COURSE.

COMMENTS

83-1: 1900 FT. OF DESCENT AT A MEAN RATE OF 600 f.p.m. DUE TO MODERATE HEADWIND. - THREE MINUTE TRACKING TASK WHICH IS TOO LONG A PERIOD OF SUSTAINED HIGH WORKLOAD.

6. BREAKOUT AND FLARE

	83-1	96-1
EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY	MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR/GOOD	FAIR

COMMENTS

83-1: DIFFICULTY DUE TO LEARNING COORDINATION OF ELEVATOR AND THRUST LEVER.

96-1: PITCH OSCILLATION UNPLEASANT CLOSE TO GROUND DURING FLARE. IT INHIBITS FIRM ACTION.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

83-1: NONE

96-1: NONE

9. LEAST OBJECTIONABLE FEATURES

83-1: GOOD u, V, θ HOLD (STABILITY) GOOD SEPARATION OF CONTROLS/RESPONSE TURBULENCE SENSITIVITY MINIMAL.

96-1: RELATIVELY LITTLE ATTENTION REQUIRED TO MAINTAIN SPEED AND RATE OF DESCENT (TURNS EXCEPTED).

10. MOST OBJECTIONABLE FEATURES

83-1: COCKPIT DISPLAYS FOR TASK ACCOMPLISHMENT.

96-1: LIGHTLY DAMPED PITCH OSCILLATION.

11. MISCELLANEOUS

83-1: BIGGEST RESERVATION HERE IS NOT WITH RESPECT TO HANDLING QUALITIES, BUT THE INSTRUMENT APPROACH AND DISPLAY SYSTEM, BREAKOUT HEIGHT ETC. WOULD BE RATED 3 TO 3½ WITH A 300'-400' BREAKOUT HEIGHT.

96-1: ELEVATOR FORCES WERE TOO HIGH AND DISPLACEMENTS TOO SMALL.

CONFIGURATION	A4-IL	CONFIGURATION	A4-IL
FLIGHT NUMBER	131-4	FLIGHT NUMBER	129-1
PILOT	A	PILOT	B
PILOT-RATING	3	PILOT-RATING	4C
WIND (knots)	10	WIND (knots)	5
WIND SHEAR	MODERATE	WIND SHEAR	NEGLIGIBLE
EXTERNAL TURBULENCE	NEGLIGIBLE	EXTERNAL TURBULENCE	NEGLIBIBLE

CHARACTERISTIC ROOTS (131-4): -.03 | -.65 | -1.05 ± 1.06i

CHARACTERISTIC ROOTS (129-1): -.03 | -.65 | -1.05 ± 1.06i

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	131-4 Elevator		131-4 Thrust lever		129-1 Elevator		129-1 Thrust lever	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.3 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in		$M_{\delta E}$ = 0.3 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

Flight 131-4

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	SLIGHT	SLIGHT	NONE	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	± 5 knots			± 200 fpm		

Flight 129-1

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	NONE	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	+8, -7 knots			fpm		

COMMENTS:

131-4: THE ATTITUDE COMMAND SYSTEM SEEMED TO WORK WELL IN GIVING THE DESIRED AIRSPEED, BUT SOMEWHAT TOO MUCH ATTENTION IS STILL REQUIRED.

129-1: GOOD ATTITUDE AND SPEED TRIM IN CRUISE. SPEED CONTROL NOT SO GOOD ON APPROACH (SLIGHT TO MODERATE DIFFICULTY DURING THIS PHASE).

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	131-4 AMPLITUDE	PERIOD	DAMPING	129-1 AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO			ZERO		
HEAVE	ZERO			ZERO		

	131-4 SOURCE	DEGREE	129-1 SOURCE	DEGREE
EXCITATION:				
CONTROL:				

COMMENTS

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	131-4	129-1
CHANGE REQUIRED	NEGLIGIBLE	NEGLIGIBLE
EASE OF COMPENSATION:	NO DIFFICULTY	NO DIFFICULTY

COMMENTS:

5. FLIGHT PATH CONTROL

Flight 131-4

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
PRECISION	FAIR	FAIR	POOR	FAIR	FAIR	FAIR

Flight 129-1

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	NONE	NONE	NONE	NONE
PRECISION	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 200 (131-4); — (129-1)

COMMENTS

131-4: A FOLLOWING WIND REQUIRED HIGH (UP TO 1500 f.p.m.) RATES OF DESCENT BUT THESE WERE FAIRLY EASILY SELECTED.

129-1: SPEED CONTROL ON APPROACH NOT AS GOOD AS MIGHT BE EXPECTED IN LIGHT OF HIGH PITCH ATTITUDE STABILITY, PERHAPS DUE TO TRYING TO MAKE GLIDE SLOPE CORRECTIONS WITH ATTITUDE, HENCE SPEED. SPEED ERRORS OFTEN OCCURRED (PERSISTED) AND WERE DIFFICULT TO CORRECT.

6 BREAKOUT AND FLARE

	131-4	129-1
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	POOR

COMMENTS

129-1: DIFFICULTY DUE TO UNEXPECTEDLY GOING HIGH AT BREAKOUT. PULLED OFF POWER TO GET DOWN AND FOUND I NEEDED LOTS TO ARREST THE RESULTING HIGH SINK RATE - BALLOONED, AND LANDED LONG.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT — 131-4: SMALL

9 LEAST OBJECTIONABLE FEATURES

131-4: GOOD ATTITUDE HOLD

129-1: TURBULENCE UPSETS NOT BAD
PITCH ATTITUDE VERY STABLE - GOOD FOR CRUISE AND EASY TO TRIM BUT, DURING MANOEUVRES IT IS DIFFICULT TO CHANGE SPEED.

10. MOST OBJECTIONABLE FEATURES

11 MISCELLANEOUS

129-1: EXCEPT FOR PROBLEM AFTER BREAKOUT WHERE AN UNEXPECTED AMOUNT OF POWER WAS NEEDED. THRUST LEVER CHARACTERISTICS SEEMED QUITE GOOD.

	Flight 66-2		Flight 45-3	
CONFIGURATION	R4-2	WIND (knots): CALM	R4-2	WIND (knots)
FLIGHT NUMBER	66-2	WIND SHEAR: SMALL	45-3	WIND SHEAR
PILOT	A	EXTERNAL TURBULENCE: NEGLIGIBLE	B	EXTERNAL TURBULENCE
PILOT-RATING	4		3C	

CHARACTERISTIC ROOTS

Flight 66-2	-.02	-.67	-1.06	± 1.041
Flight 45-3	-.02	-.67	-1.06	± 1.041

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY (66-2)	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE (66-2)	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY
CONTROL SENSITIVITY (45-3)	$M_{\delta E}$ = 0.25 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE (45-3)	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	MODERATE	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	+5, -10 knots			0 K fpm		

COMMENTS: UNTIL GOING UNDER THE HOOD THE PITCH ATTITUDE SEEMED TO BE QUITE SOLID BUT, WITH THE ADDITION OF I.F.R. AND TURBULENCE THE WANDER BECAME BOTHERSOME TO A POINT AT WHICH I WAS WORKING TOO HARD FOR MY LIKING.

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	NONE	NONE	NONE	NONE	NONE
MAXIMUM UNDESIRED FLUCTUATIONS	± 10 knots			fpm		

COMMENTS: IF SPEED WAS OTHER THAN 60 KNOTS, IT WAS DUE TO COMPLACENCY AND BEING ABLE TO RELAX.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH (66-2)	ZERO		
HEAVE (66-2)	ZERO		
PITCH (45-3)	ZERO		
HEAVE (45-3)	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	66-2	45-3
CHANGE REQUIRED	SMALL	NEGLIGIBLE
EASE OF COMPENSATION	SLIGHT DIFFICULTY	DIFFICULTY

COMMENTS

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY (66-2)	SLIGHT	SLIGHT	SLIGHT	MODERATE	SLIGHT	MODERATE
PRECISION (66-2)	FAIR		FAIR		FAIR	
DIFFICULTY (45-3)	NONE	NONE	NONE	NONE	NONE	NONE
PRECISION (45-3)	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: (66-2) ALTITUDE ___; (45-3) O K

COMMENTS: (45-3) CONTINUED DESCENT TO 150 FT BEFORE BREAKOUT.

6. BREAKOUT AND FLARE

	66-2	45-3
EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY	NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR	GOOD

COMMENTS: THERE SEEMED TO BE A TENDENCY TO START INTO A SLIGHT CLIMB AS THE AIRCRAFT WAS LEVELLED BUT THIS PORTION WAS ALL OVER SO FAST THAT NOT TOO MUCH IMPORTANCE CAN BE ATTRIBUTED TO IT.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: (45-3) NONE

9. LEAST OBJECTIONABLE FEATURES

(45-3) GOOD PITCH ATTITUDE STABILITY
GOOD RESISTANCE TO TURBULENCE.

10. MOST OBJECTIONABLE FEATURES

(45-3) TOO MUCH 'S' TURNING DOWN LOCALIZER - A DISPLAY DEFICIENCY RATHER THAN ANYTHING ELSE BUT ACCURACY GOOD.

11. MISCELLANEOUS

(66-2) THE AIRCRAFT SEEMED TO PITCH NOSE-UP WHEN DESCENDING FROM 2300 FT TO 1900 FT, BUT THIS DID NOT CAUSE PROBLEMS ON THE FINAL APPROACH.

(45-3) NEED BETTER PREDICTOR DISPLAY FOR LOCALIZER DEVIATIONS.

CONFIGURATION R4-2L
FLIGHT NUMBER 126-3
PILOT C
PILOT-RATING 3

WIND (knots) 5-10
WIND SHEAR SMALL
EXTERNAL TURBULENCE LIGHT

CHARACTERISTIC ROOTS

-.02	-.67	-1.06 ±	1.04i

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	SLIGHT	SLIGHT	SLIGHT	SLIGHT	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	5 knots			f.p.m.		

COMMENTS: THE ONLY REAL DIFFICULTY IN ACCELERATION TO AND HOLDING 70 KNOTS, HAD TO FALL BACK TO 60 KNOTS TO STABILIZE IN LEVEL FLIGHT, EXTERNAL TURBULENCE PROBABLY HAVING SOME EFFECT.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL:		

COMMENTS

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: SMALL
EASE OF COMPENSATION: SLIGHT DIFFICULTY

COMMENTS: NECESSARY TO COMPENSATE FOR SPEED VARIATIONS USING POWER LEVEL.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	SLIGHT	NONE	NONE	NONE	SLIGHT	NONE
PRECISION	FAIR	GOOD	GOOD	GOOD	FAIR	GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET:

COMMENTS: SLIGHTLY HIGH ON GLIDE PATH AT BREAKOUT (200') PICKED UP SPEED TO 65 KNOTS WHEN VMC.

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: GOOD

COMMENTS: SPEED SLIGHTLY HIGH

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER: ON INTERMEDIATE TRACK, USED POWER LEVER AS LEAD CONTROL IN POSITIONING FORWARD OR AFT OF GLIDE PATH.

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE

9. LEAST OBJECTIONABLE FEATURES

ABILITY TO HOLD SPEED WAS QUITE GOOD BUT PERHAPS COULD BE FURTHER IMPROVED?

10. MOST OBJECTIONABLE FEATURES

11. MISCELLANEOUS

EXTERNAL TURBULENCE BECOMING NOTICEABLE - PARTICULARLY AT HIGH POWER SETTINGS - EG, 70 KNOTS TURNING TO BASE LEG. THIS WAS THE LAST MODEL OF THE DAY.

CONFIGURATION
FLIGHT NUMBER
PILOT
PILOT-RATING

WIND (knots)
WIND SHEAR
EXTERNAL TURBULENCE

CHARACTERISTIC ROOTS

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = (rad/sec²)/in		$Z_{\delta T}$ = (ft/sec²)/in	
Initial	Final	Initial	Final

Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
VMC	IMC	IMC	VMC	IMC	IMC
OUT	OUT	IN	OUT	OUT	IN
knots			f.p.m.		

AMPLITUDE	PERIOD	DAMPING

SOURCE	DEGREE

DIFFICULTY

Intercept & initial track		Intermediate track		Final track	
Glide path	Localizer	Glide path	Localizer	Glide path	Localizer

DIFFICULTY

	Flight 108-2	Flight 95-1
CONFIGURATION	A4-2L	A4-2L
FLIGHT NUMBER	108-2	95-1
PILOT	A	B
PILOT-RATING	3	3½
WIND (knots)	10	8
WIND SHEAR	SMALL	
EXTERNAL TURBULENCE	NEGLIGIBLE	
CHARACTERISTIC ROOTS	-.02, -.67, -1.06, ±1.041	-.02, -.67, -1.06, ±1.041

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY / RESPONSE:

Flight	ELEVATOR $M_{\delta E} = 0.34$ (rad/sec²)/in Initial	ELEVATOR Final	THRUST LEVER $Z_{\delta T} = 15.0$ (ft/sec²)/in Initial	THRUST LEVER Final
108-2	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY
95-1	SLIGHTLY GREAT	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

Flight 108-2:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	SLIGHT	SLIGHT	NONE	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	+10, -5 knots			O K fpm		

COMMENTS: TURBULENCE WAS EVIDENT IN HEAVE AND YAW BUT DID NOT CAUSE CONCERN IN PITCH BECAUSE OF STRONG ATTITUDE STIFFNESS.

Flight 95-1:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	+10, -4 knots			O K fpm		

COMMENTS: DIFFICULTY DUE TO CROSS-CHECK, THE MODEL IS OK.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

Flight		AMPLITUDE	PERIOD	DAMPING
108-2	PITCH	ZERO		
108-2	HEAVE	ZERO		
95-1	PITCH	ZERO		
95-1	HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 108-2	Flight 95-1
CHANGE REQUIRED	NEGLIGIBLE	VERY SMALL
EASE OF COMPENSATION	NO DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS:

Flight 108-2: LONGITUDINAL CONTROL FORCES IN STEADY TURNS SOMEWHAT ANNOYING.

Flight 95-1: NO NEED TO PAY ATTENTION. HOWEVER, ONE CAN ACTUALLY TRIM A STEADY STATE 20° BANKED TURN.

5 FLIGHT PATH CONTROL

Flight		Intercept & initial track Glide path	Intercept & initial track Localizer	Intermediate track Glide path	Intermediate track Localizer	Final track Glide path	Final track Localizer
108-2	DIFFICULTY:	NONE	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
108-2	PRECISION	GOOD	FAIR	FAIR	FAIR	FAIR	FAIR
95-1	DIFFICULTY:	NONE	NONE	SLIGHT	NONE	SLIGHT	SLIGHT
95-1	PRECISION	GOOD	GOOD	GOOD	GOOD	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: (108-2) — ; (95-1) O K

COMMENTS:

Flight 95-1: DIFFICULTY DUE TO FACT THAT EVEN WITH THE GOOD PITCH STABILITY, SPEED ERRORS DEVELOPED, PROBABLY BY UNCONCIOUSLY PUTTING NOSE DOWN TO GET DOWN ON GLIDE PATH. SOME NORMAL FORCE DEVELOPS WITH SPEED CHANGES

6 BREAKOUT AND FLARE

	Flight 108-2	Flight 95-1
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	FAIR/GOOD

COMMENTS

Flight 95-1: BROKE OUT A LITTLE LOW AT 150 FT. POSITIONING OK.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

Flight 108-2: SMALL. SOME TURBULENCE EFFECTS, BUT NOT A FACTOR IN RATING.

Flight 95-1: NONE.

9 LEAST OBJECTIONABLE FEATURES

Flight 95-1: GOOD ATTITUDE STABILITY, CONTROL SENSITIVITY.

10 MOST OBJECTIONABLE FEATURES

Flight 108-2: HIGH CONTROL FORCES IN PITCH DURING SUSTAINED TURNS. TURBULENCE IN HEAVE.

Flight 95-1: A LITTLE SENSITIVE TO TURBULENCE, BUT NOT BAD AT ALL.

11 MISCELLANEOUS

Flight 108-2: ELEVATOR TRIM RATE TOO SLOW.

Flight 95-1: NB NO ARTIFICIAL TURBULENCE DURING THIS EVALUATION. TIME CONSTANT FOR PITCH RESPONSE TO ELEVATOR COULD BE JUST A LITTLE LONGER. NEEDS SOME DISPLAY IMPROVEMENT. COMPARISON WITH MODEL 19-2NL SHOWS IMPROVED LOCALIZER TRACKING WITH IMPROVED LONGITUDINAL DYNAMICS.

CONFIGURATION A4-2L　　WIND(knots) 0-5
FLIGHT NUMBER 99-1　　WIND SHEAR
PILOT C　　EXTERNAL TURBULENCE
PILOT-RATING 3

CHARACTERISTIC ROOTS

-.02	-.67	-1.06	±1.041

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.34	(rad/sec²)/in	$Z_{\delta T}$ = 15.0	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	SLIGHT	SLIGHT	NONE	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	±5		knots			fpm

COMMENTS

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED	NEGLIGIBLE	
EASE OF COMPENSATION	SLIGHT	DIFFICULTY

COMMENTS: SPEED CONTROL NOT BETTER THAN ±5 KNOTS.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	NONE	NONE	SLIGHT	NONE
PRECISION						

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

COMMENTS

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	SLIGHT	DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	

COMMENTS: DESCENT ARRESTED, BUT ALLOWED SPEED TO FALL TO 50 KNOTS.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT　NONE

9. LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES

11. MISCELLANEOUS

BEST MODEL THIS DAY, (cf. A4L, 4-2L, 2-2L)
WOULD PREFER SLIGHTLY BETTER SPEED CONTROL DURING MANOEUVRES.

CONFIGURATION　　WIND(knots)
FLIGHT NUMBER　　WIND SHEAR
PILOT　　EXTERNAL TURBULENCE
PILOT-RATING

CHARACTERISTIC ROOTS

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ =	(rad/sec²)/in	$Z_{\delta T}$ =	(ft/sec²)/in
Initial	Final	Initial	Final

Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
VMC	IMC	IMC	VMC	IMC	IMC
OUT	OUT	IN	OUT	OUT	IN
		knots			fpm

AMPLITUDE	PERIOD	DAMPING

SOURCE	DEGREE

	DIFFICULTY

Intercept & initial track		Intermediate track		Final track	
Glide path	Localizer	Glide path	Localizer	Glide path	Localizer

	DIFFICULTY

	Flight 72-3	Flight 97-2
CONFIGURATION	R4-3L	R4-3L
FLIGHT NUMBER	72-3	97-2
PILOT	A	B
PILOT-RATING	8	7½D
WIND (knots)		
WIND SHEAR	MODERATE	SMALL
EXTERNAL TURBULENCE	NEGLIGIBLE < 1100'; SMALL > 1100'	LIGHT
CHARACTERISTIC ROOTS	+.02, -.76, -1.08 ± 1.05i	+.02, -.76, -1.08 ± 1.05i

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY (72-3)	$M_{\delta E}$ = .35 (rad/sec²)/in		$Z_{\delta T}$ = 15 (ft/sec²)/in	
CONTROL SENSITIVITY (97-2)	$M_{\delta E}$ = .34 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE (72-3)	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY
RESPONSE (97-2)	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (72-3)	MODERATE	GREAT	GREAT	MODERATE	GREAT	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS (72-3)	± 5 → 10 knots			± 300 fpm		
DIFFICULTY (97-2)	SLIGHT	SLIGHT	MODERATE	SLT/MOD	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS (97-2)	+12, -9 knots			± 300 fpm		

COMMENTS:

72-3: THE INTERACTION BETWEEN AIRSPEED AND VERTICAL SPEED IS MOST DISCONCERTING. AS THE AIRSPEED FALLS OFF, THE THRUST FALLS OFF, THE RATE OF DESCENT INCREASES, THE AIRSPEED FALLS OFF MORE, ETC. CONSTANT ATTENTION IS REQUIRED TO BOTH PITCH ATTITUDE AND VERTICAL SPEED TO PREVENT THIS UNSTABLE SITUATION FROM GETTING AWAY.

97-2: LARGE EFFECT OF AIRSPEED ON NORMAL FORCES POOR ATTITUDE STABILITY (NONE).

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE (72-3)	PERIOD (72-3)	DAMPING (72-3)	AMPLITUDE (97-2)	PERIOD (97-2)	DAMPING (97-2)
PITCH	ZERO			ZERO		
HEAVE	ZERO			ZERO		

	SOURCE (72-3)	DEGREE (72-3)	SOURCE (97-2)	DEGREE (97-2)
EXCITATION				
CONTROL				

COMMENTS

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	72-3	97-2
CHANGE REQUIRED	LARGE	NEGLIGIBLE
EASE OF COMPENSATION	GREAT DIFFICULTY	NO/SLIGHT DIFFICULTY

COMMENTS:

72-3: IT WAS EXTREMELY DIFFICULT TO RETAIN AIRSPEED AND ALTITUDE IN THE TURNS FOR THE REASONS GIVEN UNDER #2.

97-2: MUST ENSURE THAT SPEED IS HELD.

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY (72-3)	SLIGHT	SLIGHT	MODERATE	MODERATE	MODERATE	MODERATE
PRECISION (72-3)	FAIR	FAIR	POOR	POOR	POOR	POOR
DIFFICULTY (97-2)	NO/SLIGHT	NO/SLIGHT	SLIGHT	SLIGHT	MODERATE	SLIGHT
PRECISION (97-2)	GOOD	GOOD	GOOD	GOOD	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500 (72-3); 300 (97-2)

COMMENTS:

72-3: SEE SECTION #2. EVERY TIME THE AIRSPEED FELL OFF, THE BOTTOM FELL OUT AND THE RATE OF DESCENT WHISTLED UP.

97-2: (1) TENDENCY TO TRACK GLIDE PATH ERRORS WITH PITCH RESULTED IN (2) SPEED ERRORS WHICH RESULTED IN (3) HEIGHT CONTROL PROBLEMS. i.e., SPEED AND THEREFORE HEIGHT CONTROL IS DIFFICULT.

6 BREAKOUT AND FLARE

	72-3	97-2
EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY	MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	POOR

COMMENTS:

97-2: UNCONSCIOUSLY FLARED ON BREAKOUT WHICH GAVE SPEED LOSS AND LARGE UNWANTED DESCENT RATE - DIFFICULT, BUT ABLE TO CORRECT.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

72-3: NONE

97-2: TOO DIFFICULT TO DO OTHER THAN TO AIM TO HOLD SPEED AT 60 KNOTS AND TO CONTROL RATE OF DESCENT WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

72-3: SMALL. TOO MUCH HEADING CHANGE WITH SMALL RUDDER INPUTS

97-2: NONE

9 LEAST OBJECTIONABLE FEATURES

10 MOST OBJECTIONABLE FEATURES

11 MISCELLANEOUS

97-2: (1) LACK OF ATTITUDE STABILITY GAVE SPEED ERRORS.
(2) SPEED ERRORS CAUSED GLIDE SLOPE TRACKING ERRORS.

Z_u EFFECT COULD CAUSE PROBLEMS NEAR TOUCHDOWN AND IN FLARE.
REQUIRED 1100 fpm ON DESCENT TWICE.

CONFIGURATION R4-3L
FLIGHT NUMBER 103-2
PILOT C
PILOT-RATING 3½
WIND (knots) 5
WIND SHEAR NEGLIGIBLE
EXTERNAL TURBULENCE NEGLIGIBLE

CHARACTERISTIC ROOTS			
+.02	-.75	-1.08 ±	1.05i

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	SLIGHT	SLIGHT	NONE	SLIGHT	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	± 2 knots			300 fpm		

COMMENTS: DIFFICULTY DUE TO LARGE THRUST CORRECTIONS REQUIRED TO RESPOND TO SPEED DEPARTURES.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION:		
CONTROL:		

COMMENTS:

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: MODERATE
EASE OF COMPENSATION: SLIGHT DIFFICULTY

COMMENTS: OVERCOMPENSATED WITH THRUST LEVER WHEN EXECUTING TURNS. THRUST USED TO CORRECT FOR SPEED RATHER THAN BANK.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	SLIGHT	NONE	NONE	NONE	MODERATE	SLIGHT
PRECISION	GOOD	GOOD	GOOD	GOOD		

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

COMMENTS: SOME LOSS OF SPEED (ABOUT 10 KNOTS) ON FINAL - RECOVERED ON FLARE.

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: GOOD

COMMENTS: DIFFICULTY DUE TO NEED TO CORRECT FOR 10 KNOT LOSS OF SPEED ON FINAL.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE

9. LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES: SMALL SPEED DEPARTURES REQUIRED RATHER LARGE POWER LEVEL CORRECTIONS. IF THESE WERE NOT MADE HEIGHT WOULD BE LOST OR GAINED.

11. MISCELLANEOUS: REASONABLE CONFIGURATION TO FLY, BUT CONSTANT ATTENTION TO POWER LEVER TO PREVENT HEIGHT CHANGES WHEN CORRECTING FOR SPEED DEPARTURES A NUISANCE.

CONFIGURATION R4-3L
FLIGHT NUMBER 121-3
PILOT C
PILOT-RATING 7
WIND (knots) 5
WIND SHEAR
EXTERNAL TURBULENCE

CHARACTERISTIC ROOTS			
+.02	-.75	-1.08 ±	1.05i

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 15 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	TOO SMALL	NOT ASSESSABLE	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	MODERATE	MODERATE	MODERATE	GREAT	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	± 10 knots			fpm		

COMMENTS: RELATIVELY SMALL SPEED DEPARTURES REQUIRED COMPENSATION BY THROTTLE TO AVOID EXCESSIVE MANIFOLD PRESSURE OR HEIGHT LOSS.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH			
HEAVE			

	SOURCE	DEGREE
EXCITATION:		
CONTROL:		

COMMENTS: NO DISCERNIBLE OSCILLATORY CHARACTERISTICS, BUT SOME EXTERNAL TURBULENCE WAS PRESENT AND THIS COULD HAVE OBSCURED THEM.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED:
EASE OF COMPENSATION: DIFFICULTY

COMMENTS: THRUST COMPENSATION REQUIRED FOR SPEED CHANGES WAS OVERRIDING.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	GREAT	MODERATE	SLIGHT	SLIGHT	MODERATE	MODERATE
PRECISION	VERY POOR	FAIR	GOOD	GOOD	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

COMMENTS: DIFFICULTY DUE TO CONSIDERABLE HEIGHT LOSS TURNING ON TO BASE LEG AND FURTHER LOSS BEFORE GLIDE PATH WAS ATTAINED.

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: SLIGHT/MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: FAIR

COMMENTS: LARGE STICK AND THROTTLE INPUTS REQUIRED.

7. CONTROL TECHNIQUE

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE

9. LEAST OBJECTIONABLE FEATURES: NO NOTICEABLE OSCILLATIONS.

10. MOST OBJECTIONABLE FEATURES: VERY DIFFICULT TO HOLD A PARTICULAR SPEED OR TO SELECT AND HOLD A DIFFERENT SPEED

11. MISCELLANEOUS

CONFIGURATION	R4-3	WIND (knots)	10-15
FLIGHT NUMBER	47-1	WIND SHEAR	MODERATE
PILOT	D	EXTERNAL TURBULENCE	MODERATE
PILOT-RATING	9		

CHARACTERISTIC ROOTS

+.02	-.76	-1.08 ±	1.051

CONFIGURATION		WIND (knots)	
FLIGHT NUMBER		WIND SHEAR	
PILOT		EXTERNAL TURBULENCE	
PILOT-RATING			

CHARACTERISTIC ROOTS

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 30 (rad/sec²)/in		$Z_{\delta T}$ = 15 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	TOO GREAT	TOO GREAT	TOO SMALL	TOO GREAT

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = (rad/sec²)/in		$Z_{\delta T}$ = (ft/sec²)/in	
Initial	Final	Initial	Final

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	MOD/GREAT	GREAT	MODERATE	MOD/GREAT	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	> 10 knots			> 500 fpm		

Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
VMC	IMC	IMC	VMC	IMC	IMC
OUT	OUT	IN	OUT	OUT	IN
knots			fpm		

COMMENTS

OBVIOUSLY ON BACKSIDE OF POWER-REQUIRED CURVE. UNLESS AIRSPEED WAS MAINTAINED VERY CLOSE TO THE TRIM POINT, PILOT WAS IN TROUBLE.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

AMPLITUDE	PERIOD	DAMPING

SOURCE	DEGREE

COMMENTS

NO PARTICULAR OSCILLATORY PROBLEMS BUT DUE TO DIFFICULTY IN CONTROLLING AIRSPEED, THERE APPEARED TO BE PITCH AND HEIGHT DYNAMICS PROBLEMS.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED	EXCESSIVE
EASE OF COMPENSATION	GREAT DIFFICULTY

DIFFICULTY

COMMENTS

IF SPEED WAS KEPT CONSTANT NO PROBLEMS AROSE BUT, ONCE THE PILOT STARTED USING POWER TO COUNTERACT EFFECTS OF AIRSPEED CHANGES, HE WAS IN TROUBLE AND LARGE THRUST INPUTS WERE REQUIRED.

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	MODERATE	MODERATE	GREAT	GREAT	GREAT	GREAT
PRECISION	POOR	POOR	POOR/ VERY POOR	POOR/ VERY POOR	VERY POOR	VERY POOR

Intercept & initial track		Intermediate track		Final track	
Glide path	Localizer	Glide path	Localizer	Glide path	Localizer

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

COMMENTS:

AIRSPEED CONTROL REQUIRED MOST OF PILOT'S TIME AND HENCE OTHER VARIABLES SUFFERED.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR

DIFFICULTY

COMMENTS:

AIRSPEED CONTROL WAS MAIN CAUSE OF DIFFICULTY. INITIALLY SPEED WAS SLIGHTLY LOW. THIS SET UP AN INCREASING RATE OF DESCENT AND CONSEQUENTLY A LARGER POWER INPUT WAS REQUIRED TO ARREST RATE OF DESCENT.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE

9 LEAST OBJECTIONABLE FEATURES: FAIR PITCH RESPONSE CHARACTERISTICS

10 MOST OBJECTIONABLE FEATURES: THE LARGE POWER CHANGES REQUIRED AND THE NEED FOR VERY PRECISE AIRSPEED CONTROL OVERBURDENED THE PILOT.

11 MISCELLANEOUS: I DO NOT LIKE IT AT ALL.

	Flight 80-3	Flight 96-4
CONFIGURATION	A4-3L	A4-3L
FLIGHT NUMBER	80-3	96-4
PILOT	A	B
PILOT-RATING	5	5B
WIND (knots)	LIGHT	10
WIND SHEAR	SMALL	SMALL
EXTERNAL TURBULENCE	NEGLIGIBLE	LIGHT
CHARACTERISTIC ROOTS	+.02, -.76, -1.08 ± 1.05i	+.02, -.76, -1.08 ± 1.05i

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	Flight 80-3	Flight 96-4
CONTROL SENSITIVITY — ELEVATOR	$M_{\delta E}$ = .34 (rad/sec²)/in	$M_{\delta E}$ = .34 (rad/sec²)/in
CONTROL SENSITIVITY — THRUST LEVER	$Z_{\delta T}$ = 15.0 (ft/sec²)/in	$Z_{\delta T}$ = 15.0 (ft/sec²)/in
RESPONSE — ELEVATOR Initial	SATISFACTORY	SATISFACTORY
RESPONSE — ELEVATOR Final	SATISFACTORY	SATISFACTORY
RESPONSE — THRUST LEVER Initial	SATISFACTORY	SATISFACTORY
RESPONSE — THRUST LEVER Final	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

Flight 80-3:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	NONE	NONE	NONE	NONE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	± 2 - 3 knots			± 300 fpm		

COMMENTS: THE TURBULENCE PRODUCED A 'RIDING THE SWELLS' EFFECT WHICH CHANGED THE VERTICAL VELOCITY SIGNIFICANTLY AND WAS THE ONLY OBJECTIONABLE PART OF THIS MODEL.

Flight 96-4:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	± 6 knots			fpm		

COMMENTS: HAD TO PAY CLOSER ATTENTION TO SPEED BECAUSE OF AIRSPEED EFFECTS ON NORMAL FORCES.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

Flight 80-3:

	AMPLITUDE	PERIOD	DAMPING
PITCH			
HEAVE	LARGE	LONG	MODERATE

	SOURCE	DEGREE
EXCITATION	TURBULENCE	EASILY
CONTROL	THRUST LEVER	EFFECTIVE

COMMENTS: SEE PART 2.

Flight 96-4:

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 80-3	Flight 96-4
CHANGE REQUIRED	MODERATE	SMALL
EASE OF COMPENSATION	SLIGHT DIFFICULTY	SLIGHT DIFFICULTY
COMMENTS		NEED TO HOLD SPEED PRECISELY IN ORDER TO BEST HOLD HEIGHT.

5 FLIGHT PATH CONTROL

Flight 80-3:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	MODERATE	SLIGHT	SLIGHT	MODERATE
PRECISION	GOOD	GOOD	POOR	FAIR	GOOD	VERY POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET:

COMMENTS: THE WIND CHANGE IN THE LAST 600→700 FT REQUIRED ABOUT 20° OF HEADING CHANGE. THIS WAS NOT CAUGHT IN TIME AND THE LOCALIZER NEEDLE WAS HARD OVER TO LEFT AT BREAKOUT. THIS WAS NOT TOO DISCONCERTING SINCE THE HANDLING QUALITIES WERE QUITE GOOD ENOUGH FOR THE SIDESTEP MANOEUVRE.

Flight 96-4:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	SLIGHT	SLIGHT	SLIGHT	SLIGHT
PRECISION	GOOD	GOOD	FAIR	FAIR	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 300

COMMENTS: 200 FT; JUST NOT ENOUGH TIME TO ASSESS GLIDE PATH AND SITUATION AT BREAKOUT. DIFFICULTY DUE MAINLY TO NORMAL FORCES GENERATED BY AIRSPEED CHANGES.

6 BREAKOUT AND FLARE

	Flight 80-3	Flight 96-4
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	SLIGHT/MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	GOOD/FAIR

COMMENTS (Flight 96-4): NEED TO CLOSELY MONITOR SPEED DURING LAST 200 FT. WENT HIGH AT BREAK OUT, USED A HIGHER THAN WANTED DESCENT RATE AND NEEDED MORE THRUST THAN EXPECTED TO ARREST IT. MUST NOT LOSE SPEED!!

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

Flight 96-4: IF ERROR WAS SUCH THAT A CHANGE IN SPEED GAVE AN APPROPRIATE CHANGE IN RATE OF DESCENT, I USED THIS, BUT NEVER UNLESS BOTH SPEED AND HEIGHT ERRORS WERE IN CORRECT SENSE.

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT — Flight 80-3: SMALL; Flight 96-4: NONE

9 LEAST OBJECTIONABLE FEATURES

Flight 80-3: THE AIRSPEED CONTROL THROUGH THE ATTITUDE CONTROL SYSTEM WAS VERY FINE.

10. MOST OBJECTIONABLE FEATURES

Flight 80-3: THE HEAVE RESPONSE TO TURBULENCE.

Flight 96-4: THE EFFECT OF NORMAL FORCE VARIATIONS WITH SPEED ON GLIDE PATH TRACKING TASK - PITCH STABILITY DID NOT HELP THAT MUCH.
LOCALIZER TASK STILL SOMEWHAT DEGRADED.

11 MISCELLANEOUS

Flight 96-4: PILOT RATING OF 5B BECAUSE OF NEED TO HOLD SPEED PRECISELY FOR GOOD GLIDE PATH PERFORMANCE.
NB - NO ARTIFICIAL TURBULENCE DURING THIS EVALUATION.

CONFIGURATION A4-3L
FLIGHT NUMBER L14-2
PILOT B
PILOT-RATING 4½D

WIND(knots) 8
WIND SHEAR SMALL
EXTERNAL TURBULENCE LIGHT

CHARACTERISTIC ROOTS

+.02	-.76	-1.08 ±	1.051

CONFIGURATION
FLIGHT NUMBER
PILOT
PILOT-RATING

WIND (knots)
WIND SHEAR
EXTERNAL TURBULENCE

CHARACTERISTIC ROOTS

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.30	(rad/sec²)/in	$Z_{\delta T}$ = 15.0	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	SATISFACTORY	TOO SMALL	SATISFACTORY

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ =	(rad/sec²)/in	$Z_{\delta T}$ =	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE				

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	± 8		knots			fpm

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY						
MAXIMUM UNDESIRED FLUCTUATIONS			knots			fpm

COMMENTS: TOO STIFF IN PITCH.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

	AMPLITUDE	PERIOD	DAMPING
PITCH			
HEAVE			

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: SMALL
EASE OF COMPENSATION: SLIGHT DIFFICULTY

CHANGE REQUIRED:
EASE OF COMPENSATION: DIFFICULTY

COMMENTS: MUST MAINTAIN SPEED DURING MANOEUVRES OR A HEIGHT LOSS WILL ENSUE.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	NONE	NONE	SLIGHT	SLIGHT
PRECISION	GOOD	GOOD	FAIR	FAIR	FAIR	FAIR

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY						
PRECISION						

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 300

COMMENTS: SPEED CHANGES DIFFICULT - HAD TO USE LARGE AMOUNTS OF CONTROL TO ADJUST SPEED, EVEN 5 KNOTS, AT A FAST ENOUGH RATE. LOW ON GLIDE SLOPE AT BREAKOUT - REGAINED AT MINIMUMS BUT THEN WENT HIGH.

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: FAIR

EASE OF ARRESTING RATE OF DESCENT: DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT:

COMMENTS: GOOD HEIGHT CONTROL.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

9. LEAST OBJECTIONABLE FEATURES: GOOD HEIGHT CONTROL.

10. MOST OBJECTIONABLE FEATURES: TOO STABLE - DIFFICULT TO CONTROL CHANGES. THE HIGH AMOUNT OF STABILITY REQUIRES ANY CONTROL INPUTS TO HAVE TO BE CLOSELY MONITORED TO ENSURE THEIR EFFECT. SENSITIVE TO TURBULENCE ESPECIALLY IN HEAVE, CAUSING BOTHERSOME ENGINE SURGES.

11. MISCELLANEOUS

CONFIGURATION	R19L	WIND(knots)	5
FLIGHT NUMBER	64-1	WIND SHEAR	MODERATE
PILOT	A	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	2		

CHARACTERISTIC ROOTS: | -.04 | -.50 | -1.05± | 1.081 |

CONFIGURATION	R19L	WIND(knots)	CALM
FLIGHT NUMBER	52-2	WIND SHEAR	MODERATE
PILOT	B	EXTERNAL TURBULENCE	LIGHT/MODERATE
PILOT-RATING	4½C		

CHARACTERISTIC ROOTS: | -.04 | -.5 | -1.05± | 1.081 |

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	TOO SMALL	SATISFACTORY	TOO SMALL

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	SLIGHT	SLIGHT	NONE	NONE	NONE
MAXIMUM UNDESIRED FLUCTUATIONS	+5, 0 knots			0 K fpm		

COMMENTS: ONLY DIFFICULTY IS THAT DUE TO AIRSPEED CONTROL ON INSTRUMENTS BEING SOMEWHAT OF A PROBLEM.

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	+10, -4 knots			? fpm		

COMMENTS: MODERATE DIFFICULTY WAS EXPERIENCED IN CONTROLLING RATE OF DESCENT ON APPROACH BECAUSE OF WIND SHEAR.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION:		
CONTROL:		

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION:		
CONTROL:		

COMMENTS

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Pilot A	Pilot B
CHANGE REQUIRED	SMALL	SMALL
EASE OF COMPENSATION:	NO DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
PRECISION	GOOD	FAIR	FAIR	FAIR	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET:

COMMENTS: SOME PROBLEMS WERE ENCOUNTERED DUE TO THE WIND SHEAR WHICH REQUIRED A HEADING CHANGE OF ABOUT 40° ON THE APPROACH.

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	NONE	NONE	MODERATE	SLIGHT
PRECISION	GOOD	GOOD	FAIR/GOOD	GOOD	FAIR	GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 400

COMMENTS: DIFFICULTY DUE TO WIND SHEAR - HEADWIND CHANGING TO A TAIL WIND DOWN LOW.

6. BREAKOUT AND FLARE

	Pilot A	Pilot B
EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY	VERY SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR	FAIR/GOOD

COMMENTS: UNCERTAIN ABOUT THRUST LEVER CHARACTERISTICS BUT THERE PROBABLY WAS NOT A VALID CAUSE FOR THIS. OTHER PROBLEMS DUE TO WIND SHEAR.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE

9. LEAST OBJECTIONABLE FEATURES

REASONABLE BUT A STRANGE KIND OF PITCH ATTITUDE STABILITY.

10. MOST OBJECTIONABLE FEATURES

HEIGHT CONTROL NOT VERY EFFECTIVE FOR SHEAR SITUATION ENCOUNTERED.

11. MISCELLANEOUS

	Left evaluation	Right evaluation
CONFIGURATION	R19L	R19L
FLIGHT NUMBER	55-2	86-1
PILOT	B	C
PILOT-RATING	4D	3
WIND (knots)	CALM	10-15
WIND SHEAR	SMALL	SMALL
EXTERNAL TURBULENCE	MODERATE	LIGHT
CHARACTERISTIC ROOTS	-.04 | -.50 | -1.05 ± 1.08i	-.04 | -.50 | -1.05 ± 1.08i

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR Initial	ELEVATOR Final	THRUST LEVER Initial	THRUST LEVER Final
CONTROL SENSITIVITY (left)	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
RESPONSE (left)	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY
CONTROL SENSITIVITY (right)	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
RESPONSE (right)	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS) VMC	IMC	IMC	Vertical velocity (h) VMC	IMC	IMC
TURBULENCE (left)	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (left)	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (left)	±8 knots			O K fpm		
TURBULENCE (right)	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (right)	NONE	SLIGHT	SLIGHT	NONE	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (right)	±5 knots			fpm		

COMMENTS

Left: DIFFICULTY DUE TO CROSS-CHECK AND TURBULENCE.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH (left)	ZERO		
HEAVE (left)	ZERO		
PITCH (right)	ZERO		
HEAVE (right)	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

Right: NO NOTICEABLE OSCILLATION.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Left	Right
CHANGE REQUIRED	NEGLIGIBLE	SMALL
EASE OF COMPENSATION	NO DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS

Right: DIFFICULTY DUE TO NEED FOR THRUST CHANGE NOT BEING IMMEDIATELY EVIDENT.

5. FLIGHT PATH CONTROL

	Intercept & initial track: Glide path	Localizer	Intermediate track: Glide path	Localizer	Final track: Glide path	Localizer
DIFFICULTY (left)	SLIGHT	NONE	NONE	NONE	MODERATE	SLIGHT
PRECISION (left)	GOOD	GOOD	FAIR	FAIR/GOOD	FAIR	FAIR
DIFFICULTY (right)	SLIGHT	NONE	SLIGHT	NONE	MODERATE	SLIGHT
PRECISION (right)	FAIR	GOOD	FAIR	GOOD	POOR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

COMMENTS

Left: DIFFICULTIES DUE TO: (1) CROSS-CHECK, (2) SOME WIND SHEAR, (3) QUITE SENSITIVE TO TURBULENCE. SPEED CONTROL WAS NOT BAD BUT I DID GET TO 70 KNOTS ONCE.

Right: SOME WIND SHEAR AFFECTING GLIDE SLOPE ADHERENCE. SOME SMALL LATERAL AND DIRECTIONAL OUT-OF-TRIM REDUCED LOCALIZER PRECISION.

6. BREAKOUT AND FLARE

	Left	Right
EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY	NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR/GOOD	GOOD

COMMENTS

Left: SLIGHTLY LOW AT BREAKOUT. FAIRLY REASONABLE CONTROL OVER RATE OF DESCENT WITH THRUST LEVER.

Right: SPEED WAS 70 KNOTS AT START OF FLARE TO CORRECT FOR HIGH POSITION ON GLIDE PATH.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

Left: NONE. MODERATE EXTERNAL TURBULENCE, LOOSE DIRECTIONALLY.

Right: MODERATE: LATERAL FORCES THOUGHT TO BE RATHER HIGH AND LATERAL TRIM RATE A BIT FAST.

9. LEAST OBJECTIONABLE FEATURES

Left: CONTROL OF RATE OF DESCENT WITH THRUST LEVER WAS PRETTY GOOD. SOME PITCH ATTITUDE STABILITY WAS PRESENT.

Right: NO UNEXPECTED LONGITUDINAL OR HEAVE RESPONSES.

10. MOST OBJECTIONABLE FEATURES

Left: MODERATELY SUSCEPTIBLE TO VERTICAL TURBULENCE.

Right: SEE NOTE ON LATERAL/DIRECTIONAL CHARACTERISTICS ABOVE.

11. MISCELLANEOUS

Left: SLIGHT TAIL WIND AT SURFACE.

Right: ONE OF THE BETTER MODELS. BELIEVE FINAL APPROACH PERFORMANCE WOULD IMPROVE WITH PRACTICE ON THIS MODEL. EXTERNAL TURBULENCE PRESENT BUT EFFECTS THOUGHT TO BE MINOR ON THIS MODEL.

CONFIGURATION R19
FLIGHT NUMBER 41-1
PILOT D
PILOT-RATING 6½

WIND (knots) 15-20
WIND SHEAR SMALL
EXTERNAL TURBULENCE LIGHT

CHARACTERISTIC ROOTS

-.04	-.50	-1.05 ±	1.081

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = .34 (rad/sec²)/in		$Z_{\delta T}$ = 15 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	TOO SMALL	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	N
DIFFICULTY	SLIGHT	MODERATE	>MODERATE	SLIGHT	SLIGHT	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	± 10 knots			300 fpm		

COMMENTS: THERE SEEMS TO BE A COUPLING BETWEEN THRUST LEVER AND PITCH ATTITUDE AND I.A.S.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS: HAD DIFFICULTY MAINTAINING DESIRED PITCH ATTITUDE WHEN MANOEUVRING AND APPLYING THRUST. - NO PARTICULAR TENDENCY TO P.I.O.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED	MODERATE/LARGE	
EASE OF COMPENSATION	MODERATE	DIFFICULTY

COMMENTS: DIFFICULTY DUE TO COUPLING BETWEEN PITCH ATTITUDE AND THRUST LEVER.

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	MODERATE	MODERATE	GREAT	MODERATE	GREAT	GREAT
PRECISION	FAIR	POOR	POOR	POOR	VERY POOR	VERY POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

COMMENTS

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	SLIGHT	DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	POOR	

COMMENTS

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER: HARD TO COORDINATE THRUST CONTROL AND PITCH ATTITUDE (WHEN MAKING LARGE CORRECTIONS, I HAD TROUBLE CONTROLLING IAS AND PITCH ATTITUDE).

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE

9 LEAST OBJECTIONABLE FEATURES: GOOD DAMPING IN PITCH - NO PIO TENDENCY.

10 MOST OBJECTIONABLE FEATURES: DIFFICULTY IN CONTROLLING I.A.S. AND GLIDE PATH.

11 MISCELLANEOUS

CONFIGURATION
FLIGHT NUMBER
PILOT
PILOT-RATING
WIND (knots)
WIND SHEAR
EXTERNAL TURBULENCE
CHARACTERISTIC ROOTS
ELEVATOR $M_{\delta E}$ = (rad/sec²)/in Initial Final
THRUST LEVER $Z_{\delta T}$ (ft/sec²)/in Initial Final
Longitudinal velocity (IAS) VMC IMC IMC OUT OUT IN knots
Vertical velocity (ḣ) VMC IMC IMC OUT OUT IN fpm
AMPLITUDE PERIOD DAMPING
SOURCE DEGREE
DIFFICULTY
Intercept & initial track Intermediate track Final track
Glide path Localizer Glide path Localizer Glide path Localizer
DIFFICULTY

	Flight 131-2		Flight 128-2
CONFIGURATION	R19-1L	CONFIGURATION	R19-1L
FLIGHT NUMBER	131-2	FLIGHT NUMBER	128-2
PILOT	A	PILOT	B
PILOT-RATING	3½	PILOT-RATING	3½C
WIND (knots)		WIND (knots)	5
WIND SHEAR	MODERATE	WIND SHEAR	NEGLIGIBLE
EXTERNAL TURBULENCE	NEGLIGIBLE	EXTERNAL TURBULENCE	NEGLIGIBLE

CHARACTERISTIC ROOTS

Flight				
131-2	-.04	-.51	-1.05 ±	1.081
128-2	-.04	-.51	-1.05 ±	1.081

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY / RESPONSE:

Flight	ELEVATOR $M_{\delta E}$ = 0.3 (rad/sec²)/in Initial	ELEVATOR Final	THRUST LEVER $Z_{\delta T}$ = 15.0 (ft/sec²)/in Initial	THRUST LEVER Final
131-2	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY
128-2	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

Flight 131-2:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	SLIGHT	SLIGHT	NONE	SLIGHT	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	±7 – 8 knots			±200 fpm		

Flight 128-2:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	NONE	NONE	NONE	NONE	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	±[illegible] knots			±200 fpm		

COMMENTS:

Flight 131-2: A STEADY ELEVATOR INPUT RESULTED IN A PITCH RATE BUT THIS PRESENTED LITTLE DIFFICULTY IN AIRSPEED CONTROL. TURBULENCE PRODUCED A NOTICEABLE BUT NOT A BOTHERSOME EFFECT - ESPECIALLY NOTICEABLE IN YAW.

Flight 128-2: SOME TURBULENCE UPSETS IN PITCH AND HEAVE, BUT NOT SIGNIFICANT.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

Flight		AMPLITUDE	PERIOD	DAMPING
131-2	PITCH	ZERO		
131-2	HEAVE	ZERO		
128-2	PITCH	ZERO		
128-2	HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS:

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

Flight	CHANGE REQUIRED	EASE OF COMPENSATION
131-2	SMALL	NO DIFFICULTY
128-2	NEGLIGIBLE	NO DIFFICULTY

COMMENTS:

5. FLIGHT PATH CONTROL

Flight		Intercept & initial track Glide path	Intercept & initial track Localizer	Intermediate track Glide path	Intermediate track Localizer	Final track Glide path	Final track Localizer
131-2	DIFFICULTY	MODERATE	NONE	MODERATE	NONE	SLIGHT	NONE
131-2	PRECISION	POOR	GOOD	POOR	GOOD	FAIR	GOOD
128-2	DIFFICULTY	SLIGHT	NONE	NONE	NONE	SLIGHT	SLIGHT
128-2	PRECISION						

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: Flight 131-2: 300; Flight 128-2: O K

COMMENTS:

Flight 131-2: ON INITIAL GLIDE PATH INTERCEPTION WE WENT HIGH AND A SURPRISINGLY LOW THRUST HAD TO BE SELECTED (APPROX. 6?%) TO GET THE AIRCRAFT DESCENDING AT ABOUT 1000 F.P.M. APPROX. 1300 F.P.M. WAS USED AND A MEAN OF ABOUT 1000 F.P.M. WAS NECESSARY.

Flight 128-2: GLIDE PATH DIFFICULTY DUE TO BEING LATE, LOCALIZER TO TENDENCY TO 'S' TURN SLIGHTLY.ONE DOES NOT HAVE MUCH TIME TO 'DECIDE' TO LAND FROM A BREAKOUT HEIGHT OF 300 FT.

6. BREAKOUT AND FLARE

Flight	EASE OF ARRESTING RATE OF DESCENT	PRECISION OF ATTAINING TOUCHDOWN POINT
131-2	NO DIFFICULTY	GOOD
128-2	NO DIFFICULTY	GOOD

COMMENTS:

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: Flight 131-2: SMALL; Flight 128-2: NONE

9. LEAST OBJECTIONABLE FEATURES

Flight 128-2: PITCH AND SPEED CONTROL QUITE SATISFACTORY THRUST LEVER SENSITIVITY SATISFACTORY, GOOD.

10. MOST OBJECTIONABLE FEATURES

11. MISCELLANEOUS

Flight 131-2: THERE MAY HAVE BEEN A SLIGHT FOLLOWING WIND. 1000 F.P.M. ON DESCENT.

Flight 128-2: THRUST LEVER SENSITIVITY MUCH LOWER THAN A6I, AND WAS OK! PITCH RESPONSE TO ELEVATOR APPEARED TO BE A WEAK TO MODERATE PITCH ATTITUDE STABILITY WITH AN UNDERLYING WEAK DIVERGENCE?? QUITE REASONABLE ANYHOW. MOTIVATED TO DRIVE AIRCRAFT IN SAME WAY AS R6L.

	Flight 65-1	Flight 93-2
CONFIGURATION	R19-2L	R19-2L
FLIGHT NUMBER	65-1	93-2
PILOT	A	B
PILOT RATING	3	5D
WIND (knots)	ALMOST CALM	CALM
WIND SHEAR	MODERATE	SMALL
EXTERNAL TURBULENCE	NEGLIGIBLE	NEGLIGIBLE
CHARACTERISTIC ROOTS	-.03, -.51, -1.05 ± 1.07i	-.03, -.51, -1.05 ± 1.07i

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

		ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY		$M_{\delta E}$ = 0.34 (rad/sec^2)/in		$Z_{\delta T}$ = 15.0 (ft/sec^2)/in	
		Initial	Final	Initial	Final
RESPONSE:	65-1	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY
RESPONSE:	93-2	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

		Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION		VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE		OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	65-1	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	65-1	±10 knots			OK fpm		
DIFFICULTY	93-2	SLIGHT	SLIGHT	>SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	93-2	+10, -5 knots			±200 fpm		

COMMENTS

65-1: THERE WAS A HINT OF SINK WITH DECREASING AIRSPEED AND VICE VERSA, BUT THIS WAS NOT SERIOUS.

93-2: DIFFICULTY DUE TO THRUST EFFECTS ON PITCH ATTITUDE, ALTHOUGH NOT AS MUCH AS CONFIGURATION 1-2L.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

		AMPLITUDE	PERIOD	DAMPING
PITCH	65-1	ZERO		
HEAVE	65-1	ZERO		
PITCH	93-2	ZERO		
HEAVE	93-2	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	65-1	93-2
CHANGE REQUIRED:	NEGLIGIBLE	NEGLIGIBLE
EASE OF COMPENSATION	NO DIFFICULTY	NO DIFFICULTY

COMMENTS

5 FLIGHT PATH CONTROL

		Intercept & initial track		Intermediate track		Final track	
		Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	65-1	SLIGHT	SLIGHT	SLIGHT	SLIGHT	MODERATE	SLIGHT
PRECISION	65-1	FAIR	FAIR	FAIR	FAIR	POOR	FAIR
DIFFICULTY:	93-2	NONE	SLIGHT	SLIGHT	SLIGHT	MODERATE	SLIGHT
PRECISION	93-2	GOOD	GOOD	FAIR	FAIR	POOR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 65-1: —; 93-2: 300

COMMENTS

65-1: I SUNK FAIRLY LOW ON THE GLIDE PATH AT THE VERY END BUT 200 FT AGL APPEARED TO ALLOW PLENTY OF CLEARANCE TO EFFECT THE MANOEUVRES REQUIRED TO GET TO THE LANDING SPOT.

93-2: DIFFICULTY DUE TO: (1) POWER CHANGES AFFECT PITCH AND SPEED, (2) SOME TAIL WIND ON APPROACH, THIS RESULTED IN A DESCENT RATE OF 1200 F.P.M. ONCE FROM AN AVERAGE OF 900 F.P.M.

6 BREAKOUT AND FLARE

	65-1	93-2
EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY	SLIGHT/MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR	FAIR/GOOD

COMMENTS:

65-1: THE AIRCRAFT SEEMED TO BALLOON SOMEWHAT AS THE TOUCHDOWN SPOT WAS APPROACHED. (THE AIRCRAFT WAS BEING ACCELERATED AT THAT TIME.)

93-2: DIFFICULTY DUE TO RATE OF DESCENT NOT RESPONDING AS QUICKLY TO POWER INCREASE AS ANTICIPATED. HOWEVER, TOUCHDOWN AND FLARE WERE OK.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

93-2: NONE

9 LEAST OBJECTIONABLE FEATURES

93-2: ATTITUDE STABILITY HELPS.

10 MOST OBJECTIONABLE FEATURES

93-2: NEED TO RETRIM EVERY TIME THE POWER CHANGES SIGNIFICANTLY.

11 MISCELLANEOUS

93-2: SENSITIVE TO TURBULENCE IN HEAVE AND PITCH. TAIL WIND DID NOT AFFECT RATING. TRIM RATE TOO FAST (NEED TO TRIM A LOT DUE TO THRUST EFFECT ON PITCH - TRIM RATE SLIGHTLY TOO FAST FOR THIS CONFIGURATION AND 1-2L).

CONFIGURATION R19-2
FLIGHT NUMBER 44-3
PILOT D
PILOT-RATING 6
WIND (knots) 5-10
WIND SHEAR MODERATE
EXTERNAL TURBULENCE MODERATE

CHARACTERISTIC ROOTS

-.03	-.51	-1.05±	1.07i

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SLIGHTLY SMALL	SLIGHTLY LARGE	SLIGHTLY SMALL	SLIGHTLY LARGE

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	>SLIGHT	SLIGHT	>SLIGHT	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	5 TO 10 knots			±200 fpm		

COMMENTS: DIFFICULTY DUE TO LAGS IN INITIAL RESPONSE.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	VERY SMALL		
HEAVE	VERY SMALL		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS: AIRCRAFT FELT SLIGHTLY SLUGGISH IN PITCH AND IN HEIGHT CONTROL.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED	SMALL/MODERATE
EASE OF COMPENSATION	SLIGHT/MODERATE DIFFICULTY

COMMENTS

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	NONE	>SLIGHT	>SLIGHT	MODERATE	MODERATE
PRECISION	FAIR	FAIR	FAIR	FAIR	POOR	POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

COMMENTS: DIFFICULTY DUE TO OVERCONTROL WITH THRUST LEVER. ALSO I BELIEVE PILOT FATIGUE IS A FACTOR. GUESS I AM SATURATED.

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR

COMMENTS

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE.

9. LEAST OBJECTIONABLE FEATURES: ATTITUDE CONTROL WAS FAIR.

10. MOST OBJECTIONABLE FEATURES: POWER MANIPULATION WAS SOMEWHAT EXCESSIVE - POSSIBLY A TENDENCY TO OVERCONTROL EXISTED.

11. MISCELLANEOUS: AIRCRAFT IS DOWNGRADED MAINLY DUE TO POOR TRACKING NEAR TOUCHDOWN (IMC PORTION). UP AND AWAY THE PILOT PERFORMANCE WAS ADEQUATE. RATING COULD POSSIBLY BE 6+.

CONFIGURATION
FLIGHT NUMBER
PILOT
PILOT-RATING
WIND (knots)
WIND SHEAR
EXTERNAL TURBULENCE

CHARACTERISTIC ROOTS

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = (rad/sec²)/in		$Z_{\delta T}$ = (ft/sec²)/in	
Initial	Final	Initial	Final

Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
VMC	IMC	IMC	VMC	IMC	IMC
OUT	OUT	IN	OUT	OUT	IN
knots			fpm		

AMPLITUDE	PERIOD	DAMPING

SOURCE	DEGREE

DIFFICULTY

Intercept & initial track		Intermediate track		Final track	
Glide path	Localizer	Glide path	Localizer	Glide path	Localizer

DIFFICULTY

	Flight 108-3	Flight 100-3
CONFIGURATION	R19-3L	R19-3L
FLIGHT NUMBER	108-3	100-3
PILOT	A	B
PILOT-RATING	8½	4½B
WIND (knots)	10-15	CALM
WIND SHEAR	MODERATE	SMALL
EXTERNAL TURBULENCE	LIGHT	NEGLIGIBLE
CHARACTERISTIC ROOTS	-.02 | -.54 | -1.05 ± 1.061	-.02 | -.54 | -1.05 ± 1.061

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY:

	ELEVATOR		THRUST LEVER	
Flight 108-3	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	TOO GREAT	SATISFACTORY	TOO GREAT
Flight 100-3	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
Flight 108-3						
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	GREAT	GREAT	MODERATE	GREAT	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	±12 knots			± 300 fpm		
Flight 100-3						
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	+14, -5 knots			±200 fpm		

COMMENTS

Flight 108-3: AIRSPEED EFFECTS ON NORMAL FORCES VERY BOTHERSOME. NORMAL FORCE INCREASES WITH AIRSPEED CAUSING INSTABILITY AND UNPREDICTABLE RATES OF CLIMB. TURBULENCE IN HEAVE ALSO VERY BOTHERSOME.

Flight 100-3: DIFFICULTY CAUSED BY TENDENCY TO PUT NOSE DOWN IF HIGH ON GLIDE SLOPE.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
Flight 108-3 PITCH	SMALL	SHORT	HIGH
Flight 108-3 HEAVE	ZERO		
Flight 100-3 PITCH	ZERO		
Flight 100-3 HEAVE	ZERO		

EXCITATION CONTROL	SOURCE	DEGREE
Flight 108-3	ELEVATOR	MODERATE
Flight 100-3		

COMMENTS:

Flight 108-3: ON OCCASION PITCH ATTITUDE COMMAND APPEARED TO BE PRESENT BUT IT WAS RATHER SLOPPY AND TENDED TO BOUNCE BACK. FELT SPONGY THROUGHOUT.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 108-3	Flight 100-3
CHANGE REQUIRED:	MODERATE	SMALL
EASE OF COMPENSATION:	MODERATE DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS:

Flight 108-3: AIRSPEED CONTROL WAS NOT GOOD AND THIS REQUIRED POWER CHANGES WHICH NEEDED TOO MUCH ATTENTION TO HEIGHT CONTROL.

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
Flight 108-3 DIFFICULTY:	MODERATE	MODERATE	GREAT	MODERATE	MODERATE	GREAT
Flight 108-3 PRECISION	POOR	POOR	POOR	POOR	VERY POOR	VERY POOR
Flight 100-3 DIFFICULTY:	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
Flight 100-3 PRECISION	FAIR	FAIR	FAIR	FAIR	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 700 (Flight 108-3); 300 (Flight 100-3)

COMMENTS

Flight 108-3: DIFFICULTY CAUSED BY WIND SHEAR, TURBULENCE AND AIRSPEED - VERTICAL SPEED INTERACTION.

Flight 100-3: WIND CONDITION REQUIRES HIGH RATES OF DESCENT. GENERALLY HIGH ON THE GLIDESLOPE. SPEED CONTROL POOR BECAUSE OF TENDENCY TO PUT NOSE DOWN TO CORRECT GLIDESLOPE ERROR.

6 BREAKOUT AND FLARE

	Flight 108-3	Flight 100-3
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR/GOOD	FAIR

COMMENTS:

Flight 100-3: HIGH RATES OF DESCENT NOT PLEASANT NEAR THE GROUND - HENCE RECOMMENDED BREAKOUT HEIGHT.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: SMALL (Flight 108-3); NONE (Flight 100-3)

9 LEAST OBJECTIONABLE FEATURES

Flight 100-3: SATISFACTORY ATTITUDE STABILITY.

10 MOST OBJECTIONABLE FEATURES

Flight 100-3: THRUST LEVER SENSITIVITY WAS POSSIBLY A LITTLE HIGH AND MAY HAVE CONTRIBUTED TO AN OSCILLATION DOWN GLIDE PATH.

11 MISCELLANEOUS

Flight 100-3: TURBULENCE NOT NOTICED.

CONFIGURATION	R19-3L	WIND (knots)	5
FLIGHT NUMBER	123-I	WIND SHEAR	SMALL
PILOT	C	EXTERNAL TURBULENCE	LIGHT
PILOT-RATING	7		

CHARACTERISTIC ROOTS

-.02	-.54	-1.05 ±	1.061

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	TOO SMALL	TOO GREAT	TOO SMALL	TOO GREAT

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	MODERATE	SLIGHT	MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	-15 knots			fpm		

COMMENTS

DIFFICULTY DUE TO EFFECT OF AIRSPEED ON CLIMB OR SINK IF THROTTLE LEFT ALONE.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH			
HEAVE			

	SOURCE	DEGREE
EXCITATION:		
CONTROL:		

COMMENTS

NO NOTICEABLE OSCILLATORY CHARACTERISTICS, ALTHOUGH THEY COULD HAVE BEEN MASKED BY THE EFFECTS OF THE MARGINAL EXTERNAL TURBULENCE LEVEL.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: SMALL
EASE OF COMPENSATION: MODERATE DIFFICULTY

COMMENTS

EFFECT OF BANK ANGLE INSIGNIFICANT IN COMPARISON WITH EFFECT OF AIRSPEED VARIATIONS.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	GREAT	SLIGHT	SLIGHT	SLIGHT	MODERATE	SLIGHT
PRECISION	VERY POOR	FAIR	GOOD	GOOD	FAIR	GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

COMMENTS

INITIAL DIFFICULTY IN MAINTAINING HEIGHT PRIOR TO ACQUISITION OF GLIDE PATH. CONSIDERABLE HEIGHT LOSS ON TURNING TO BASE LEG DUE TO OVERCONTROLLING WITH THROTTLE IN COMPENSATING FOR AIRSPEED CHANGES. CAPTURED GLIDE PATH AT 1100 FEET.

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: GOOD

COMMENTS:

USE OF FORWARD STICK TO MAINTAIN AIRSPEED AND THROTTLE TO ARREST RATE OF DESCENT RELATIVELY EASY UNDER V.M.C. CONDITIONS.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE

9. LEAST OBJECTIONABLE FEATURES

VMC OPERATION CONSIDERABLY LESS DIFFICULT THAN IMC.

10. MOST OBJECTIONABLE FEATURES

LARGE MANIFOLD PRESSURE FLUCTUATIONS WITH AIRSPEED CHANGES CAUSING LARGE CORRECTIONS WITH THROTTLE ON SEVERAL OCCASIONS TO AVOID OVER BOOSTING ENGINE, RESULTING IN HEIGHT LOSS.

11. MISCELLANEOUS

EFFECT OF EXTERNAL TURBULENCE APPROACHING LIMITS OF TOLERANCE (NO FURTHER EVALUATIONS). MIGHT HAVE GIVEN A RATING OF 6 IF LESS CONCERNED WITH OVER BOOSTING ENGINE.

CONFIGURATION
FLIGHT NUMBER
PILOT
PILOT-RATING
WIND (knots)
WIND SHEAR
EXTERNAL TURBULENCE

CHARACTERISTIC ROOTS

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = (rad/sec²)/in		$Z_{\delta T}$ = (ft/sec²)/in	
Initial	Final	Initial	Final

Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
VMC	IMC	IMC	VMC	IMC	IMC
OUT	OUT	IN	OUT	OUT	IN
knots			fpm		

AMPLITUDE	PERIOD	DAMPING

SOURCE	DEGREE

DIFFICULTY

Intercept & initial track		Intermediate track		Final track	
Glide path	Localizer	Glide path	Localizer	Glide path	Localizer

DIFFICULTY

	Flight 109-2	Flight 102-1
CONFIGURATION	A19-3L	A19-3L
FLIGHT NUMBER	109-2	102-1
PILOT	A	B
PILOT-RATING	7	3C
WIND (knots)	10	10
WIND SHEAR	MODERATE	SMALL
EXTERNAL TURBULENCE	NEGLIGIBLE	LIGHT
CHARACTERISTIC ROOTS	-.02 | -.54 | -1.05 ± | 1.061	-.02 | -.54 | -1.05 ± | 1.061

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY — ELEVATOR: $M_{\delta E}$ = 0.34 (rad/sec²)/in; THRUST LEVER: $Z_{\delta T}$ = 15.0 (ft/sec²)/in (both flights)

RESPONSE	Elevator Initial	Elevator Final	Thrust Lever Initial	Thrust Lever Final
Flight 109-2	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY
Flight 102-1	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (109-2)	SLIGHT	MODERATE	MODERATE	SLIGHT	MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS (109-2)	±10 knots			±300 fpm		
DIFFICULTY (102-1)	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (102-1)	±5 knots			O.K. fpm		

COMMENTS:

109-2: AIRSPEED EFFECT ON POWER CAUSED DIFFICULTIES IN CONTROLLING BOTH AIRSPEED AND VERTICAL SPEED. ON THE APPROACH THE AIRSPEED BUILT UP CAUSING AN INCREASE IN LIFT WHICH ARRESTED THE RATE OF DESCENT.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE (109-2)	PERIOD	DAMPING	AMPLITUDE (102-1)	PERIOD	DAMPING
PITCH	ZERO			ZERO		
HEAVE	ZERO			ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS:

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 109-2	Flight 102-1
CHANGE REQUIRED	MODERATE	VERY SMALL
EASE OF COMPENSATION	MODERATE DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS:

109-2: NO PROBLEM IF AIRSPEED IS MAINTAINED IN TURNS, BUT AIRSPEED ERRORS INDUCE LARGE LIFT CHANGES.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY (109-2)	SLIGHT		MODERATE	SLIGHT	GREAT	MODERATE
PRECISION (109-2)			POOR	FAIR	VERY POOR	POOR
DIFFICULTY (102-1)	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
PRECISION (102-1)	FAIR/GOOD	FAIR/GOOD	FAIR/GOOD	FAIR/GOOD	FAIR/GOOD	FAIR/GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 700 (109-2); O.K. (102-1)

COMMENTS:

109-2: SEE SECTION 2. ALSO WIND SHEAR CAUSED LOCALIZER PROBLEM. AIRSPEED INCREASED TO 70 KNOTS AT ABOUT 500 FEET, CAUSING THE RATE OF DESCENT TO DECREASE, AND THE AIRCRAFT TO GO HIGH ON THE GLIDE PATH.

6. BREAKOUT AND FLARE

	Flight 109-2	Flight 102-1
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR/GOOD	FAIR/GOOD

COMMENTS:

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

102-1: NONE

9. LEAST OBJECTIONABLE FEATURES

102-1: ATTITUDE STABILITY GOOD FOR THIS TASK. EASY TO MAINTAIN SPEED AND TO MAKE SPEED CHANGES.

10. MOST OBJECTIONABLE FEATURES

109-2: SEE SECTION 2.

102-1: ONLY A SLIGHTLY NOTICEABLE BUT ACCEPTABLE COUPLING EFFECT BETWEEN AIRSPEED AND VERTICAL SPEED CHANNELS.

11. MISCELLANEOUS

109-2: THE TURBULENCE WAS CAUSING THE MANIFOLD PRESSURE NEEDLE TO WHIP ABOUT VISCIOUSLY AND THIS WAS BOTHERSOME.

102-1: GOOD RELAXED APPROACH WITH LOW LEVELS OF CONTROL ACTIVITY.

Contrails

CONFIGURATION R8L
FLIGHT NUMBER 7B-1
PILOT A
PILOT-RATING 4½
WIND (knots) LIGHT
WIND SHEAR NEGLIGIBLE
EXTERNAL TURBULENCE LIGHT

CHARACTERISTIC ROOTS

-.04	-.26	-1.05 ±	1.061

CONFIGURATION R8L
FLIGHT NUMBER 38-3
PILOT B
PILOT-RATING 6C
WIND (knots) 10-15
WIND SHEAR SMALL
EXTERNAL TURBULENCE LIGHT

CHARACTERISTIC ROOTS

-.04	-.26	-1.05 ±	1.061

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 15 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = .39 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	SATISFACTORY	SATISFACTORY	NOT ASSESSABLE

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	MODERATE	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	± 5 knots			0 K fpm		

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	NONE	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	+10, -5 knots			fpm		

COMMENTS

THE PITCH ATTITUDE STIFFNESS COULD HAVE BEEN MUCH STRONGER TO CLAMP THE ATTITUDE WHERE IT IS PUT. AIRSPEED CONTROL REQUIRES TOO MUCH ATTENTION.

REASON FOR HEAVE DIFFICULTY WAS THAT THE FINAL RESPONSE TO THRUST LEVER WAS UNKNOWN.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: SMALL
EASE OF COMPENSATION: SLIGHT DIFFICULTY

CHANGE REQUIRED: SOME
EASE OF COMPENSATION: SLIGHT/MODERATE DIFFICULTY

COMMENTS

POWER WAS REQUIRED BUT IT WAS NATURAL AND EASILY LEARNED.

NOT ENOUGH TIME TO THOROUGHLY INVESTIGATE THE SOURCE OF THE PROBLEM. THERE APPEARS TO BE A NORMAL FORCE DUE TO ROLL RATE BUT IT IS PROBABLY DUE TO ANGLE OF ATTACK.

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
PRECISION	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	NONE	NONE		SLIGHT
PRECISION	GOOD	GOOD	FAIR/GOOD	FAIR/GOOD	FAIR/GOOD	FAIR/GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

300

COMMENTS

THE LOCALIZER WENT TO FULL DEFLECTION BELOW 300 FT. THE TALAR SENSITIVITY IS TOO HIGH BELOW 300 FT IN THE PRESENCE OF MORE EXTENSIVE CROSS-CHECK REQUIREMENTS ON GLIDE SLOPE.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: GOOD

EASE OF ARRESTING RATE OF DESCENT: SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: FAIR/GOOD

COMMENTS:

RESPONSE TO THRUST LEVER UNCERTAIN AGAIN, AS FOR MODEL # 9 . RATE OF SINK AT TOUCH DOWN WAS OK BUT WAS NOT PRECISELY UNDER CONTROL.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

FIXED-WING TECHNIQUE SUBCONCIOUSLY USED TO RETAIN GLIDE PATH IN THE PRESENCE OF POOR THRUST LEVER CHARACTERISTICS. THIS RESULTED IN SOME PROBLEM WITH SPEED.

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

SMALL

NONE

9 LEAST OBJECTIONABLE FEATURES

GOOD PITCH ATTITUDE STABILITY.

10 MOST OBJECTIONABLE FEATURES

UNCERTAIN HEAVE CHARACTERISTICS ESPECIALLY IN TURBULENCE.

11 MISCELLANEOUS

ELEVATOR TRIM RATE TOO FAST.
MENTAL ASSESSMENT REQUIRED OF WHAT TO DO TO KEEP THE SAME GLIDE SLOPE WHILST ADJUSTING TO A NEW, CORRECT SPEED.

Flight 99-3

CONFIGURATION R8L
FLIGHT NUMBER 99-3
PILOT C
PILOT-RATING 4½

WIND (knots) 0
WIND SHEAR NEGLIGIBLE
EXTERNAL TURBULENCE NEGLIGIBLE

CHARACTERISTIC ROOTS

-.04	-.26	-1.05 ±	1.061

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = .34 $(rad/sec^2)/in$		$Z_{\delta T}$ = 15 $(ft/sec^2)/in$	
	Initial	Final	Initial	Final
RESPONSE	TOO SMALL	TOO GREAT	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	MODERATE	SLIGHT	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	± 8 knots			fpm		

COMMENTS: SPEED AND ALTITUDE OFTEN CONSTANT FOR CONSIDERABLE PERIODS, BUT SOME DIFFICULTY WAS EXPERIENCED IN CHANGING FROM ONE CONDITION TO ANOTHER.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	SMALL	MEDIUM	MODERATE
HEAVE	SMALL	MEDIUM	MODERATE

	SOURCE	DEGREE
EXCITATION	ELEVATOR	MODERATELY
CONTROL	ELEVATOR	EFFECTIVE

COMMENTS: UNCERTAIN OF HEAVE OSCILLATION, BUT I HAD THE IMPRESSION THAT THERE WAS SOME NEGATIVE RESPONSE IN HEAVE WHEN THE AIRCRAFT WAS PITCHED.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: SMALL
EASE OF COMPENSATION: SLIGHT DIFFICULTY

COMMENTS:

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	MODERATE	SLIGHT	MODERATE	SLIGHT
PRECISION	FAIR	FAIR	GOOD	GOOD	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

COMMENTS

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: FAIR

COMMENTS

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: SMALL: CHARACTERISTICS WERE NOTICEABLE IN TURN COORDINATION.

9 LEAST OBJECTIONABLE FEATURES

ABILITY TO COMPLETE APPROACH, BUT WITH CONSIDERABLE CONCENTRATION.

10 MOST OBJECTIONABLE FEATURES

MODEL RESPONSE TO SHARPER PITCH INPUTS WAS UNPLEASANT DUE TO UNEXPECTED HEAVE BEHAVIOUR.

11 MISCELLANEOUS

MODEL MIGHT BE IMPROVED BY SMALL BREAKOUT FORCE.

Flight 43-1

CONFIGURATION R8L
FLIGHT NUMBER 43-1
PILOT D
PILOT-RATING 6

WIND (knots) 5
WIND SHEAR SMALL
EXTERNAL TURBULENCE LIGHT/MODERATE

CHARACTERISTIC ROOTS

-.04	-.26	-1.05 ±	1.061

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.3 $(rad/sec^2)/in$		$Z_{\delta T}$ = 7.4 $(ft/sec^2)/in$	
	Initial	Final	Initial	Final
RESPONSE	TOO SMALL	TOO GREAT	TOO SMALL	TOO GREAT

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	MODERATE	SLIGHT	SLIGHT	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	+5, -10 knots			±200 fpm		

COMMENTS: DIFFICULTY DUE TO LAG IN RESPONSE TO PILOT'S INPUTS.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE			

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS: IT SEEMED SLIGHTLY STATICALLY UNSTABLE - AT LEAST IT WAS DIFFICULT TO FIND THE TRIM POINT.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: MODERATE
EASE OF COMPENSATION: SLIGHT/MODERATE DIFFICULTY

COMMENTS: DIFFICULTY DUE TO LAG IN NOTICEABLE RESPONSE.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	>SLIGHT	>SLIGHT	>MODERATE	>MODERATE
PRECISION	GOOD	GOOD	FAIR	FAIR	POOR	POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

COMMENTS: DIFFICULTY DUE TO PILOT BEING BEHIND THE AIRPLANE.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: FAIR

COMMENTS: MADE A TWO STEP LEVEL OFF, ie. AIRSPEED WAS TOO LOW AND I ANTICIPATED THE THRUST APPLICATION TOO MUCH.

7 CONTROL TECHNIQUE

COMMENTS: THERE DEFINITELY SEEMED TO BE A COUPLING BETWEEN PITCH ATTITUDE AND THRUST LEVER IN CONTROLLING AIRSPEED AND VERTICAL VELOCITY.

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT:

9 LEAST OBJECTIONABLE FEATURES

NO PITCH OSCILLATION.

10 MOST OBJECTIONABLE FEATURES

POOR PRECISION OF AIRSPEED AND VERTICAL VELOCITY, OVERCONTROL DUE TO LAG IN NOTICEABLE RESPONSE TO PILOT INPUTS.

11 MISCELLANEOUS

CONFIGURATION 88
FLIGHT NUMBER 42-2
PILOT D
PILOT-RATING 7½

WIND (knots) 0
WIND SHEAR VERY SMALL
EXTERNAL TURBULENCE MODERATE

CHARACTERISTIC ROOTS

-.04	-.26	-1.05 ±	1.061

CONFIGURATION
FLIGHT NUMBER
PILOT
PILOT-RATING

WIND (knots)
WIND SHEAR
EXTERNAL TURBULENCE

CHARACTERISTIC ROOTS

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = .30 (rad/sec²)/in		$Z_{\delta T}$ = 7.4 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	TOO SMALL	TOO GREAT	TOO SMALL	TOO GREAT

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = (rad/sec²)/in		$Z_{\delta T}$ = (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:				

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	MODERATE	>MODERATE	MODERATE	>MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS		> 10	knots	> 300		fpm

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY						
MAXIMUM UNDESIRED FLUCTUATIONS			knots			fpm

COMMENTS

DIFFICULTY DUE TO SUBSTANTIAL LAG BETWEEN CONTROL APPLICATION AND NOTICEABLE RESPONSE IN AIRSPEED AND VERTICAL VELOCITY. THIS WAS COMPLICATED BY LARGE LATERAL MANOEUVRES.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	VERY SMALL	MEDIUM	MODERATE
HEAVE			

	AMPLITUDE	PERIOD	DAMPING
PITCH			
HEAVE			

	SOURCE	DEGREE
EXCITATION		
CONTROL		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

HAD TROUBLE IN ACHIEVING STEADY STATE VERTICAL VELOCITIES BUT I CANNOT CALL IT OSCILLATORY.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: MODERATE/LARGE
EASE OF COMPENSATION: MODERATE DIFFICULTY

CHANGE REQUIRED:
EASE OF COMPENSATION: DIFFICULTY

COMMENTS

I AM BEHIND THE AIRPLANE. VERTICAL VELOCITY CHANGES SLOWLY INITIALLY AND IT TAKES TIME TO NOTICE IT.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	SLIGHT	SLIGHT	> SLIGHT	SLIGHT	>MODERATE	>MODERATE
PRECISION	FAIR	FAIR	FAIR/POOR	FAIR	POOR	POOR

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:						
PRECISION						

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

COMMENTS

DIFFICULTY PROBABLY DUE TO OVERCONTROL OF ELEVATOR AND THRUST CONTROL AND TO THE PILOT BEING BEHIND THE AIRPLANE.

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: SLIGHT/MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: FAIR

EASE OF ARRESTING RATE OF DESCENT: DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT:

COMMENTS:

DIFFICULTY DUE TO WORRYING ABOUT LOW I.A.S. - THERE SEEMED TO BE A LAG IN THRUST LEVER RESPONSE.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE

9. LEAST OBJECTIONABLE FEATURES

GOOD PITCH DAMPING.

10. MOST OBJECTIONABLE FEATURES

TOO MUCH CONTROL MANIPULATION WAS REQUIRED AND STILL THE PERFORMANCE WAS NOT CONSIDERED GOOD.

11. MISCELLANEOUS

POWER AND IAS GOT OUT OF HAND ON FINAL. I DO NOT KNOW WHY, BUT THE SAFETY PILOT TOOK OVER. MAYBE I WENT BEYOND LIMITS OF MODEL ON THRUST LEVER.

	Flight 80-1		Flight 85-1	
CONFIGURATION	ABL		ABL	
FLIGHT NUMBER	80-1		85-1	
PILOT	A		B	
PILOT-RATING	3½		6C	
WIND (knots)	10		0	
WIND SHEAR	NEGLIGIBLE		NEGLIGIBLE	
EXTERNAL TURBULENCE	NEGLIGIBLE		NEGLIGIBLE	
CHARACTERISTIC ROOTS	-.04, -.26	1.05 ± 1.06i	-.04, -.26	1.05 ± 1.06i

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

Flight 80-1:

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

Flight 85-1:

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.25 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY		SATISFACTORY	TOO GREAT

2 EASE OF MAINTAINING DESIRED VELOCITIES

Flight 80-1:

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	SLIGHT	SLIGHT	NONE	NONE	NONE
MAXIMUM UNDESIRED FLUCTUATIONS	+5, -0 knots			O K fpm		

Flight 85-1:

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	NONE	NONE	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	+3, -6 knots			+300 fpm		

COMMENTS:

Flight 85-1: DIFFICULTY DUE TO APPARENTLY HIGHER THAN NORMAL THRUST LEVER SENSITIVITY AND LOWER THAN NORMAL HEIGHT RATE DAMPING.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

Flight 80-1:

	AMPLITUDE	PERIOD	DAMPING
PITCH	SMALL	SHORT	MODERATE
HEAVE	SMALL	SHORT	MODERATE

	SOURCE	DEGREE
EXCITATION	ELEVATOR	MODERATELY
CONTROL	NOT ATTEMPTED	

Flight 85-1:

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

Flight 80-1: A SLIGHT NIBBLE OF AN OSCILLATION WAS EVIDENT WHEN THE PITCH CONTROL WAS MOVED RAPIDLY, BUT THIS SEEMED TO BE MORE OF A HEAVING MOTION.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 80-1	Flight 85-1
CHANGE REQUIRED	MODERATE	SMALL
EASE OF COMPENSATION:	SLIGHT DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS

Flight 80-1: IF AIRSPEED IS GOOD, THE ALTITUDE STICKS ON THE DESIRED VALUE. DURING THE FIRST TURN THE AIRSPEED DECREASED TO 55 KNOTS AND THE VERTICAL SPEED WENT TO 300 F.P.M. DOWN.

Flight 85-1: DIFFICULTY DUE SIMPLY TO COORDINATION.

5. FLIGHT PATH CONTROL

Flight 80-1:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	NONE	SLIGHT	NONE	SLIGHT	NONE	NONE
PRECISION	GOOD	FAIR	GOOD	FAIR	GOOD	GOOD

Flight 85-1:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	SLIGHT	SLIGHT	NONE	SLIGHT	NONE	NONE
PRECISION	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

Flight 80-1: (blank)

Flight 85-1: 300

COMMENTS

Flight 85-1: ALTHOUGH TURBULENCE BOTHERED ENGINE POWER SETTINGS QUITE SIGNIFICANTLY, IT DID NOT UPSET PITCH ATTITUDE OR VERTICAL VELOCITY VERY MUCH - EASILY ABLE TO FIND AND MAINTAIN GOOD VERTICAL VELOCITY.

6 BREAKOUT AND FLARE

	Flight 80-1	Flight 85-1
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	FAIR

COMMENTS:

Flight 80-1: FROM EXPERIENCE WITH A PREVIOUS SIMILAR MODEL AND THE HINT OF AN OSCILLATION, CARE WAS TAKEN NOT TO PITCH THE AIRCRAFT DURING THE LEVELLING OFF PROCESS.

Flight 85-1: HAD HIGHER THAN NORMAL OR WANTED RATE OF DESCENT AT TOUCHDOWN - DUE TO IMPROPERLY COMPENSATING FOR APPARENT LOW HEIGHT RATE DAMPING.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

Flight 85-1: NONE

9 LEAST OBJECTIONABLE FEATURES

Flight 80-1: AIRSPEED CONTROL WAS QUITE EASY.

Flight 85-1: VERY GOOD AND STIFF PITCH ATTITUDE HOLD.

10. MOST OBJECTIONABLE FEATURES

Flight 80-1: THE PITCH ATTITUDE DOES NOT CHANGE THE ALTITUDE AT ALL, BUT JUST THE AIRSPEED. THERE IS A STRANGE SENSATION WHEN, FOR INSTANCE, THE NOSE IS PULLED UP AND THE ACCELERATION IS DOWNWARDS.

Flight 85-1: APPARENT LOW HEIGHT RATE DAMPING. ARTIFICIAL TURBULENCE CAUSED SIGNIFICANT, BOTHERSOME ENGINE TRANSIENTS.

11 MISCELLANEOUS

Flight 85-1: ELEVATOR CONTROL FORCES ARE TOO HIGH FOR THIS LEVEL OF STABILITY.

	Flight 131-3		Flight 128-3
CONFIGURATION	R8-IL	CONFIGURATION	R8-IL
FLIGHT NUMBER	131-3	FLIGHT NUMBER	128-3
PILOT	A	PILOT	B
PILOT-RATING	4	PILOT-RATING	4C
WIND (knots)	10	WIND (knots)	5
WIND SHEAR	MODERATE	WIND SHEAR	NEGLIGIBLE
EXTERNAL TURBULENCE	NEGLIGIBLE	EXTERNAL TURBULENCE	NEGLIGIBLE

CHARACTERISTIC ROOTS				
Flight 131-3	-.03	-.28	1.05 ±	1.061
Flight 128-3	-.03	-.28	1.05 ±	1.061

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.3 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE (131-3)	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY
RESPONSE (128-3)	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (131-3)	NONE	SLIGHT	SLIGHT	NONE	SLIGHT	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS (131-3)	+10, -5 knots			± 200 fpm		
DIFFICULTY (128-3)	V. SLIGHT	V. SLIGHT	V. SLIGHT	V. SLIGHT	V. SLIGHT	V. SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (128-3)	± 6 knots			O K fpm		

COMMENTS: (131-3) MAIN REASON FOR VERTICAL SPEED PROBLEM WAS THAT THERE MUST HAVE BEEN A FOLLOWING WIND WHICH NECESSITATED A DESCENT RATE GREATER THAN 1000 F.P.M. TO HOLD THE GLIDE PATH. AIRSPEED HOLD WAS QUITE GOOD BUT DID REQUIRE MUCH CONCENTRATION.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH (131-3)	MODERATE	SHORT	LOW
HEAVE (131-3)			
PITCH (128-3)	ZERO		
HEAVE (128-3)	ZERO		

EXCITATION CONTROL	SOURCE	DEGREE
(131-3)	ELEVATOR	EASILY
(131-3)	ELEVATOR	INEFFECTIVE
(128-3)		

COMMENTS: (131-3) THE OSCILLATION ONLY OCCURRED AT TOUCHDOWN (SEE SECTION #6).

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 131-3	Flight 128-3
CHANGE REQUIRED:	NEGLIGIBLE	NEGLIGIBLE
EASE OF COMPENSATION	NO DIFFICULTY	NO DIFFICULTY

COMMENTS

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY: (131-3)	SLIGHT	SLIGHT	MODERATE	SLIGHT	MODERATE	SLIGHT
PRECISION (131-3)	FAIR	FAIR	POOR	FAIR	POOR	FAIR
DIFFICULTY: (128-3)	NONE	NONE	NONE	NONE	SLIGHT	NONE
PRECISION (128-3)	GOOD	GOOD	GOOD	GOOD	FAIR	GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: (131-3) 300 TO 400; (128-3) O K

COMMENTS: (131-3) 200 FT WOULD PROBABLY BE OK WITHOUT A FOLLOWING WIND (SURFACE WIND WAS IN CORRECT DIRECTION).

(128-3) ONLY DIFFICULTY DUE TO TALAR SENSITIVITY ON FINAL TRACK - 'S' TURN TENDENCY ON LOCALIZER.

6. BREAKOUT AND FLARE

	Flight 131-3	Flight 128-3
EASE OF ARRESTING RATE OF DESCENT	MODERATE DIFFICULTY	NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	POOR	GOOD

COMMENTS: (131-3) GOT INTO A PIO IN PITCH. THE ATTITUDE CHANGES RAPIDLY IMMEDIATELY FOLLOWING AN ELEVATOR INPUT AND THEN RATE SLOWS DOWN. WITHOUT THIS OSCILLATION WOULD PROBABLY BE RATED 3.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: (131-3) SMALL; (128-3) NONE

9. LEAST OBJECTIONABLE FEATURES

(128-3) GOOD HEIGHT CONTROL - MINIMAL THRUST CONTROL ACTIVITY ON DESCENT (APPROX. 850 F.P.M.) RESPONSE TO TURBULENCE NOT SIGNIFICANT.

10. MOST OBJECTIONABLE FEATURES

(131-3) SEE SECTION #6.

11. MISCELLANEOUS

(131-3) WITHOUT OSCILLATION (SECTION #6) WOULD PROBABLY BE RATED 3.

(128-3) PITCH RESPONSE - INITIALLY SATISFACTORILY RAPID, DECAYING TO WEAK DIVERGENCE - REASONABLE TO TRIM. THIS AND MODEL R19-IL PRODUCED TENDENCY TO USE LARGE AGGRESSIVE ELEVATOR CONTROL INPUTS TO ADJUST SPEED. WANT TO 'HAMMER' IT AROUND DURING MANOEUVRES.

	Flight 131-1	Flight 128-1
CONFIGURATION	A8-IL	A8-IL
FLIGHT NUMBER	131-1	128-1
PILOT	A	B
PILOT-RATING	4	4D
WIND (knots)	5	5
WIND SHEAR	NEGLIGIBLE	NEGLIGIBLE
EXTERNAL TURBULENCE	NEGLIGIBLE	NEGLIGIBLE
CHARACTERISTIC ROOTS	-.03, -.28, 1.05 ± 1.06i	-.03, -.28, 1.05 ± 1.06i

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY (131-1)	$M_{\delta E} = 0.3$ (rad/sec²)/in		$Z_{\delta T} = 11.9$ (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE (131-1)	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY
CONTROL SENSITIVITY (128-1)	$M_{\delta E} = 0.3$ (rad/sec²)/in		$Z_{\delta T} = 11.9$ (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE (128-1)	TOO GREAT	TOO GREAT	SATISFACTORY	TOO GREAT

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE (131-1)	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (131-1)	NONE	SLIGHT	MODERATE	NONE	NONE	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (131-1)	+10, -5 knots			200 fpm		
TURBULENCE (128-1)	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (128-1)	NONE	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (128-1)	± 8 knots			± 250 fpm		

COMMENTS

131-1: THE AIRSPEED GOT UP TO 70 KNOTS AND THE RATE OF DESCENT FELL OFF ON APPROACH CAUSING FAIRLY LARGE DEVIATIONS FROM GLIDE PATH. AIRSPEED CONTROL WAS MAIN PROBLEM - ATTITUDE HOLD FELT GOOD BUT DID NOT PRODUCE A GOOD AIRSPEED HOLD.

128-1: DIFFICULTY DUE TO: (1) HIGH THRUST LEVER SENSITIVITY (2) LARGE AMOUNT OF PITCH STABILITY MAKES IT DIFFICULT TO ADJUST SPEED AND YET SPEED STILL VARIED ON DESCENT.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE (131-1)	PERIOD	DAMPING	AMPLITUDE (128-1)	PERIOD	DAMPING
PITCH	ZERO			ZERO		
HEAVE	ZERO			ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS:

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	131-1	128-1
CHANGE REQUIRED:	NEGLIGIBLE	NEGLIGIBLE
EASE OF COMPENSATION	NO DIFFICULTY	NO DIFFICULTY

COMMENTS:

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY (131-1)	SLIGHT	SLIGHT	MODERATE	MODERATE	SLIGHT	SLIGHT
PRECISION (131-1)	FAIR	FAIR	POOR	POOR	FAIR	FAIR
DIFFICULTY (128-1)	SLIGHT	NO	SLIGHT	NO	SLIGHT	NO
PRECISION (128-1)	FAIR/GOOD	FAIR/GOOD	FAIR/GOOD	FAIR/GOOD	FAIR/GOOD	FAIR/GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500 (131-1); — (128-1)

COMMENTS:

131-1: THE AIRSPEED INCREASED AND WE FLEW AWAY FROM THE GLIDE PATH. UP TO 1300 F.P.M., DOWN WAS REQUIRED TO GET BACK ON. HAD DIFFICULTY HOLDING HEADING PRECISELY ENOUGH TO TRACK LOCALIZER COMFORTABLY.

128-1: HIGH THRUST LEVER SENSITIVITY CAUSED HUNTING ON GLIDE PATH. I AM NOT SURE WHY, BUT HAD GREATER SPEED VARIATIONS THAN ANTICIPATED - PERHAPS DUE TO UNCONCIOUSLY PUSHING NOSE DOWN IF HIGH OR PULLING UP IF LOW.

6. BREAKOUT AND FLARE

	131-1	128-1
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	GOOD

COMMENTS:

128-1: DIFFICULTY IN ADJUSTING SPEED TO 60 KNOTS (AT BREAKOUT SPEED WAS 52 KNOTS) - PERHAPS DUE TO HIGH PITCH ATTITUDE STABILITY.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

131-1: SMALL. SEE SECTION 5.

128-1: NONE

9. LEAST OBJECTIONABLE FEATURES

131-1: NO EFFECTS OF TURBULENCE.

10. MOST OBJECTIONABLE FEATURES

128-1: SENSITIVITY TO TURBULENCE (LONG PERIOD) IN HEAVE. HIGH PITCH STABILITY - EASY TO TRIM BUT DIFFICULT TO CHANGE SPEED.
HIGH THRUST LEVER SENSITIVITY AND POSSIBLY LOW DAMPING.

11. MISCELLANEOUS

131-1: N.B. HAD TO USE 1300 F.P.M. RATE OF DESCENT TO RECOVER GLIDE PATH.

128-1: ELEVATOR STICK FORCES HIGH FOR THIS LEVEL OF STABILITY. THRUST LEVER DISPLACEMENTS TOO SMALL.

	Flight 112-1	Flight 100-1
CONFIGURATION	RB-2L	RB-2L
FLIGHT NUMBER	112-1	100-1
PILOT	A	B
PILOT-RATING	8	7C
WIND (knots)	0-5	CALM
WIND SHEAR	MODERATE	SMALL
EXTERNAL TURBULENCE	NEGLIGIBLE	LIGHT
CHARACTERISTIC ROOTS	-.01 | -.31 | -1.04 ± 1.061	-.01 | -.31 | -1.04 ± 1.061

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	Flight 112-1 ELEVATOR		Flight 112-1 THRUST LEVER		Flight 100-1 ELEVATOR		Flight 100-1 THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 15 (ft/sec²)/in		$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	TOO GREAT	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

Flight 112-1:

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	GREAT	GREAT	SLIGHT	MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	± 12 knots			± 300 fpm		

COMMENTS: INCREASING AIRSPEED CAUSED AN INCREASE IN NORMAL FORCE WHICH CAUSED PROBLEMS IN HOLDING AIRSPEED AND VERTICAL SPEED. THE PITCH ATTITUDE WAS DIFFICULT TO SETTLE ON. THE HEAVE RESPONSE TO POWER CHANGES TOOK A LONG TIME TO SETTLE.

Flight 100-1:

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	MODERATE	SLIGHT	SLIGHT	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	+12, -4 knots			fpm		

COMMENTS: IF I GET HIGH ON GLIDE SLOPE I TEND TO PUSH NOSE DOWN WHICH INCREASES SPEED UNDESIRABLY. I WAS HIGH ON GLIDE SLOPE AND HIGH ON SPEED GENERALLY. I WAS UP TO - 1300 fpm ONCE ON DESCENT.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	Flight 112-1 AMPLITUDE	PERIOD	DAMPING	Flight 100-1 AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO			ZERO		
HEAVE	ZERO			ZERO		

	Flight 112-1 SOURCE	DEGREE	Flight 100-1 SOURCE	DEGREE
EXCITATION				
CONTROL				

COMMENTS

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 112-1	Flight 100-1
CHANGE REQUIRED:	LARGE	SMALL
EASE OF COMPENSATION	GREAT DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS: THE AIRSPEED VARIED AND THIS CAUSED LARGE VARIATIONS IN THE POWER REQUIRED - NEVER DID GET IT SORTED OUT AT DESIRED CONDITIONS.

5. FLIGHT PATH CONTROL

Flight 112-1:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	SLIGHT	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE
PRECISION	FAIR	POOR	POOR	POOR	POOR	POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 800

COMMENTS: DIFFICULTY DUE TO QUITE LARGE WIND SHEAR - AS AIRSPEED INCREASED THE RATE OF DESCENT DECREASED, CAUSING THE AIRCRAFT TO GO HIGH ON THE GLIDE PATH.

Flight 100-1:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	SLIGHT	SLIGHT	MODERATE	SLIGHT	MODERATE	MODERATE
PRECISION	GOOD	GOOD	FAIR/POOR	FAIR	POOR	POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 400

COMMENTS: DIFFICULTY DUE TO WIND SHEAR, ie TAIL WIND I SUSPECT, WHICH, BECAUSE OF POOR CONTROL TECHNIQUE, CAUSED ME TO HAVE HEIGHT CONTROL DIFFICULTIES. I USED NOSE DOWN TO CORRECT WHEN HIGH ON GLIDE SLOPE WHICH CAUSED HIGH SPEED AND CHANGING RATES OF DESCENT. MAYBE HIGH THRUST-LEVER SENSITIVITY WAS A CONTRIBUTING FACTOR.

6 BREAKOUT AND FLARE

	Flight 112-1	Flight 100-1
EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY	SLIGHT/MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	POOR	FAIR

COMMENTS:

Flight 112-1: A PITCH OSCILLATION DEVELOPED WHILE TRYING TO GET TO THE LANDING ATTITUDE.

Flight 100-1: DIFFICULTY DUE TO POOR POSITIONING AT BREAKOUT ON BOTH GLIDE SLOPE AND LOCALIZER.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

Flight 112-1: SMALL

Flight 100-1: NONE: BUT PROBLEMS WITH HEIGHT TASK CAUSED A DEGRADATION OF LOCALIZER TRACKING.

9 LEAST OBJECTIONABLE FEATURES

Flight 100-1: ATTITUDE INSTABILITY NOT BAD AND IS, BY ITSELF, TOLERABLE.

10. MOST OBJECTIONABLE FEATURES

Flight 112-1: AIRSPEED EFFECT ON NORMAL FORCE

Flight 100-1: HEIGHT CONTROL: SOME DUE TO AIRSPEED EFFECT ON NORMAL FORCE AND SOME TO HIGH THRUST LEVER SENSITIVITY, WEAK ATTITUDE STABILITY.

11. MISCELLANEOUS

Flight 112-1: TALAR WAS SET ON 250° BUT WIND AT ATTITUDE WAS APPROX. 160°. TALAR WAS REORIENTATED AFTER THIS EVALUATION.

Flight 100-1: Z_{δ_T} WAS REDUCED FROM 15 TO 11.9 BUT WAS STILL SLIGHTLY TOO SENSITIVE.

CONFIGURATION	AB-2L	WIND (knots)	5
FLIGHT NUMBER	112-3	WIND SHEAR	MODERATE (300°→230°)
PILOT	A	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	7½		

CHARACTERISTIC ROOTS: -.01 | -.31 | -1.04 ± 1.06i

CONFIGURATION	AB-2L	WIND (knots)	10
FLIGHT NUMBER	96-1	WIND SHEAR	SMALL
PILOT	B	EXTERNAL TURBULENCE	LIGHT
PILOT-RATING	4½B		

CHARACTERISTIC ROOTS: -.01 | -.31 | -1.04 ± 1.06i

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER		ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 15 (ft/sec²)/in		$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 15 (ft/sec²)/in	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	SATISFACTORY	SATISFACTORY	TOO GREAT	SATISFACTORY		TOO GREAT	TOO GREAT

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)			Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	MODERATE	GREAT	SLIGHT	MODERATE	GREAT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	+15, -10 knots			± 300 fpm			+8, -4 knots			± 200 fpm		

COMMENTS

THE POWER SEEMED TO HAVE A MIND OF ITS OWN AND CONTINUOUSLY VARIED. THE VARIATION DID NOT APPEAR TO BE PERIODIC. I KEPT ON LOSING HEIGHT ON DOWNWIND LEG AND COULD NOT GET IT BACK BECAUSE OF POWER LIMITING ON EXCURSIONS.

DIFFICULTY DUE TO SPEED AFFECTING RATE OF DESCENT AND TO HIGH THRUST-LEVER SENSITIVITY.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING	AMPLITUDE	PERIOD	DAMPING
PITCH				ZERO		
HEAVE				ZERO		

	SOURCE	DEGREE	SOURCE	DEGREE
EXCITATION				
CONTROL				

COMMENTS

MUCH DIFFICULTY IN HEAVE, BUT I COULD NOT TELL IF IT WAS OSCILLATORY.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED	SMALL	NEGLIGIBLE
EASE OF COMPENSATION	SLIGHT DIFFICULTY	NONE DIFFICULTY

COMMENTS:

OK AS LONG AS SPEED IS HELD.

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	SLIGHT	SLIGHT	MODERATE	MODERATE	GREAT	MODERATE
PRECISION	FAIR	FAIR	POOR	POOR	VERY POOR	VERY POOR

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	SLIGHT	NONE	SLIGHT	SLIGHT	SLIGHT	SLIGHT
PRECISION	GOOD	GOOD	FAIR/GOOD	FAIR/GOOD	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 800 | 300

COMMENTS:

SEE SECTION #2. WIND SHEAR QUITE CONFUSING; I ANTICIPATED TOO MUCH SHEAR AND ENDED UP ON THE UPWIND SIDE OF LOCALIZER AT BREAKOUT DESCENDING TOO RAPIDLY.

DIFFICULT DUE TO:
(1) SOME WIND SHEAR
(2) EFFECT OF SPEED ON RATE OF DESCENT NOTICEABLE
(3) HIGHER THAN DESIRABLE THRUST-LEVER SENSITIVITY

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	MODERATE DIFFICULTY	SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	VERY POOR	FAIR/POOR

COMMENTS:

POWER WAS APPLIED TO ARREST RATE OF DESCENT AND JUST AS I THOUGHT ALL WAS SORTED OUT, THE AIRCRAFT STARTED TO CLIMB AND JOSTLE IN PITCH.

NOT SURE OF HEIGHT CONTROL NEAR GROUND - PERFORMED A VERY ASYMPTOTIC TOUCHDOWN, ON GUIDE SLOPE AT BREAKOUT.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

SPEED WAS EFFECTIVE IN CONTROLLING RATE OF DESCENT - THIS TECHNIQUE WAS USED AS LONG AS BOTH SPEED AND GUIDE SLOPE WERE IN CORRECT SENSE, ie, IF HIGH ON GLIDE PATH AND HIGH ON SPEED, THEN REDUCE SPEED.

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: SMALL | NONE

9 LEAST OBJECTIONABLE FEATURES: PITCH CONTROL VERY PLEASANT. | GOOD ATTITUDE STABILITY.

10 MOST OBJECTIONABLE FEATURES: HEAVE VARIATIONS | HEIGHT CONTROL, PARTICULARLY CLOSE TRACKING OF HEIGHT RATE.

11 MISCELLANEOUS

THRUST LEVER DISPLACEMENTS TOO SMALL - SENSITIVITY A LITTLE TOO HIGH ALTHOUGH IT DID NOT AFFECT RATING.

CONFIGURATION R14L
FLIGHT NUMBER 106-2
PILOT A
PILOT-RATING 6

WIND (knots)
WIND SHEAR MODERATE
EXTERNAL TURBULENCE LIGHT

CHARACTERISTIC ROOTS

-.04	-1.43	-1.06 ±	1.05i

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.34	(rad/sec²)/in	$Z_{\delta T}$ = 15.0	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	SLIGHT	MODERATE	NONE	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	+12, -10		knots	± 200		fpm

COMMENTS

DIFFICULTY DUE TO TURBULENCE CONTINUALLY DISTURBING THE PITCH ATTITUDE AND CAUSING THE AIRSPEED TO CHANGE

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: NEGLIGIBLE
EASE OF COMPENSATION: NO DIFFICULTY

COMMENTS:

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	MODERATE	SLIGHT	MODERATE	SLIGHT	MODERATE
PRECISION	GOOD	POOR	FAIR	POOR	FAIR	VERY POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500

COMMENTS

THE WIND SHEAR REQUIRED QUITE LARGE HEADING ALTERATIONS

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: GREAT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: VERY POOR

COMMENTS:

DIFFICULTY DUE TO A PITCH OSCILLATION WHICH WENT THROUGH ABOUT 2 CYCLES BEFORE STOPPING. IT COULD HAVE STARTED AGAIN IF THE FINAL TOUCHDOWN PHASE HAD BEEN COMPLETED.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE

9 LEAST OBJECTIONABLE FEATURES

10 MOST OBJECTIONABLE FEATURES: TURBULENCE RESPONSE, PIO AT FLARE.

11 MISCELLANEOUS

THE RATING WAS DEGRADED FROM 5 TO 6 BECAUSE OF THE PITCH OSCILLATION DURING FLARE. ITS TRANSIENT NATURE MAKES IT DIFFICULT TO ASSESS.

CONFIGURATION R14L
FLIGHT NUMBER 96-3
PILOT B
PILOT-RATING 4D

WIND (knots) 5
WIND SHEAR SMALL
EXTERNAL TURBULENCE LIGHT

CHARACTERISTIC ROOTS

-.04	-1.43	-1.06 ±	1.05i

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.34	(rad/sec²)/in	$Z_{\delta T}$ = 15.0	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	+8, -4		knots			fpm

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: NEGLIGIBLE
EASE OF COMPENSATION: NO DIFFICULTY

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	NONE	NONE	SLIGHT	SLIGHT
PRECISION	FAIR/GOOD	FAIR/GOOD	FAIR/GOOD	FAIR/GOOD	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 300

COMMENTS

UNCERTAIN OF REASON FOR DIFFICULTY, SOME LOCALIZER 'S' TURNING BECAUSE HEIGHT CONTROL WAS MODERATELY DIFFICULT

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: FAIR

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE

9 LEAST OBJECTIONABLE FEATURES

GOOD ATTITUDE STABILITY

10 MOST OBJECTIONABLE FEATURES

HEAVE SENSITIVE TO TURBULENCE (BUMPY) SOME LOCALIZER 'S' TURNING BECAUSE HEIGHT CONTROL MODERATELY DIFFICULT

11 MISCELLANEOUS

MODEL DID NOT APPEAR TO BE VERY DIFFERENT FROM MODEL A14-1L, BUT HEIGHT CONTROL TASK ON APPROACH WAS APPRECIABLY MORE DIFFICULT FOR SOME UNDETERMINED REASON - POSSIBLY CROSS CHECK AND BAD LUCK.

CONFIGURATION	A14L	WIND (knots)	10
FLIGHT NUMBER	109-1	WIND SHEAR	MODERATE
PILOT	A	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	5		

CHARACTERISTIC ROOTS: | -.04 | -1.43 | -1.06 ± 1.051 |

CONFIGURATION	A14L	WIND (knots)	15
FLIGHT NUMBER	91-2	WIND SHEAR	MODERATE
PILOT	B	EXTERNAL TURBULENCE	
PILOT-RATING	3½C		

CHARACTERISTIC ROOTS: | -.04 | -1.43 | -.106 ± 1.051 |

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

Flight 109-1:

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

Flight 91-2:

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

Flight 109-1:

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	MODERATE	SLIGHT	SLIGHT	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	-10, -5 knots			± 200 fpm		

COMMENTS: GENERAL UNSTEADINESS IN HEAVE AND PITCH WITH TURBULENCE IN. ATTITUDE COMMAND HELPS BUT PRODUCES A HEAVY FEEL.

Flight 91-2:

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	NONE	NONE	NONE	NONE	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	± 3 knots			OK fpm		

COMMENTS: DIFFICULTY DUE TO THRUST LEVER SENSITIVITY OR DAMPING BEING A LITTLE LOW. SPEED DROPPED 9 KNOTS AT BREAKOUT AND FLARE DUE, I THINK, TO SHEAR

3 RESIDUAL OSCILLATORY CHARACTERISTICS

Flight 109-1:

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION: CONTROL		

Flight 91-2:

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION: CONTROL		

COMMENTS

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

Flight 109-1:
CHANGE REQUIRED: SMALL
EASE OF COMPENSATION: SLIGHT DIFFICULTY

COMMENTS

Flight 91-2:
CHANGE REQUIRED: NEGLIGIBLE
EASE OF COMPENSATION: SLIGHT DIFFICULTY

COMMENTS: NEED TO ADVANCE SOME POWER IN TURNS

5 FLIGHT PATH CONTROL

Flight 109-1:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE
PRECISION	FAIR	FAIR	FAIR	FAIR	POOR	VERY POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500

COMMENTS: DIFFICULTY DUE TO TURBULENCE WHICH DISTURBS BOTH HEAVE AND PITCH AND TO WIND SHEAR.

Flight 91-2:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	SLIGHT	SLIGHT	SLIGHT	SLIGHT
PRECISION	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: OK

COMMENTS: DIFFICULTY DUE TO WIND SHEAR. THERE APPEARED TO BE SOME LAG IN HEIGHT CONTROL, BUT COULD NOT BE CERTAIN OF THIS IN PRESENCE OF THIS WIND

6 BREAKOUT AND FLARE

Flight 109-1:
EASE OF ARRESTING RATE OF DESCENT: NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: FAIR

COMMENTS:

Flight 91-2:
EASE OF ARRESTING RATE OF DESCENT: SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: GOOD

COMMENTS: SENSED THE POSSIBILITY OF A SLIGHT HEAVE PIO NEAR TOUCHDOWN. SET A REASONABLE RATE OF DESCENT AND HELD IT - THIS WAS SATISFACTORY.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

Flight 91-2: NONE. SOME LOCALIZER "S" TURNING BELOW 1000 FT.

9 LEAST OBJECTIONABLE FEATURES

Flight 91-2: GOOD PITCH STIFFNESS. SPEED AND HEIGHT TRIMMABILITY GOOD.

10 MOST OBJECTIONABLE FEATURES

Flight 109-1: A GENERAL UNSTEADINESS MADE IT FEEL UNCOMFORTABLE

Flight 91-2: NOTICEABLY SENSITIVE TO TURBULENCE IN HEAVE, NOT PITCH.

11 MISCELLANEOUS

Flight 91-2: REVERSE GRADIENT IN WIND SHEAR I THINK. LIGHT WIND AT ALTITUDE, STRONG AT SURFACE.

CONFIGURATION	A14L	WIND(knots)	5
FLIGHT NUMBER	104-1	WIND SHEAR	NEGLIGIBLE
PILOT	C	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	4		

CHARACTERISTIC ROOTS: | -.04 | -1.43 | -1.06 ± | 1.051 |

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	TOO SMALL	TOO SMALL	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	SLIGHT	MODERATE	NONE	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	± 6 knots			fpm		

COMMENTS: SOME DIFFICULTY IN PREVENTING MODERATE SPEED DEPARTURES IN IMC TASK.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	SMALL	SHORT	HIGH
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION:	ELEVATOR	HARDLY
CONTROL:		

COMMENTS: SLIGHT PITCH OSCILLATION JUST DETECTABLE WITH SHARPER ELEVATOR INPUTS. VERY SMALL AND POSSIBLY DUE TO AUTOPILOT.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: NEGLIGIBLE

EASE OF COMPENSATION: DIFFICULTY

COMMENTS:

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	NONE	NONE	SLIGHT	NONE	MODERATE	SLIGHT
PRECISION	GOOD	GOOD	FAIR	GOOD	POOR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: [ ]

COMMENTS: GAINED 10 KNOTS IN TRYING TO KEEP DOWN ON GLIDE PATH DURING INTERMEDIATE TRACK.

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: SLIGHT DIFFICULTY

PRECISION OF ATTAINING TOUCHDOWN POINT: FAIR

COMMENTS

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE

9. LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES: CONTROL OF SPEED LACKS CRISPNESS. TOO EASY TO ALLOW RATHER LARGE DEPARTURES.

11. MISCELLANEOUS: ELEVATOR TRIM RATE NOTICEABLY SLOWER THAN SOME PREVIOUS MODELS. SPEED HOLDING RATHER POORER THAN IN PREVIOUS TWO MODELS (8-2L, R4-3L) BUT LESS NEED EXISTS FOR POWER LEVER ADJUSTMENTS.

CONFIGURATION		WIND(knots)	
FLIGHT NUMBER		WIND SHEAR	
PILOT		EXTERNAL TURBULENCE	
PILOT-RATING			

CHARACTERISTIC ROOTS: | | | | |

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = (rad/sec²)/in		$Z_{\delta T}$ = (ft/sec²)/in	
Initial	Final	Initial	Final

Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
VMC	IMC	IMC	VMC	IMC	IMC
OUT	OUT	IN	OUT	OUT	IN
knots			fpm		

AMPLITUDE	PERIOD	DAMPING

SOURCE	DEGREE

DIFFICULTY

Intercept & initial track		Intermediate track		Final track	
Glide path	Localizer	Glide path	Localizer	Glide path	Localizer

DIFFICULTY

	Flight 110-L	Flight 101-1
CONFIGURATION	R14-1L	R14-1L
FLIGHT NUMBER	110-L	101-1
PILOT	A	B
PILOT-RATING	2	4C
WIND (knots)	5-10	10
WIND SHEAR		VERY SMALL
EXTERNAL TURBULENCE		LIGHT
CHARACTERISTIC ROOTS	-.03 | -1.45 | -1.05 ± | 1.061	-.03 | -1.46 | -1.06 ± | 1.061

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY: ELEVATOR $M_{\delta E} = 0.34$ (rad/sec²)/in; THRUST LEVER $Z_{\delta T} = 15.0$ (ft/sec²)/in

RESPONSE	Elevator Initial	Elevator Final	Thrust lever Initial	Thrust lever Final
Flight 110-L	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY
Flight 101-1	SATISFACTORY	SATISFACTORY	GOOD	GOOD

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (110-L)	NONE	SLIGHT	SLIGHT	NONE	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (110-L)	± 5 knots			OK fpm		
DIFFICULTY (101-1)	> SLIGHT	> SLIGHT	> SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (101-1)	± 5 knots			fpm		

COMMENTS:

Flight 110-L: TURBULENCE RESPONSE IN HEAVE TENDS TO KEEP ONE HONEST, BUT NO GREAT PROBLEMS - THE AIRSPEED DID WANDER SOMEWHAT, BUT THIS MODEL FELT BETTER THAN THE ATTITUDE COMMAND TYPE SINCE THE CONTROL FORCES DID NOT HAVE TO BE HELD TO MAINTAIN A NEW AIRSPEED.

Flight 101-1: DIFFICULTY MAY HAVE BEEN DUE TO OFFSET ELEVATOR TRIM.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE (110-L)	PERIOD (110-L)	DAMPING (110-L)	AMPLITUDE (101-1)	PERIOD (101-1)	DAMPING (101-1)
PITCH	ZERO			ZERO		
HEAVE	ZERO			ZERO		

	SOURCE (110-L)	DEGREE (110-L)	SOURCE (101-1)	DEGREE (101-1)
EXCITATION				
CONTROL				

COMMENTS

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 110-L	Flight 101-1
CHANGE REQUIRED	NEGLIGIBLE	NEGLIGIBLE
EASE OF COMPENSATION	NO DIFFICULTY	VERY SLIGHT DIFFICULTY

COMMENTS: NO PROBLEM - STEERS LIKE A KIDDIE CAR

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY (110-L)	NONE	NONE	NONE	NONE	NONE	NONE
PRECISION (110-L)	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD
DIFFICULTY (101-1)		SLIGHT	NONE	SLIGHT	< 400 FT. SLIGHT	SLIGHT
PRECISION (101-1)	FAIR/GOOD	FAIR	FAIR/GOOD	FAIR/GOOD	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

COMMENTS

Flight 101-1: OVERSHOT INITIALLY ON LOCALIZER.
GLIDESLOPE: PERHAPS A WIND SHEAR CAUSED ME TO GO LOW IN CLOSE - PERHAPS CROSSCHECK - 2 DOTS LOW AT BREAKOUT AT 200 FT.

6 BREAKOUT AND FLARE

	Flight 110-L	Flight 101-1
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	VERY SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	FAIR/GOOD

COMMENTS

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

Flight 110-L: SMALL

Flight 101-1: NONE

9 LEAST OBJECTIONABLE FEATURES

Flight 110-L: PITCH CONTROL WAS POSITIVE AND VERY STABLE

Flight 101-1: HEIGHT CONTROL SEEMED GOOD
ATTITUDE STABILITY, ALTHOUGH WEAK, WAS SATISFACTORY AND DID MAKE FOR GOOD TRIMMABILITY AND SPEED CONTROL.

10 MOST OBJECTIONABLE FEATURES

Flight 110-L: HEAVE RESPONSE TO TURBULENCE

11 MISCELLANEOUS

Flight 101-1: SENSITIVE TO TURBULENCE IN HEAVE (BUMPY RIDE).

	Left	Right
CONFIGURATION	A14-1L	A14-1L
FLIGHT NUMBER	115-3	96-2
PILOT	A	B
PILOT-RATING	4	3C
WIND (knots)		10
WIND SHEAR	NEGLIGIBLE	
EXTERNAL TURBULENCE	LIGHT	LIGHT
CHARACTERISTIC ROOTS	-.03, -1.46, -1.05 ± 1.061	-.03, -1.46, -1.05 ± 1.061

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER		ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in		$M_{\delta E}$ = 0.34 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

Left (Flight 115-3):

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	SLIGHT	MODERATE	NONE	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	+10, -5 knots			OK fpm		

COMMENTS: RESPONSE TO TURBULENCE GAVE SOME DIFFICULTY - THERE SEEMED TO BE A BOUNCINESS FOLLOWING A MODERATE TO LARGE TURBULENCE DISTURBANCE.

Right (Flight 96-2):

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	V.SLIGHT	V.SLIGHT	V.SLIGHT	V.SLIGHT	V.SLIGHT	V.SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	± 5 knots			fpm		

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING	AMPLITUDE	PERIOD	DAMPING
PITCH	SMALL	SHORT	MODERATE	ZERO		
HEAVE				ZERO		

	SOURCE	DEGREE	SOURCE	DEGREE
EXCITATION	TURBULENCE	EASILY		
CONTROL	ELEVATOR	EFFECTIVE		

COMMENTS: SEE SECTION #2

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Left	Right
CHANGE REQUIRED	NEGLIGIBLE	NEGLIGIBLE
EASE OF COMPENSATION	NO DIFFICULTY	VERY SLIGHT DIFFICULTY

COMMENTS

5 FLIGHT PATH CONTROL

Left (Flight 115-3):

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	MODERATE	SLIGHT	SLIGHT	SLIGHT
PRECISION	FAIR	FAIR	POOR	FAIR	FAIR	FAIR

Right (Flight 96-2):

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	NONE	V.SLIGHT	V.SLIGHT	SLIGHT	SLIGHT
PRECISION	FAIR/GOOD	GOOD	FAIR/GOOD	GOOD	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500 (left); OK (right)

COMMENTS

6 BREAKOUT AND FLARE

	Left	Right
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	FAIR/GOOD

COMMENTS: (right) BEING A LITTLE LOW AT BREAKOUT REQUIRED A SLIGHTLY DIFFERENT FLARE TECHNIQUE

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: SMALL (left); NONE. LOCALIZER TRACKING EASY BECAUSE HEIGHT CONTROL FAST. (right)

9 LEAST OBJECTIONABLE FEATURES

(right) GOOD ATTITUDE STABILITY
FLEW FIRST PART OF CIRCUIT, 900 FT TO DOWNWIND HANDS OFF!

10 MOST OBJECTIONABLE FEATURES

(left) RESPONSE TO TURBULENCE CAUSED A VERY UNSTEADY FEELING.

(right) A LITTLE SENSITIVE TO TURBULENCE

11 MISCELLANEOUS

(left) ELEVATOR CONTROL FORCES HIGH
ELEVATOR TRIM RATE SOMEWHAT TOO SLOW

CONFIGURATION A14-1 WIND (knots) 10-15
FLIGHT NUMBER 130-2 WIND SHEAR MODERATE
PILOT A EXTERNAL TURBULENCE NEGLIGIBLE (LIGHT BELOW 1200 FT)
PILOT-RATING 5½

CHARACTERISTIC ROOTS

-.03	-1.46	-1.05 ±	1.06i

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.3 (rad/sec²)/in		$Z_{\delta T}$ = 15.5 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	SLIGHT	MODERATE	NONE	SLIGHT	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	+10, -5 knots			± 200 fpm		

COMMENTS I HAD MUCH MORE DIFFICULTY ON THE APPROACH THAN WAS ANTICIPATED FROM V.F.R.FLYING. THE TURBULENCE BOUNCED THE AIRCRAFT AROUND SUFFICIENTLY TO DISTURB THE AIRSPEED AND VERTICAL SPEED CONTROL UNSATISFACTORILY.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: SMALL
EASE OF COMPENSATION: NO DIFFICULTY

COMMENTS:

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	MODERATE	MODERATE	GREAT
PRECISION	FAIR	FAIR	FAIR	POOR	POOR	VERY POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500

COMMENTS

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: GOOD

COMMENTS THE DESCENT RATE WAS HIGH AND THE APPLICATION OF POWER LEVER DID NOT SEEM TO BITE AS QUICKLY AS EXPECTED.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT SMALL TO MODERATE. THE WIND SHEAR OCCUPIED MORE ATTENTION THAN WAS AVAILABLE FOR LATERAL DIRECTIONAL CHARACTERISTICS WITHOUT SACRIFICING LONGITUDINAL CONTROL POSITION. HEADING CHANGES ON APPROACH TO MAINTAIN LOCALIZER WERE UNEXPECTEDLY LARGE.

9. LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES

11. MISCELLANEOUS

CONFIGURATION WIND (knots)
FLIGHT NUMBER WIND SHEAR
PILOT EXTERNAL TURBULENCE
PILOT-RATING

CHARACTERISTIC ROOTS

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = (rad/sec²)/in		$Z_{\delta T}$ = (ft/sec²)/in	
Initial	Final	Initial	Final

Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
VMC	IMC	IMC	VMC	IMC	IMC
OUT	OUT	IN	OUT	OUT	IN
knots			fpm		

AMPLITUDE	PERIOD	DAMPING

SOURCE	DEGREE

DIFFICULTY

Intercept & initial track		Intermediate track		Final track	
Glide path	Localizer	Glide path	Localizer	Glide path	Localizer

DIFFICULTY

CONFIGURATION	R14-2L	WIND (knots)	10
FLIGHT NUMBER	89-2	WIND SHEAR	SMALL
PILOT	A	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT RATING	4		

CHARACTERISTIC ROOTS

-.01	-1.52	-1.03 ±	1.07i

CONFIGURATION	R14-2L	WIND (knots)	10
FLIGHT NUMBER	102-3	WIND SHEAR	SMALL
PILOT	B	EXTERNAL TURBULENCE	MODERATE
PILOT-RATING	7½C		

CHARACTERISTIC ROOTS

-.01	-1.52	-1.03 ±	1.07i

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

Flight 89-2:

CONTROL SENSITIVITY:	ELEVATOR $M_{\delta E}$ = 0.35 (rad/sec²)/in		THRUST LEVER $Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

Flight 102-3:

CONTROL SENSITIVITY:	ELEVATOR $M_{\delta E}$ = 0.35 (rad/sec²)/in		THRUST LEVER $Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

Flight 89-2:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	SLIGHT	MODERATE	NONE	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	+10, -5 knots			± 100 fpm		

COMMENTS: THIS MODEL OBVIOUSLY HAD DECREASING VERTICAL FORCE WITH DECREASING LONGITUDINAL VELOCITY, BUT THIS WAS NOT BOTHERSOME. THE LACK OF ATTITUDE COMMAND OR STABILIZATION AS EVIDENCED BY RESPONSE TO ELEVATOR MADE AIRSPEED CONTROL SOMEWHAT DIFFICULT. THE TURBULENCE PRODUCED MORE MOTION IN HEAVE THAN NORMAL - NOT A PROBLEM.

Flight 102-3:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	GREAT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	5 knots			fpm		

COMMENTS: DIFFICULTY IN CONTROLLING SPEED ON APPROACH, WHICH REQUIRED BIG ELEVATOR AND PITCH ATTITUDE CHANGES TO CONTROL, WAS POSSIBLY DUE TO ATTITUDE INSTABILITY, CROSSCHECK OR TURBULENCE.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

Flight 89-2:

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION:		
CONTROL:		

COMMENTS

Flight 102-3:

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION:		
CONTROL:		

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 89-2	Flight 102-3
CHANGE REQUIRED	NEGLIGIBLE	SMALL
EASE OF COMPENSATION	NO DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS: (Flight 102-3) MUST BE CAREFUL TO COORDINATE AND MONITOR SPEED - LARGE NORMAL FORCES RESULT FROM AIRSPEED CHANGES.

5 FLIGHT PATH CONTROL

Flight 89-2:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	SLIGHT	NONE	SLIGHT	NONE
PRECISION	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD

Flight 102-3:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	NONE	SLIGHT	SLIGHT	MODERATE	MODERATE
PRECISION	FAIR	FAIR	FAIR	FAIR	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

COMMENTS: (Flight 102-3) SPEED CONTROL VERY POOR - OSCILLATING 5 KNOTS REGULARLY, SOMETIMES 10 - LARGE AGGRESSIVE CONTROL INPUTS TO CORRECT - OVERCORRECTED OFTEN.

6 BREAKOUT AND FLARE

	Flight 89-2	Flight 102-3
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	FAIR/GOOD

COMMENTS: (Flight 102-3) ALTHOUGH SPEED HELD WELL AT 60 KNOTS, A VERY HIGH RATE OF DESCENT DEVELOPED AT ABOUT 100 FT. A.G.L. JUST ENOUGH (LARGE) THRUST APPLIED TO ARREST TO REASONABLE DESCENT RATE AT TOUCHDOWN. COULD HAVE BEEN CAUSED BY WIND SHEAR.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: (Flight 89-2) SMALL; (Flight 102-3) NONE

9 LEAST OBJECTIONABLE FEATURES

(Flight 89-2) THE TURBULENCE RESPONSE CERTAINLY ADDED AT LEAST ONE RATING POINT TO THIS MODEL.

(Flight 102-3)
(1) WEAK ATTITUDE STABILITY BUT NOT TOO DIVERGENT - STILL SPEED CONTROL DIFFICULT.
(2) LARGE NORMAL FORCES WITH AIRSPEED CHANGES.
(3) THRUST CONTROL OF RATE OF DESCENT SLOW.

10 MOST OBJECTIONABLE FEATURES

(Flight 102-3) WIND STRONG AT SURFACE - WEAKER ABOVE. LARGE AGGRESSIVE CONTROL INPUTS ON APPROACH - BECAUSE OF PILOT FATIGUE AND HYPERACTIVITY I THINK - THIS WAS THE SEVENTH CONSECUTIVE APPROACH WITHOUT BREAKS.

11 MISCELLANEOUS

	Flight 90-2	Flight 93-3
CONFIGURATION	A14-2L	A14-2L
FLIGHT NUMBER	90-2	93-3
PILOT	A	B
PILOT-RATING	3	6D
WIND (knots)	10	CALM
WIND SHEAR	SMALL	SMALL
EXTERNAL TURBULENCE	LIGHT	LIGHT
CHARACTERISTIC ROOTS	-.01, -1.52, -1.03 ± 1.07i	-.01, -1.52, -1.03 ± 1.07i

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY:

	ELEVATOR		THRUST LEVER	
Flight 90-2	$M_{\delta E} = 0.34$ (rad/sec²)/in		$Z_{\delta T} = 15.0$ (ft/sec²)/in	
Flight 93-3	$M_{\delta E} = 0.34$ (rad/sec²)/in		$Z_{\delta T} = 15.0$ (ft/sec²)/in	

RESPONSE:

	ELEVATOR Initial	ELEVATOR Final	THRUST LEVER Initial	THRUST LEVER Final
Flight 90-2	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY
Flight 93-3	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

Flight 90-2:

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	NONE	NONE	NONE	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	± 5 knots			± 200 fpm		

COMMENTS: THE ATTITUDE COMMAND SYSTEM WORKED WELL IN HOLDING AIRSPEED. THE VERTICAL VELOCITY WAS INFLUENCED BY GUSTS AND BY AIRSPEED BUT NEITHER WERE SERIOUS.

Flight 93-3:

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	MODERATE	> SLIGHT	> SLIGHT	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	± 4 knots			fpm		

COMMENTS: DIFFICULTY DUE TO LARGE NORMAL FORCES CAUSED BY AIRSPEED CHANGES. NEED TO HOLD SPEED PRECISELY.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	Flight 90-2 AMPLITUDE	PERIOD	DAMPING	Flight 93-3 AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO			ZERO		
HEAVE	ZERO			ZERO		

	Flight 90-2 SOURCE	DEGREE	Flight 93-3 SOURCE	DEGREE
EXCITATION				
CONTROL				

COMMENTS

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 90-2	Flight 93-3
CHANGE REQUIRED	NEGLIGIBLE	NEGLIGIBLE
EASE OF COMPENSATION	NO DIFFICULTY	NO DIFFICULTY

COMMENTS: (Flight 93-3) AS LONG AS SPEED IS HELD PRECISELY.

5 FLIGHT PATH CONTROL

		Intercept & initial track Glide path	Intercept & initial track Localizer	Intermediate track Glide path	Intermediate track Localizer	Final track Glide path	Final track Localizer
Flight 90-2	DIFFICULTY	NONE	NONE	SLIGHT	NONE	SLIGHT	NONE
Flight 90-2	PRECISION	GOOD	GOOD	FAIR	GOOD	FAIR	GOOD
Flight 93-3	DIFFICULTY	NONE	NONE	SLIGHT	SLIGHT	MODERATE	MODERATE
Flight 93-3	PRECISION	FAIR/GOOD	FAIR/GOOD	FAIR	POOR	POOR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: (Flight 90-2) —; (Flight 93-3) 400

COMMENTS:

(Flight 90-2) THE THRUST CONTROL DID NOT SEEM TO SETTLE US INTO A STEADY DESCENT FOR QUITE A WHILE AND THE LEVER HAD TO BE INCHED WELL BACK TO GET THE DESIRED EFFECT.

(Flight 93-3) DIFFICULTY ON LOCALIZER DUE TO CROSS CHECK. AT ONE POINT, ABOUT 700 FT., FORGOT TO NOTICE LOCALIZER AT ALL AND, WHEN NOTICED, IT HAD GONE FULL DEFLECTION RIGHT - CORRECTED OK.

6 BREAKOUT AND FLARE

	Flight 90-2	Flight 93-3
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	FAIR/GOOD

COMMENTS: (Flight 93-3) DIFFICULTY DUE TO NEED TO HOLD SPEED PRECISELY AND THEN THE RATE OF DESCENT IS CONTROLLED ONLY BY THRUST LEVER. IF SPEED WERE TO BE CHANGING, IT WOULD BE VERY DIFFICULT TO COORDINATE THRUST LEVER POSITION WITH AIRSPEED TO GIVE PROPER RATE OF DESCENT AT TOUCHDOWN.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: (Flight 90-2) SMALL; (Flight 93-3) NONE

9 LEAST OBJECTIONABLE FEATURES

(Flight 93-3) VERY STIFF ATTITUDE STABILITY, BUT IT DOES NOT SIGNIFICANTLY ALLEVIATE THE PROBLEMS CAUSED BY THE LARGE NORMAL FORCES GENERATED WITH AIRSPEED CHANGES.

10 MOST OBJECTIONABLE FEATURES

(Flight 93-3) NOTICEABLY SENSITIVE TO TURBULENCE IN HEAVE AND PITCH.

11 MISCELLANEOUS

(Flight 93-3) SOME TAILWIND WHICH DID NOT AFFECT RATING. RATING 6 BECAUSE, EVEN WITH GOOD ATTITUDE STIFFNESS THERE IS A STRONG REQUIREMENT FOR THE PILOT TO MONITOR AIRSPEED TO KEEP RATE OF DESCENT UNDER CONTROL.

CONFIGURATION	A14-2L	WIND (knots)	10
FLIGHT NUMBER	120-1	WIND SHEAR	SMALL
PILOT	C	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	7		

CHARACTERISTIC ROOTS

-.01	-1.52	-1.03[illegible]	1.07[illegible]

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = 0.34	(rad/sec²)/in	$Z_{\delta T}$ = 15.0	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE	TOO SMALL	NOT ASSESSABLE	TOO SMALL	TOO SMALL

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	MODERATE	SLIGHT	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	± 5		knots			fpm

COMMENTS: LONGITUDINAL AND VERTICAL VELOCITY DIFFICULT TO HOLD ON FINAL STAGE OF APPROACH, V.M.C. SPEED TO 40 KNOTS DURING FLARE.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	SMALL	SHORT	LOW
HEAVE	SMALL	SHORT	LOW

	SOURCE	DEGREE
EXCITATION	ELEVATOR, TURBULENCE	EASILY
CONTROL	NOT ATTEMPTED	

COMMENTS: SMALL BUT SHARP OSCILLATION. DIFFICULT TO TELL WHETHER PITCH OR HEAVE OR BOTH.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED	MODERATE	
EASE OF COMPENSATION	MODERATE	DIFFICULTY

COMMENTS: AFFECTED BY SMALL SPEED CHANGES. LOST HEIGHT ([illegible] FT) ON TURNING BASE

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	GREAT	SLIGHT	SLIGHT	SLIGHT	MODERATE	SLIGHT
PRECISION	VERY POOR	GOOD	FAIR	POOR	POOR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 250

COMMENTS: GREATEST DIFFICULTY IN COMPLETING FLARE.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	GREAT	DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	VERY POOR	

COMMENTS: ALLOWED SPEED TO FALL TO 40 KNOTS DURING FLARE - UNABLE TO RECOVER SPEED EFFECTIVELY PRIOR TO TOUCHDOWN.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER: USED NORMAL TECHNIQUE, BUT INEFFECTIVE IN FLARE AND TURNS IF SPEED ALLOWED TO CHANGE.

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NO[illegible]

9 LEAST OBJECTIONABLE FEATURES

RELATIVELY EASY TO MAINTAIN STEADY STRAIGHT AND LEVEL OR DESCENDING FLIGHT.

10 MOST OBJECTIONABLE FEATURES

DIFFICULTY IN VERTICAL FLIGHT PATH CONTROL WHEN SPEED ALLOWED TO CHANGE.

11 MISCELLANEOUS

ELEVATOR FORCES HIGH AND TRIM RATE TOO SLOW.
THRUST LEVER DISPLACEMENTS TOO LARGE.
POWER INCREASES REQUIRED WHEN SPEED ALLOWED TO DROP, ARE TOO LARGE.

CONFIGURATION		WIND (knots)	
FLIGHT NUMBER		WIND SHEAR	
PILOT		EXTERNAL TURBULENCE	
PILOT-RATING			

CHARACTERISTIC ROOTS

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ =	(rad/sec²)/in	$Z_{\delta T}$ =	(ft/sec²)/in
Initial	Final	Initial	Final

Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
VMC	IMC	IMC	VMC	IMC	IMC
OUT	OUT	IN	OUT	OUT	IN
		knots			fpm

AMPLITUDE	PERIOD	DAMPING

SOURCE	DEGREE

DIFFICULTY

Intercept & initial track		Intermediate track		Final track	
Glide path	Localizer	Glide path	Localizer	Glide path	Localizer

DIFFICULTY

	Run 1	Run 2
CONFIGURATION	1-[illegible]	1-20
FLIGHT NUMBER	[illegible]-[illegible]	93-1
PILOT	[illegible]	B
PILOT-RATING	5	7C
WIND (knots)	1[illegible]-15 (GUSTS)	5
WIND SHEAR	MODERATE	
EXTERNAL TURBULENCE	NEGLIGIBLE	NEGLIGIBLE
CHARACTERISTIC ROOTS	-.01 ± .19i, -.59 ± .48i	-.01 ± .19i, -.59 ± .48i

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY / RESPONSE:

	ELEVATOR		THRUST LEVER	
Run 1	$M_{\delta E}$ = 0.5 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY
Run 2	$M_{\delta E}$ = .25 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (Run 1)	SLIGHT	SLIGHT	MODERATE	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (Run 1)	-4, -8 knots			O.K. fpm		
DIFFICULTY (Run 2)	SLIGHT	SLIGHT	>SLIGHT	>SLIGHT	> SLIGHT	>SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (Run 2)	+10, -2 knots			±200 fpm		

COMMENTS:

Run 1: A GENERAL PITCH ATTITUDE PROBLEM, NAMELY IT WAS TOO DIFFICULT TO FIND AND MAINTAIN THE CORRECT PITCH ATTITUDE TO GIVE THE DESIRED AIRSPEED.

Run 2: DIFFICULTY DUE TO PITCHING MOMENT ARISING FROM POWER CHANGES BECAUSE NOSE DROPS SIGNIFICANTLY WHEN POWER IS REDUCED, AND CONVERSELY WHEN POWER IS INCREASED. NEED TO TRIM LONGITUDINALLY AS RESULTING FORCES ARE REASONABLY HIGH.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE (Run 1)	PERIOD	DAMPING	AMPLITUDE (Run 2)	PERIOD	DAMPING
PITCH	ZERO			ZERO		
HEAVE	ZERO			ZERO		

EXCITATION:	SOURCE	DEGREE
CONTROL		

COMMENTS

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Run 1	Run 2
CHANGE REQUIRED	SMALL	NEGLIGIBLE
EASE OF COMPENSATION	NO DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS:

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY (Run 1)	SLIGHT	SLIGHT	MODERATE	MODERATE	MODERATE	MODERATE
PRECISION (Run 1)						
DIFFICULTY (Run 2)	NONE	NONE	SLIGHT/ MODERATE	SLIGHT	MODERATE	SLIGHT/ MODERATE
PRECISION (Run 2)	GOOD	GOOD	FAIR	FAIR	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: Run 1: 500; Run 2: 300

COMMENTS:

Run 1: PITCH ATTITUDE PROBLEM AS IN SECTION [illegible] ABOVE.

Run 2: DIFFICULTY DUE TO S-TURNING TO STAY ON LOCALISER. DISPLAY AND CROSS-CHECK WEAK ON HEADING.

6 BREAKOUT AND FLARE

	Run 1	Run 2
EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY	VERY SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	FAIR

COMMENTS:

Run 1: WAS SURPRISED AT BREAKOUT TO FIND HOW [illegible], AND THERE WAS SOME OVER-CONTROL [illegible] WHEN TRYING TO GET TO THE TOUCHDOWN POINT.

Run 2: DIFFICULTY DUE TO NEED TO KEEP CONTROL OF ATTITUDE WHILE MAKING SMALL POWER CHANGES.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: Run 1: NONE; Run 2: NONE

9 LEAST OBJECTIONABLE FEATURES

10 MOST OBJECTIONABLE FEATURES

Run 2: NO ATTITUDE STABILITY. COUPLING OF POWER CHANGES TO PITCH ATTITUDE BOTHERSOME ON GLIDE SLOPE CAUSING POOR SPEED CONTROL. SOME TURBULENCE UPSETS IN PITCH.

11 MISCELLANEOUS

Run 1: NOTE. THRUST LEVER SENSITIVITY CHANGED FROM 1[illegible] TO 15 F.S.[illegible]/IN.

Run 2: UP TO 1400 F.P.M. DESCENT RATE WERE REQUIRED TO CORRECT AND MAINTAIN GLIDE SLOPE.

	Flight 57-2		Flight 42-1
CONFIGURATION	1-2L		1-2
FLIGHT NUMBER	57-2		42-1
PILOT	C		D
PILOT-RATING	5½		7
WIND (knots)	5		5-10
WIND SHEAR	SMALL		SMALL
EXTERNAL TURBULENCE	NEGLIGIBLE		LIGHT/MODERATE
CHARACTERISTIC ROOTS	-.01± .19i, -.89± .48i		-.01± .19i, -.89± .48i

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

Flight 57-2

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = .30 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	NOT ASSESSABLE	SATISFACTORY	NOT ASSESSABLE

Flight 42-1

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = .30 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	SATISFACTORY	SLIGHTLY SMALL	TOO GREAT

2 EASE OF MAINTAINING DESIRED VELOCITIES

Flight 57-2

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	MODERATE	SLIGHT	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	±10 knots			fpm		

COMMENTS: BOTH AIRSPEED AND VERTICAL VELOCITY TENDED TO CREEP AWAY FROM DESIRED VALUES UNLESS GIVEN CONSTANT ATTENTION.

Flight 42-1

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	>MODERATE	SLIGHT	MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	±10 knots			±300-400 fpm		

COMMENTS: DIFFICULTY DUE TO OVERCONTROL IN HEADING AND HENCE LARGE BANK ANGLES. AIRSPEED IS AFFECTED BY LARGE BANK ANGLES WHICH THEN REQUIRE POWER CHANGES SINCE VERTICAL VELOCITY BUILDS UP.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

Flight 57-2

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS:

Flight 42-1

	AMPLITUDE	PERIOD	DAMPING
PITCH	SMALL	MEDIUM	MODERATE
HEAVE			

	SOURCE	DEGREE
EXCITATION	ELEVATOR TURBULENCE	HARDLY/MODERATELY
CONTROL	ELEVATOR	EFFECTIVE

COMMENTS: PROBLEM SEEMS TO BE A COUPLING BETWEEN PITCH ATTITUDE AND POWER LEVER. HEIGHT DAMPING IS PROBABLY LOW.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

Flight 57-2

CHANGE REQUIRED: NEGLIGIBLE

EASE OF COMPENSATION: SLIGHT DIFFICULTY

COMMENTS: WHEN ADDITIONAL THRUST WAS APPLIED, [illegible] ALTITUDE IN TURNS. OVER-COMPENSATION FOR THRUST DEMANDS.

Flight 42-1

CHANGE REQUIRED: MODERATE

EASE OF COMPENSATION: MODERATE DIFFICULTY

COMMENTS: SEEMS TO BE A LAG IN POWER LEVER RESPONSE.

5 FLIGHT PATH CONTROL

Flight 57-2

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	MODERATE	SLIGHT	GREAT	MODERATE
PRECISION						

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 300

COMMENTS: INADEQUATE CONTROL OF DESCENT RATE [illegible] APPROACH RESULTED IN CONSIDERABLE AIRSPEED VARIATION. AIRSPEED DECREASED TO BELOW 50 KNOTS AT ONE POINT AND SO BREAKOUT AT 300 FEET [illegible] FLARE.

Flight 42-1

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	MODERATE	MODERATE	MODERATE/GREAT	GREAT	GREAT	GREAT
PRECISION	FAIR	FAIR	POOR/VERY POOR	VERY POOR	VERY POOR	VERY POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET:

COMMENTS: MADE TWO FINAL APPROACHES. THE FIRST ONE VERY POOR PERFORMANCE. VERY HIGH RATE OF DESCENT AND STILL COULD NOT CATCH UP WITH THE GLIDE SLOPE. CONSEQUENTLY VERY POOR LOCALIZER TRACKING ALSO. SECOND APPROACH BETTER FROM 1000 FEET BUT STILL POOR PERFORMANCE DUE MAINLY TO OVERCONTROL.

6 BREAKOUT AND FLARE

Flight 57-2

EASE OF ARRESTING RATE OF DESCENT: MODERATE DIFFICULTY

PRECISION OF ATTAINING TOUCHDOWN POINT: FAIR

COMMENTS: DIFFICULTY DUE TO NEED TO CORRECT AIRSPEED FROM 50 KNOTS TO 50 KNOTS AFTER BREAKOUT.

Flight 42-1

EASE OF ARRESTING RATE OF DESCENT: SLIGHT DIFFICULTY

PRECISION OF ATTAINING TOUCHDOWN POINT: VERY POOR

COMMENTS: TRYING TO KEEP SPEED UP WHICH REQUIRED NOSE-DOWN, SEEMED INCOMPATIBLE WITH HIGH RATES OF SINK.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER:

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT:

- Flight 57-2: SMALL. IMPRESSION THAT [illegible] ANGLES [illegible] [illegible] LATERAL [illegible].
- Flight 42-1: NONE SMALL.

9 LEAST OBJECTIONABLE FEATURES

- Flight 57-2: NO NOTICEABLE OSCILLATION [illegible].
- Flight 42-1: GOOD PITCH DAMPING.

10 MOST OBJECTIONABLE FEATURES

- Flight 57-2: LACK OF PRECISION [illegible] APPROACH.
- Flight 42-1: DIFFICULTY IN ACHIEVING AND MAINTAINING AIRSPEED AND VERTICAL VELOCITY.

11 MISCELLANEOUS

- Flight 57-2:
- Flight 42-1: MAY BE POOR PILOT TECHNIQUE. FIRST FLIGHT OF THE DAY. NOT VERY CONFIDENT OF THIS RATING.

	Flight 75-1	Flight 34-2
CONFIGURATION	1-3L	1-3
FLIGHT NUMBER	75-1	34-2
PILOT	A	B
PILOT-RATING	8	10
WIND (knots)		10
WIND SHEAR	SMALL	MODERATE
EXTERNAL TURBULENCE	NEGLIGIBLE	MODERATE
CHARACTERISTIC ROOTS	.027 ± / .3211 / -.926 ± / .4711	.027 ± / .3211 / -.926 ± / .4711

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY (75-1)	$M_{\delta E}$ = 0.25 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE (75-1)	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY
CONTROL SENSITIVITY (34-2)	$M_{\delta E}$ = 0.40 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE (34-2)	TOO GREAT	CONFUSING	NOT ASSESSABLE	NOT ASSESSABLE

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (75-1)	MODERATE	GREAT	GREAT	MODERATE	GREAT	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS (75-1)	± 10 knots			± 300 fpm		
DIFFICULTY (34-2)	MODERATE	MODERATE	GREAT	MODERATE	GREAT	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS (34-2)	knots			fpm		

COMMENTS

75-1: COUPLING BETWEEN AIRSPEED AND VERTICAL SPEED IS STRONG AND IN ABNORMAL SENSE. NOSE DOWN INCREASES AIRSPEED AND ALTITUDE. THIS MAKES PRECISE AIRSPEED CONTROL DIFFICULT, SINCE THRUST CHANGES VARY THE AIRSPEED THROUGH THE ATTITUDE.

34-2: LARGE APPARENT AIRSPEED - VERTICAL VELOCITY COUPLING EFFECT.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH (75-1)	ZERO		
HEAVE (75-1)	ZERO		
PITCH (34-2)	SMALL	LONG	ZERO
HEAVE (34-2)	MODERATE/LARGE	LONG	ZERO

	SOURCE	DEGREE
EXCITATION (75-1)		
CONTROL (75-1)		
EXCITATION (34-2)	ELEVATOR, THRUST, TURBULENCE	EASILY
CONTROL (34-2)	ELEVATOR	AGGRAVATING

COMMENTS

34-2: HEAVE OSCILLATION COULD NOT BE CONTROLLED.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	75-1	34-2
CHANGE REQUIRED	SMALL	NEGLIGIBLE
EASE OF COMPENSATION	NO DIFFICULTY	NO DIFFICULTY

COMMENTS:

75-1: NO GREAT PROBLEM ENCOUNTERED BUT ONE IS OBLIGED TO MAINTAIN AIRSPEED VERY PRECISELY DURING MANOEUVRES IN ORDER TO KEEP THE VERTICAL SPEED UNDER CONTROL.

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY (75-1)	MODERATE	MODERATE	MODERATE	GREAT	MODERATE	MODERATE
PRECISION (75-1)	POOR	POOR	POOR	VERY POOR	POOR	POOR
DIFFICULTY (34-2)		MODERATE		SLIGHT		MODERATE
PRECISION (34-2)	FAIR	FAIR-GOOD	FAIR	GOOD		FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

75-1: 500

34-2:

COMMENTS

75-1: THE CHANGING VERTICAL SPEED WITH THE CHANGING AIRSPEED IN ADDITION TO THE PROBLEM OF FINDING THE PROPER HEADING TO ACHIEVE THE DESIRED TRACK (WIND HAS CHANGED FROM PREVIOUS FLIGHT), PRESENTS REAL DIFFICULTIES.

34-2: I.M.C. WOULD NOT BE ALLOWED WITH THIS MODEL. POOR CROSS-CHECK ON ENTRY AND CAPTURE. VERY DIFFICULT TO TRIM DURING INTERMEDIATE PHASE OF APPROACH DUE TO HIGH LONGITUDINAL AND GLIDE SLOPE TRACKING WORK LOAD.

6 BREAKOUT AND FLARE

	75-1	34-2
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	FAIR/GOOD

COMMENTS

34-2: HIGH ON BREAKOUT. ATTEMPTED TO SLOWLY BLEED OFF SPEED TO GIVE DESIRED VERTICAL VELOCITY AT TOUCHDOWN. HAD DECIDED TO MINIMISE USE OF POWER LEVER CONTROL IN TOUCHDOWN BECAUSE OF OSCILLATION CHARACTERISTICS. UNSUCCESSFUL BECAUSE RATE OF DESCENT TOO HIGH AT TOUCH DOWN.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

34-2: USED AIRSPEED - VERTICAL VELOCITY COUPLING EFFECT TO ATTEMPT TO CONTROL VERTICAL VELOCITY. MODERATELY EFFECTIVE BUT LEADS TO A VERY HIGH WORK LOAD.

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

75-1: SMALL. SOME [illegible] TO CHANGE RUDDER TRIM.

34-2: NONE.

9 LEAST OBJECTIONABLE FEATURES

10 MOST OBJECTIONABLE FEATURES

34-2: OSCILLATION. CONFUSING AND DISORIENTATING INTERACTION BETWEEN ELEVATOR AND POWER LEVER CONTROLS. COUPLING BETWEEN AIRSPEED AND VERTICAL VELOCITY NOT NICE. SHARP DISORIENTATING TURBULENCE RESPONSE.

11 MISCELLANEOUS

34-2: IMPROVEMENT REQUIREMENT IS MANDATORY. TOUCHDOWN DESCENT RATE TOO HIGH. [illegible] DISORIENTATING.

	Flight 71-2		Flight 75-3	
CONFIGURATION	2-2L		2-2L	
FLIGHT NUMBER	71-2		75-3	
PILOT	A		A	
PILOT-RATING	71/2		4	
WIND (knots)				
WIND SHEAR	MODERATE		SMALL	
EXTERNAL TURBULENCE	NEGLIGIBLE		LIGHT	

CHARACTERISTIC ROOTS

Flight 71-2	-.015±	.145i	-.50	-1.26
Flight 75-3	-.015±	.145i	-.50	-1.26

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY (71-2)	$M_{\delta E}$ = 0.30 (rad/sec²)/in		$Z_{\delta T}$ = 11.90 (ft/sec²)/in	
RESPONSE (71-2)	Initial	Final	Initial	Final
	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY
CONTROL SENSITIVITY (75-3)	$M_{\delta E}$ = 0.3 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
RESPONSE (75-3)	Initial	Final	Initial	Final
	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

Flight 71-2

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	GREAT	SLIGHT	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	+20, -10 knots			±200 fpm		

COMMENTS: PITCH ATTITUDE WAS IN A CONSTANT STATE OF CHANGE ESPECIALLY WITH TURBULENCE ON. AIRSPEED GOT AS HIGH AS 80 KNOTS JUST BEFORE BREAKOUT AS I WAS PREOCCUPIED WITH VERTICAL VELOCITY

Flight 75-3

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	MODERATE	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	+6, -5 knots			O.K. fpm		

COMMENTS: THE PITCH ATTITUDE DID NOT STAY WHERE DESIRED FOR VERY LONG AND MADE AIRSPEED CONTROL DIFFICULT. HOWEVER, THIS WAS ONLY MODERATELY BOTHERSOME AND, ON APPROACH, AIRSPEED WAS HELD RELATIVELY WELL.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH (71-2)	SMALL	MEDIUM	MODERATE
HEAVE (71-2)			
PITCH (75-3)	ZERO		
HEAVE (75-3)	ZERO		

	SOURCE	DEGREE
EXCITATION (71-2)	ELEVATOR, TURBULENCE	MODERATE
CONTROL (71-2)	ELEVATOR	PARTIALLY EFFECTIVE
EXCITATION (75-3)		
CONTROL (75-3)		

COMMENTS (71-2): THE NOSE SEEMS TO BOUNCE BACK AFTER BEING DISTURBED AND ONE HAS GREAT DIFFICULTY IN SETTING A PITCH ATTITUDE.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 71-2	Flight 75-3
CHANGE REQUIRED	MODERATE	SMALL
EASE OF COMPENSATION	SLIGHT DIFFICULTY	NO DIFFICULTY

COMMENTS

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY (71-2)	SLIGHT	SLIGHT	SLIGHT	SLIGHT	MODERATE	MODERATE
PRECISION (71-2)	FAIR	FAIR	FAIR	FAIR	POOR	POOR
DIFFICULTY (75-3)	SLIGHT	N/A	SLIGHT	N/A	SLIGHT	N/A
PRECISION (75-3)						

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500 (71-2); — (75-3)

COMMENTS (71-2): LOW ON THE GLIDE PATH AT 6-700 FEET A.G.L. AND A LARGE POWER INCREASE WAS MADE. THIS ARRESTED THE RATE OF SINK TOO MUCH AND CAUSED PROBLEMS ALL ROUND WITH AIRSPEED, HEADING, AND VERTICAL VELOCITY ALL AWAY FROM DESIRED VALUES.

COMMENTS (75-3): THE TALAR LOCALIZER FAILED AND THE APPROACH WAS CONTINUED ON STEERS BY THE SAFETY PILOT. THIS WORKED WELL BUT THE OVERALL WORK LOAD WAS DECREASED CONSIDERABLY.

6 BREAKOUT AND FLARE

	Flight 71-2	Flight 75-3
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	GOOD

COMMENTS

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: SMALL (71-2)

SMALL: THE HEADING CONTROL ON APPROACH WAS SLOPPY AND PERTURBATIONS AS GREAT AS 5 TO 10 DEGREES OCCURRED WITHOUT ADEQUATE DETECTION. (75-3)

9 LEAST OBJECTIONABLE FEATURES

10 MOST OBJECTIONABLE FEATURES

11 MISCELLANEOUS

THE TALAR LOCALIZER FAILED ON APPROACH AND THE LATTER WAS CONTINUED ON STEERS GIVEN BY SAFETY PILOT. THIS REDUCED OVERALL WORK LOAD CONSIDERABLY. (75-3)

	Flight 83-3	Flight 98-3
CONFIGURATION	2-2L	2-2L
FLIGHT NUMBER	83-3	98-3
PILOT	B	C
PILOT-RATING	4 1/2 D	6
WIND (knots)	15 KNOTS	ZERO
WIND SHEAR	SMALL	SMALL
EXTERNAL TURBULENCE	LIGHT	NEGLIGIBLE
CHARACTERISTIC ROOTS	-.015 ± .1451, -.50, -1.26	-.015 ± .1451, -.50, -1.26

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	Flight 83-3	Flight 98-3
CONTROL SENSITIVITY, ELEVATOR	$M_{\delta E}$ = .25 (rad/sec²)/in	$M_{\delta E}$ = 0.30 (rad/sec²)/in
CONTROL SENSITIVITY, THRUST LEVER	$Z_{\delta T}$ = 11.9 (ft/sec²)/in	$Z_{\delta T}$ = 11.9 (ft/sec²)/in
RESPONSE, ELEVATOR, Initial	SATISFACTORY	SATISFACTORY
RESPONSE, ELEVATOR, Final	SATISFACTORY	NOT ASSESSABLE
RESPONSE, THRUST LEVER, Initial	SATISFACTORY	TOO SMALL
RESPONSE, THRUST LEVER, Final	SATISFACTORY	NOT ASSESSABLE

2. EASE OF MAINTAINING DESIRED VELOCITIES

Flight 83-3:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	+5, -4 knots			OK fpm		

COMMENTS: SPEED FLUCTUATIONS WERE USUALLY CAUSED BY TURBULENCE.

Flight 98-3:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	GREAT	SLIGHT	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	+10, -5 knots			fpm		

COMMENTS: VERY DIFFICULT TO KEEP SPEED TO LESS THAN 70 KNOTS ON GLIDE PATH. WIND SHEAR POSSIBLY HAVING AN EFFECT.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	Flight 83-3 Amplitude	Period	Damping	Flight 98-3 Amplitude	Period	Damping
PITCH	ZERO			SMALL	MEDIUM	LOW
HEAVE	ZERO			ZERO		

	Flight 83-3 Source	Degree	Flight 98-3 Source	Degree
EXCITATION			UNKNOWN	HARDLY
CONTROL			ELEVATOR	EFFECTIVE

COMMENTS:

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 83-3	Flight 98-3
CHANGE REQUIRED	NEGLIGIBLE	SMALL
EASE OF COMPENSATION	NO DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS: (Flight 98-3) THRUST REQUIREMENTS NOT VERY APPARENT. TENDENCY TO LOSE SPEED AND GAIN ALTITUDE.

5. FLIGHT PATH CONTROL

	Intercept & initial track, Glide path	Intercept & initial track, Localizer	Intermediate track, Glide path	Intermediate track, Localizer	Final track, Glide path	Final track, Localizer
DIFFICULTY (83-3)	NONE	NONE	NONE	SLIGHT	NONE	SLIGHT
PRECISION (83-3)	GOOD	GOOD	GOOD	FAIR/GOOD	FAIR/GOOD	FAIR/GOOD
DIFFICULTY (98-3)	SLIGHT	SLIGHT	MODERATE	SLIGHT	GREAT	MODERATE
PRECISION (98-3)						

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: (83-3) — ; (98-3) 250

COMMENTS: (83-3) 500 FEET BREAKOUT O.K. IF "IN THE SLOT". ONLY DIFFICULTIES WERE CAUSED BY SLIGHTLY WEAK INSTRUMENT CROSS-CHECKS AND SOME WIND SHEAR.

(98-3) DIFFICULTY IN KEEPING SPEED LESS THAN 70 KNOTS. LARGE THRUST LEVER SETTING CHANGES.

6. BREAKOUT AND FLARE

	Flight 83-3	Flight 98-3
EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY	MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	POOR

COMMENTS: (83-3) SOME DIFFICULTY IN MAINTAINING SPEED ON BREAKOUT AND FLARE. PERHAPS DUE TO LOW GROUND SPEED.

(98-3) EXCESSIVE USE OF THRUST CONTROL AND ELEVATOR IN RETAINING GLIDE PATH DURING FINAL APPROACH.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: (83-3) NONE. (98-3) SMALL.

9. LEAST OBJECTIONABLE FEATURES: (83-3) GOOD PITCH ATTITUDE STABILITY. VERTICAL CHARACTERISTICS NOT AS GOOD AS PREVIOUS CONFIGURATION [illegible] FLOWN, BUT NOT BAD.

10. MOST OBJECTIONABLE FEATURES: (83-3) [illegible] SENSITIVE TO TURBULENCE. (98-3) OVERCOMPENSATION IN USE OF THRUST CONTROL.

11. MISCELLANEOUS: (83-3) INTERCEPTED GLIDE SLOPE AT 1700 FEET AND HELD GLIDE SLOPE WITH 450 [illegible] RATE OF DESCENT DOWN TO [illegible] FEET. THEREAFTER IT REQUIRED [illegible] RATE OF DESCENT. (98-3) THRUST LEVER DISPLACEMENTS TOO LARGE.

	Flight 79-2	Flight 97-3
CONFIGURATION	2-3L	2-3L
FLIGHT NUMBER	79-2	97-3
PILOT	A	B
PILOT RATING	6	8D
WIND (knots)		
WIND SHEAR	SMALL	SMALL
EXTERNAL TURBULENCE	MODERATE	MODERATE
CHARACTERISTIC ROOTS	+.006 ± , .2451 | -.51 | -1.30	+.006 ± , .2451 | -.51 | -1.30

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

Flight 79-2:

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E} = .30$ (rad/sec²)/in		$Z_{\delta T} = 11.90$ (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

Flight 97-3:

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E} = .30$ (rad/sec²)/in		$Z_{\delta T} = 11.90$ (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

Flight 79-2:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	MODERATE	GREAT	MODERATE	GREAT	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	+10, -5 knots			±300 fpm		

COMMENTS: UNSTABLE, AIRSPEED - VERTICAL SPEED COUPLING. THAT IS, AS AIRSPEED DECREASES, LIFT DECREASES RESULTING IN A DECREASE IN AIRSPEED AND THE AIRCRAFT SINKS AND SLOWS AT THE SAME TIME. THE REVERSE IS ALSO TRUE. THUS THE AIRCRAFT GOT HIGH ON GLIDE PATH AS AIRSPEED INCREASED.

Flight 97-3:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	>SLIGHT	>SLIGHT	>SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	±8 knots			fpm		

COMMENTS: RATE OF DESCENT UP TO 1200 F.P.M. INADVERTENTLY ONCE WHEN AIRSPEED WAS LOW. DIFFICULTY WAS DUE TO LACK OF PITCH STABILITY (THERE APPEARED TO BE A LOW AMPLITUDE PITCH-HEAVE OSCILLATION) AND TO AN INTERACTION BETWEEN AIRSPEED AND VERTICAL SPEED.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

Flight 79-2:

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS:

Flight 97-3:

	AMPLITUDE	PERIOD	DAMPING
PITCH	SMALL	LONG	ZERO/LOW
HEAVE	SMALL	LONG	ZERO/LOW

	SOURCE	DEGREE
EXCITATION	UNKNOWN	EASILY
CONTROL	ELEVATOR	EFFECTIVE

COMMENTS: NOTICE A "SWING BACK" EFFECT SOMETIMES. CAN JUST SEE AN OSCILLATION IN RESPONSE TO A STEP ELEVATOR INPUT.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 79-2	Flight 97-3
CHANGE REQUIRED	SMALL	SMALL
EASE OF COMPENSATION	SLIGHT DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS (79-2): DIFFICULTY WAS ONLY SLIGHT AS LONG AS AIRSPEED WAS HELD, BUT IF THE AIRSPEED CHANGED, [illegible] OCCURRED, THRUST ALTERATIONS WERE REQUIRED.

COMMENTS (97-3): MUST BE SURE TO HOLD AIRSPEED AND ATTITUDE.

5 FLIGHT PATH CONTROL

Flight 79-2:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	MODERATE	SLIGHT	[illegible]	SLIGHT
PRECISION	GOOD	GOOD	POOR	FAIR	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 50[illegible]

COMMENTS: AS PER SECTION 2 ABOVE.

Flight 97-3:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	V. SLIGHT	V. SLIGHT	SLIGHT	SLIGHT	MODERATE	MODERATE
PRECISION						

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: [illegible]

COMMENTS: NEARLY LOST CONTROL AT 800 FEET IN A P.I.O. STARTED AFTER MAKING A QUICK ELEVATOR INPUT TO CORRECT PITCH ATTITUDE. THIS DISRUPTED THE FLIGHT PATH WHICH WAS GENERALLY LOW THEREAFTER.

6 BREAKOUT AND FLARE

	Flight 79-2	Flight 97-3
EASE OF ARRESTING RATE OF DESCENT	MODERATE DIFFICULTY	MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	POOR	FAIR

COMMENTS (79-2): [illegible] PITCH AND [illegible] OVERRIDING THE [illegible] WOULD ONLY RESULT IN AN INCREASE IN AIRSPEED [illegible] RATE OF [illegible] DID NOT WORK TOO WELL.

COMMENTS (97-3): MUST RESIST THE TENDENCY TO PITCH AND FLARE THE AIRCRAFT [illegible] WHICH WOULD REDUCE AIRSPEED AND UNDESIRABLY INCREASE VERTICAL VELOCITY.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: [illegible] (79-2); N.A. (97-3)

9 LEAST OBJECTIONABLE FEATURES

10 MOST OBJECTIONABLE FEATURES

(79-2): [illegible]

(97-3): PITCH INSTABILITY AND LOW AMPLITUDE OSCILLATION COMBINED WITH NEED TO HOLD SPEED CONSTANT BECAUSE OF AIRSPEED - VERTICAL SPEED COUPLING EFFECT.

11 MISCELLANEOUS

	Flight 72-2		Flight 26-2	
CONFIGURATION	4-21		4-2	
FLIGHT NUMBER	72-2		26-2	
PILOT	A		B	
PILOT-RATING	4 1/2		6 1/2	
WIND (knots)			10	
WIND SHEAR	NEGLIGIBLE		MODERATE	
EXTERNAL TURBULENCE	LIGHT/MODERATE		MODERATE	

CHARACTERISTIC ROOTS

Flight 72-2	-.157 ±	.181i	+.12	-1.6
Flight 26-2	-.157 ±	.181i	+.12	-1.6

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY (72-2)	$M_{\delta E}$ = .25 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
CONTROL SENSITIVITY (26-2)	$M_{\delta E}$ = .4 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE (72-2)	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY
RESPONSE (26-2)	SATISFACTORY	NOT ASSESSABLE	SLIGHTLY SMALL	NOT ASSESSABLE

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (72-2)	NONE	SLIGHT	MODERATE	NONE	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (72-2)	+10, -5 knots			±100 fpm		
DIFFICULTY (26-2)	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (26-2)	+6, -10 knots			±200 fpm		

COMMENTS

72-2: PITCH ATTITUDE REQUIRED TOO MUCH ATTENTION TO STABILIZE. WIND DIRECTION AND SPEED CHANGED GREATLY DURING APPROACH CAUSING CONSTANT CHANGE IN HEADING AND RATE OF DESCENT.

26-2: REASON FOR DIFFICULTY NOT KNOWN.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE (72-2)	PERIOD (72-2)	DAMPING (72-2)	AMPLITUDE (26-2)	PERIOD (26-2)	DAMPING (26-2)
PITCH	ZERO			ZERO		
HEAVE	ZERO			ZERO		

	SOURCE (72-2)	DEGREE (72-2)	SOURCE (26-2)	DEGREE (26-2)
EXCITATION:				
CONTROL				

COMMENTS

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	72-2	26-2
CHANGE REQUIRED:	SMALL	NEGLIGIBLE
EASE OF COMPENSATION	SLIGHT DIFFICULTY	NO DIFFICULTY

COMMENTS:

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY: (72-2)	NONE	SLIGHT	SLIGHT	MODERATE	SLIGHT	GREAT
PRECISION (72-2)	GOOD	FAIR	FAIR	POOR	FAIR	POOR
DIFFICULTY: (26-2)	SLIGHT	NONE				
PRECISION (26-2)	FAIR/GOOD	GOOD	FAIR	FAIR	POOR/FAIR	POOR/FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 72-2: 500; 26-2: 400

COMMENTS

72-2: SEE SECTION 2 ABOVE.

26-2: DIFFICULTY DUE TO SLOW RESPONSE TO THRUST LEVER. NOT ABLE TO ANTICIPATE PRECISELY THE SLIGHT INTERACTION BETWEEN AIRSPEED AND VERTICAL VELOCITY.

6. BREAKOUT AND FLARE

	72-2	26-2
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	SLIGHT/MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	POOR

COMMENTS

72-2: AIRCRAFT BEHAVED VERY SMOOTHLY IN THIS PART OF THE FLIGHT, AND WAS IN FACT ONE OF THE BEST ENCOUNTERED.

26-2: WAS HIGH AT BREAKOUT. DIFFICULT TO ANTICIPATE THE REQUIREMENTS FOR ARRESTING HIGH RATE OF DESCENT THAT NEEDED TO BE ESTABLISHED. HOWEVER, WAS SUCCESSFUL IN ARRESTING HIGH RATE OF DESCENT FROM 400 FEET TO 20 FEET BEFORE TOUCHDOWN. LANDED LONG.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

72-2: SMALL, BUT THE LOW FREQUENCY YAW RESPONSE WAS TOO GREAT FOR SMALL RUDDER INPUTS

26-2: NONE

9. LEAST OBJECTIONABLE FEATURES

72-2: SIMULATED TURBULENCE HAD VERY LITTLE EFFECT.

10. MOST OBJECTIONABLE FEATURES

26-2: NEED TO STABILISE PITCH ATTITUDE. STILL CONFUSING THROTTLE/SPEED RELATIONSHIP.

11. MISCELLANEOUS

26-2: FELT THAT THE CONFIGURATION WAS BETTER THAN MY PERFORMANCE ON THE APPROACH INDICATED.

CONFIGURATION	4-2L	WIND(knots)	ZERO
FLIGHT NUMBER	98-2	WIND SHEAR	SMALL
PILOT	C	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	5		

CHARACTERISTIC ROOTS

-.157±	.181i	-.17	-1.6

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = .25 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	TOO SMALL	TOO GREAT	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	MODERATE	NONE	SLIGHT	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	-10, -5 knots			fpm		

COMMENTS: DIFFICULT TO CHECK LARGE SPEED CHANGES. LARGE THROTTLE MOVEMENTS REQUIRED TO CONTROL RATE OF DESCENT.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS: ANY MOTIONS HAD A RANDOM NATURE RATHER THAN AN OSCILLATORY ONE.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED	SMALL
EASE OF COMPENSATION	SLIGHT DIFFICULTY

COMMENTS: NEED FOR THRUST NOT EVIDENT.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	MODERATE	MODERATE
PRECISION						

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: [illegible]

COMMENTS: [illegible] DIFFICULTY IN CONTROLLING GLIDE PATH ON FINAL APPROACH. LARGE THROTTLE MOVEMENTS REQUIRED.

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR

COMMENTS: [illegible] RAPID ACTION

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE

9. LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES: TENDENCY [illegible]

11. MISCELLANEOUS

CONFIGURATION		WIND (knots)	
FLIGHT NUMBER		WIND SHEAR	
PILOT		EXTERNAL TURBULENCE	
PILOT-RATING			

CHARACTERISTIC ROOTS

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = (rad/sec²)/in		$Z_{\delta T}$ = (ft/sec²)/in	
Initial	Final	Initial	Final

Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
VMC	IMC	IMC	VMC	IMC	IMC
OUT	OUT	IN	OUT	OUT	IN
knots			fpm		

AMPLITUDE	PERIOD	DAMPING

SOURCE	DEGREE

DIFFICULTY

Intercept & initial track		Intermediate track		Final track	
Glide path	Localizer	Glide path	Localizer	Glide path	Localizer

DIFFICULTY

CONFIGURATION	4-3L	WIND(knots)	10
FLIGHT NUMBER	120-2	WIND SHEAR	SMALL
PILOT	A	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	8		

CHARACTERISTIC ROOTS: -.17± .29i | +.18 | -1.64

CONFIGURATION	4-3L	WIND(knots)	5
FLIGHT NUMBER	76-1	WIND SHEAR	SMALL
PILOT	B	EXTERNAL TURBULENCE	MODERATE
PILOT-RATING	6D		

CHARACTERISTIC ROOTS: -.17± | .29i , +.18 | -1.64

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY:
RESPONSE:

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = .25	(rad/sec²)/in	$Z_{\delta T}$ = 11.9	(ft/sec²)/in
Initial	Final	Initial	Final
SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = .30	(rad/sec²)/in	$Z_{\delta T}$ = 15.0	(ft/sec²)/in
Initial	Final	Initial	Final
SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY:	MODERATE	GREAT	GREAT	SLIGHT	MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	+15, -10		knots	±300		f.p.m.

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY:	SLIGHT	MODERATE	MODERATE	SLIGHT	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	+5, -10		knots	±300		f.p.m.

COMMENTS:

AN INCREASE IN AIRSPEED CAUSES AIRCRAFT TO CLIMB AND VICE VERSA. RESULTS IN AIRSPEED AND VERTICAL SPEED DIFFICULTIES ESPECIALLY ON THE APPROACH. PITCH CONTROL CAUSES A STEADY STATE RATE FOR A STEADY INPUT RESULTING IN A HIGH WORK LOAD.

DIFFICULTY CAUSED BY BOTH EXTERNAL AND SIMULATED TURBULENCE, AND APPARENTLY HIGH COUPLING BETWEEN AIRSPEED AND VERTICAL VELOCITY.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS:

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED	MODERATE	SMALL
EASE OF COMPENSATION	SLIGHT DIFFICULTY	NONE/SLIGHT DIFFICULTY

COMMENTS:

THE AIRSPEED FELL OFF IN THE FIRST TURN AND APPLICATION OF A FAIR AMOUNT OF POWER DID NOT STOP THE DESCENT. THE SECOND TURN WENT WELL AS THE AIRSPEED WAS KEPT CONSTANT.

MUST BE CAREFUL WITH THIS MODEL TO HOLD AIRSPEED IN TURNS.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	MODERATE	SLIGHT	MODERATE	SLIGHT	GREAT	MODERATE
PRECISION	POOR	POOR	POOR	POOR	VERY POOR	POOR

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	MODERATE	SLIGHT	SLIGHT	SLIGHT	SLIGHT/ MODERATE	MODERATE
PRECISION	FAIR/POOR	FAIR/POOR	FAIR	FAIR	FAIR/POOR	FAIR/POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 800 | 500

COMMENTS:

AS THE AIRSPEED INCREASED WE FLEW HIGH ON THE GLIDE PATH. TOO MUCH ATTENTION WAS REQUIRED TO THRUST CONTROL. A VERY HIGH MEAN DESCENT RATE SEEMED NECESSARY (OF THE ORDER OF 1000 F.P.M.), AND WE STILL BROKEOUT HIGH.

DIFFICULTY AT INTERCEPTION CAUSED BY 200 FEET HEIGHT LOSS IN FINAL TURN. SPEED CONTROL VERY IMPORTANT.

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	MODERATE/GREAT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	POOR

COMMENTS

DIFFICULT MODEL FOR SPEED AND HEIGHT CONTROL. TOUCHDOWN WOULD HAVE BEEN SHORT BECAUSE OF INABILITY TO ARREST DESCENT IN TIME.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: SMALL | NONE

9. LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES

AIRSPEED EFFECT ON POWER REQUIRED.

POOR ATTITUDE STABILITY AND LARGE ATTITUDE RESPONSE TO TURBULENCE. ROUGH RIDE IN TURBULENCE. APPARENT LOW HEIGHT-RATE DAMPING.

11. MISCELLANEOUS

RATE OF DESCENT ON APPROACH SEEMED HIGHER THAN NORMAL.

DIFFICULT TO KNOW WHAT TO DO IF LOW ON GLIDE SLOPE AND OFF ON SPEED. HAD TO SEPARATE THE HEIGHT AND SPEED CONTROLS BY FIRST ADJUSTING AIRSPEED TO 60 KNOTS AND THEN THE POWER FOR HEIGHT CONTROL.

	Left	Right
CONFIGURATION	19-2	19-2L
FLIGHT NUMBER	17-2	95-2
PILOT	A	B
PILOT-RATING	6	7 1/2 C
WIND (knots)	10-15	10
WIND SHEAR	MODERATE	SMALL
EXTERNAL TURBULENCE	LIGHT	LIGHT
CHARACTERISTIC ROOTS	0 ±	.1631	-.53 ±	.0211	0 ±	.1631	-.53 ±	.0211

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	Elevator $M_{\delta E}$ (rad/sec²/in)		Thrust lever $Z_{\delta T}$ (ft/sec²/in)	
CONTROL SENSITIVITY (left)	$M_{\delta E}$ = .20		$Z_{\delta T}$ = 15.0	
CONTROL SENSITIVITY (right)	$M_{\delta E}$ = 0.25		$Z_{\delta T}$ = 11.9	
	Initial	Final	Initial	Final
RESPONSE (left)	SATISFACTORY	TOO GREAT	SLIGHTLY SMALL	SLIGHTLY SMALL
RESPONSE (right)	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (left)	SLIGHT	SLIGHT	MODERATE	SLIGHT	MODERATE	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (left)	+10, -8 knots			±200 fpm		
DIFFICULTY (right)	SLIGHT	SLIGHT	MODERATE	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (right)	+8, -5 knots			fpm		

COMMENTS

THE PITCH ATTITUDE REQUIRES TOO MUCH ATTENTION FOR COMFORTABLE FLIGHT. PITCH CONTROL WAS POSITIVE, BUT SMALL INATTENTIONS RESULTED IN THE AIRSPEED CHANGING TOO RAPIDLY.

PITCH CHARACTERISTICS MAKE AIRSPEED AND THEREFORE, HEIGHT CONTROL DIFFICULT. (SOME INTERACTION)

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	Amplitude	Period	Damping
PITCH (left)	SMALL	MEDIUM	LOW
HEAVE (left)			
PITCH (right)	SMALL	LONG	
HEAVE (right)			

	Source	Degree
EXCITATION (left)	ELEVATOR, TURBULENCE	MODERATELY
CONTROL (left)	ELEVATOR	EFFECTIVE
EXCITATION (right)	UNKNOWN	MODERATE
CONTROL (right)	ELEVATOR	EFFECTIVE

COMMENTS

A SMALL AMPLITUDE PITCH OSCILLATION DID NOT SHOW [illegible] UNDER I.M.C. THE PITCH CONTROL WAS EFFECTIVE IN CONTROLLING THIS, BUT REQUIRED TOO MUCH ATTENTION.

JUST NOTICEABLE (NOT ENTIRELY SURE) OTHERWISE THE MODEL IS UNSTABLE IN PITCH FOR LARGE INPUTS.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Left	Right
CHANGE REQUIRED	MODERATE	SMALL
EASE OF COMPENSATION	SLIGHT DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS

NEED TO HOLD AIRSPEED AND ATTITUDE PRECISELY DUE TO INTERACTION OF VERTICAL AND HORIZONTAL SPEED EFFECTS.

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY (left)	SLIGHT	SLIGHT	MODERATE	MODERATE	MODERATE	GREAT
PRECISION (left)	GOOD	FAIR	POOR	POOR	FAIR	VERY POOR
DIFFICULTY (right)	NONE	NONE	SLIGHT	SLIGHT	SLIGHT	SLIGHT
PRECISION (right)	GOOD	GOOD	FAIR	FAIR	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 400 (left); [blank] (right)

COMMENTS

THE WIND SHEAR WAS DESIGNED TO [illegible] AND [illegible] 30 DEGREES OF PORT HEADING CHANGE THROUGHOUT THE FLIGHT. THE GLIDE SLOPE GOT LOW AT INTERMEDIATE STAGES, BUT WAS RECOVERED BY [illegible] ALL.

DIFFICULT TO MAINTAIN GOOD CROSS CHECK ON LOCALIZER ERROR BECAUSE OF POOR LONGITUDINAL CHARACTERISTICS (ATTITUDE, AIRSPEED, VERTICAL VELOCITY, COUPLING).

6 BREAKOUT AND FLARE

	Left	Right
EASE OF ARRESTING RATE OF DESCENT	[illegible] DIFFICULTY	VERY SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	FAIR GOOD

COMMENTS

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE (left); NONE (right)

9 LEAST OBJECTIONABLE FEATURES

SENSITIVITY TO TURBULENCE NOT BAD

10 MOST OBJECTIONABLE FEATURES [illegible]

PITCH INSTABILITY AND APPARENT UNDERLYING SMALL PITCHING OSCILLATION [illegible] DEAL OF ATTENTION TO BE GIVEN TO [illegible] PITCH ATTITUDE. [illegible] AIRSPEED CONTROL AND POOR CONTROL [illegible] ERROR

11 MISCELLANEOUS

[illegible]

[illegible] INTERACTION OF AIRSPEED AND VERTICAL VELOCITY [illegible] THE GLIDE PATH TRACKING TASK. [illegible] NCE WAS INTRODUCED DURING [illegible]

CONFIGURATION 19-2 WIND(knots) LIGHT
FLIGHT NUMBER 43-2 WIND SHEAR SMALL
PILOT D EXTERNAL TURBULENCE MODERATE
PILOT-RATING $6^{1/2}$

CHARACTERISTIC ROOTS

0±	.1631	-.53±	.021 i

CONFIGURATION WIND (knots)
FLIGHT NUMBER WIND SHEAR
PILOT EXTERNAL TURBULENCE
PILOT-RATING

CHARACTERISTIC ROOTS

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$=0.2	(rad/sec²)/in	$Z_{\delta T}$=15.0	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE	TOO GREAT	TOO GREAT	TOO SMALL	TOO GREAT

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$=	(rad/sec²)/in	$Z_{\delta T}$=	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE				

2. EASE OF MAINTAINING DESIRED VELOCITIES -

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	>SLIGHT	MODERATE	>MODERATE	>SLIGHT	>MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	±10		knots	>300		fpm

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY						
MAXIMUM UNDESIRED FLUCTUATIONS			knots			fpm

COMMENTS

INITIAL INPUTS DID NOT GIVE IMMEDIATE NOTICEABLE CHANGES BUT THEN, ONCE THEY DID BECOME NOTICEABLE THEY WERE RAPID.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE			

	AMPLITUDE	PERIOD	DAMPING
PITCH			
HEAVE			

	SOURCE	DEGREE
EXCITATION		
CONTROL		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

CONFIGURATION VERY LOOSE IN PITCH -- LOW ANGLE OF ATTACK STABILITY OR ZERO DAMPING SEEMED OK. LOTS OF TROUBLE IN HEIGHT CONTROL

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: MODERATE/LARGE
EASE OF COMPENSATION: MODERATE DIFFICULTY

DIFFICULTY

COMMENTS:

DIFFICULTY DUE TO LAG IN RESPONSE AND THEN LARGE RESPONSE ONCE STARTED.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	SLIGHT	SLIGHT	MODERATE	MODERATE	>MODERATE	>MODERATE
PRECISION	GOOD	GOOD	GOOD	GOOD	FAIR	FAIR

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:						
PRECISION						

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

COMMENTS:

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: FAIR

DIFFICULTY

COMMENTS:

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT NONE

9 LEAST OBJECTIONABLE FEATURES NO STRONG PIO TENDENCY

10. MOST OBJECTIONABLE FEATURES REQUIREMENT TO CONSTANTLY ADJUST THRUST CONTROL AND PITCH ATTITUDE BUT MOSTLY POWER.

11 MISCELLANEOUS PILOT'S PERFORMANCE OF TASK WAS REASONABLY GOOD BUT REQUIRED HIGH WORKLOAD.

	Flight 117-3	Flight 92-1
CONFIGURATION	19-3L	19-3L
FLIGHT NUMBER	117-3	92-1
PILOT	A	B
PILOT-RATING	9	8C
WIND (knots)	5	
WIND SHEAR	SMALL	SMALL
EXTERNAL TURBULENCE	NEGLIGIBLE	NEGLIGIBLE
CHARACTERISTIC ROOTS	.04± , .26L , -.49 , -.65	.04± , .26L , -.49 , -.65

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = .30 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE (117-3)	SATISFACTORY	TOO GREAT	SATISFACTORY	
RESPONSE (92-1)	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (117-3)	MODERATE	GREAT	GREAT	SLIGHT	MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS (117-3)	+10, -10 knots			+300, -300 fpm		
DIFFICULTY (92-1)	MODERATE	MODERATE	MODERATE	SLIGHT	>SLIGHT	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS (92-1)	+10, -5 knots			+300, -300 fpm		

COMMENTS

117-3: WHAT APPEARED TO BE A DIVERGENT LONGITUDINAL OSCILLATION, COUPLED WITH A HIGH TURBULENCE SENSITIVITY AND LARGE COUPLING BETWEEN AIRSPEED AND NORMAL FORCE, GAVE THE PILOT A LARGE WORKLOAD RESULTING IN POOR CONTROL OF AIRSPEED AND VERTICAL SPEED.

92-1: DIFFICULTY CAUSED BY AIRSPEED, VERTICAL VELOCITY COUPLING. POWER CHANGES AFFECT PITCH ATTITUDE AND HENCE AIRSPEED.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE (117-3)	PERIOD (117-3)	DAMPING (117-3)	AMPLITUDE (92-1)	PERIOD (92-1)	DAMPING (92-1)
PITCH	MODERATE	MEDIUM	LOW	ZERO		
HEAVE	MODERATE	MEDIUM	LOW	ZERO		

	SOURCE (117-3)	DEGREE (117-3)	SOURCE (92-1)	DEGREE (92-1)
EXCITATION	ELEVATOR, TURBULENCE	EASILY		
CONTROL	ELEVATOR, THRUST LEVER	INEFFECTIVE		

COMMENTS

117-3: THE MODAL MOTION SEEMED TO BE LONG PERIOD DIVERGENT OR PERHAPS A STRAIGHT PITCH DIVERGENCE.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	117-3	92-1
CHANGE REQUIRED	NEGLIGIBLE	VERY SMALL
EASE OF COMPENSATION	NO DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS

117-3: NO DIFFICULTY AS LONG AS THE AIRSPEED WAS MAINTAINED.

92-1: THERE IS A NEED TO HOLD AIRSPEED CONSTANT. (ie. GOOD ATTITUDE CONTROL IS NEEDED.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY (117-3)	MODERATE	SLIGHT	GREAT	SLIGHT	GREAT	SLIGHT
PRECISION (117-3)	FAIR	FAIR	POOR	FAIR	VERY POOR	FAIR
DIFFICULTY (92-1)	SLIGHT	SLIGHT	SLIGHT	SLIGHT	>MODERATE	MODERATE
PRECISION (92-1)	FAIR	FAIR	FAIR	FAIR/POOR	VERY POOR	POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 1000 (117-3); 500 (92-1)

COMMENTS

117-3: THE ENORMOUS EFFECT OF AIRSPEED ON LIFT (INCREASE IN AIRSPEED INCREASES LIFT) MADE CONTROL OF THE RATE OF DESCENT VERY DIFFICULT.

92-1: HEIGHT CONTROL DIFFICULT DUE TO COUPLING BETWEEN AIRSPEED AND VERTICAL VELOCITY, AND PITCH ATTITUDE CHANGES DUE TO POWER LEVER OPERATION.

6 BREAKOUT AND FLARE

	117-3	92-1
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	FAIR

COMMENTS

92-1: HIGH ON GLIDE SLOPE AND BROKE OUT EARLY (350 FEET AGL) SO AS NOT TO OVERSHOOT LANDING POINT.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

92-1: NOT INTENTIONALLY DIFFERENT BUT AIRSPEED CHANGES CERTAINLY AFFECTED VERTICAL VELOCITY.

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

117-3: NONE

92-1: NONE. HOWEVER, UNABLE TO TRIM LATERAL CHANNEL.

9 LEAST OBJECTIONABLE FEATURES

117-3: NONE

10 MOST OBJECTIONABLE FEATURES

117-3: AS PER SECTION 2 ABOVE.

92-1: UNABLE TO RELATE SOME OF THE AIRCRAFT RESPONSES TO PILOT CONTROL APPLICATION. HEIGHT CONTROL POOR. AIRCRAFT DIVERGENT IN PITCH. POWER CHANGES AFFECT PITCHING MOMENT.

11 MISCELLANEOUS

92-1: ATTAINED 1500 F.P.M. RATE OF DESCENT ON APPROACH UNINTENTIONALLY SEVERAL TIMES ALTHOUGH I NEEDED IT.

CONFIGURATION 19-3
FLIGHT NUMBER 13-3
PILOT B
PILOT-RATING 10

WIND(knots) 5
WIND SHEAR SMALL
EXTERNAL TURBULENCE LIGHT

CHARACTERISTIC ROOTS

.04 ±	.261	-.49	-.65

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = .20	(rad/sec²)/in	$Z_{\delta T}$ = 15.0	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	NOT ASSESSABLE	SATISFACTORY	NOT ASSESSABLE

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY				MODERATE	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	-30, -10 knots			-700, +200 fpm		

COMMENTS UNABLE TO ASSESS WHAT IS HAPPENING ALONG THE VERTICAL AXIS.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH			
HEAVE			

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED	EXCESSIVE
EASE OF COMPENSATION	DIFFICULTY

COMMENTS UNCERTAINTY AS TO WHAT WAS HAPPENING. ON ONE OCCASION FULL THROW OF THE POWER LEVER FAILED TO PRODUCE THE REQUIRED RESPONSE. INCREASING THE VALUE OF $Z_{\delta T}$ FROM 11.9 TO 15.0 DID NOT MAKE MUCH IMPROVEMENT.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	GREAT		GREAT		GREAT	
PRECISION	VERY POOR		VERY POOR		VERY POOR	

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET 1500

COMMENTS MODEL NOT SUITABLE FOR I.M.C. FLIGHT. UNABLE TO TRACK VERTICAL VELOCITIES.

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT

COMMENTS: BREAKOUT AND FLARE NOT ACHIEVED.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

9. LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES HEIGHT CONTROL NOT ACCEPTABLE.

11. MISCELLANEOUS THRUST LEVER SENSITIVITY CHANGED FROM 11.9 TO 15.0.

CONFIGURATION
FLIGHT NUMBER
PILOT
PILOT-RATING

WIND (knots)
WIND SHEAR
EXTERNAL TURBULENCE

CHARACTERISTIC ROOTS

	ELEVATOR		THRUST LEVER	
	$M_{\delta E}$ =	(rad/sec²)/in	$Z_{\delta T}$ =	(ft/sec²)/in
	Initial	Final	Initial	Final

Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
VMC	IMC	IMC	VMC	IMC	IMC
OUT	OUT	IN	OUT	OUT	IN
knots			fpm		

AMPLITUDE	PERIOD	DAMPING

SOURCE	DEGREE

DIFFICULTY

Intercept & initial track		Intermediate track		Final track	
Glide path	Localizer	Glide path	Localizer	Glide path	Localizer

DIFFICULTY

	Flight 77-2	Flight 94-2
CONFIGURATION	7-2L	7-2L
FLIGHT NUMBER	77-2	94-2
PILOT	A	B
PILOT-RATING	9	7C
WIND (knots)	LIGHT	5
WIND SHEAR	SMALL	SMALL
EXTERNAL TURBULENCE	LIGHT	NEGLIGIBLE

CHARACTERISTIC ROOTS

-.013±	.1431	-.26	-1.51
-.013±	.1431	-.26	-1.51

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY: ELEVATOR $M_{\delta E} = 0.3$ (rad/sec²)/in; THRUST LEVER $Z_{\delta T} = 9.0$ (ft/sec²)/in

RESPONSE	Elevator Initial	Elevator Final	Thrust Lever Initial	Thrust Lever Final
Flight 77-2	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY
Flight 94-2	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION:	V.M.C.	I.M.C.	I.M.C.	V.M.C.	I.M.C.	I.M.C.
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (77-2)	MODERATE	GREAT	GREAT	MODERATE	GREAT	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS (77-2)	±15 knots			±400 fpm		
DIFFICULTY (94-2)	SLIGHT	SLIGHT	MODERATE	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (94-2)	+10, -4 knots			fpm		

COMMENTS:

STRONG COUPLING BETWEEN VERTICAL SPEED AND AIRSPEED MAKES BOTH MISERABLE TO CONTROL. THIS WAS ESPECIALLY TRUE ON APPROACH AND DURING THE 20 BANKED TURNS.

DIFFICULTY DUE TO:
1. INTERACTION BETWEEN AIRSPEED AND VERTICAL SPEED
2. PITCH INSTABILITY
3. TENDENCY TO PUT NOSE DOWN TO CATCH GLIDE SLOPE.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH (77-2)	ZERO		
HEAVE (77-2)	ZERO		
PITCH (94-2)	ZERO		
HEAVE (94-2)	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS:

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 77-2	Flight 94-2
CHANGE REQUIRED:	MODERATE	SMALL
EASE OF COMPENSATION:	GREAT DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS:

AS LONG AS THE AIRSPEED WAS MAINTAINED ACCURATELY, THE ALTITUDE DID NOT VARY, BUT A VARIATION OF 5 KNOTS WOULD RESULT IN A RATE OF DESCENT GREATER THAN 500 F.P.M.

AIRSPEED MUST BE MAINTAINED PRECISELY BECAUSE OF ITS EFFECT ON VERTICAL SPEED.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY (77-2)	MODERATE	SLIGHT	MODERATE	N/A	GREAT	N/A
PRECISION (77-2)	POOR	FAIR	VERY POOR		POOR	
DIFFICULTY (94-2)	NONE	SLIGHT	NONE	SLIGHT	SLIGHT	MODERATE
PRECISION (94-2)	GOOD	GOOD	GOOD	FAIR	FAIR	POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500 (77-2); 400 (94-2)

COMMENTS

LOCALIZER FAILED ON APPROACH. PRECISE CONTROL OF AIRSPEED IS REQUIRED FOR PRECISE CONTROL OF VERTICAL SPEED. AT ONE STAGE THE AIRSPEED FELL OFF TO AROUND 50 KNOTS AND THE RATE OF DESCENT WENT TO 1600 F.P.M. CORRECTING THE AIR-SPEED AND ADDING A TOUCH OF POWER DECREASED THE RATE OF DESCENT TO 300 F.P.M.

INITIAL LOCALIZER DIFFICULTY BECAUSE INTERCEPT ANGLE OF 90° IS TOO LARGE. 'S' TURNING ON LOCALIZER BECAUSE OF DISPLAY/CROSS-CHECK. LATERAL TASK REQUIRES TOO MUCH ATTENTION.

6. BREAKOUT AND FLARE

	Flight 77-2	Flight 94-2
EASE OF ARRESTING RATE OF DESCENT	MODERATE DIFFICULTY	SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	POOR	FAIR

COMMENTS

DIFFICULTY AS IN SECTION 2.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: SMALL: HEADING CONTROL DIFFICULT (77-2); NONE (94-2)

9. LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES

NO PERCEPTIBLE PITCH ATTITUDE STIFFNESS. AIRSPEED EFFECT ON VERTICAL SPEED.

PITCH INSTABILITY.
PITCH SOMEWHAT SENSITIVE TO TURBULENCE.

11. MISCELLANEOUS

THE LOCALIZER FAILED PART WAY DOWN APPROACH BUT I DO NOT THINK IT AFFECTED MY RATING.

NOTE: THE ARTIFICIAL TURBULENCE WAS NOT INTRODUCED DURING THIS EVALUATION.

	Flight 60-2	Flight 44-2
CONFIGURATION	8-2L	8-2L
FLIGHT NUMBER	60-2	44-2
PILOT	A	B
PILOT RATING	7	9C
WIND (knots)	5	10
WIND SHEAR	SMALL	
EXTERNAL TURBULENCE	LIGHT	MODERATE
CHARACTERISTIC ROOTS	-.10 ± .12i, 0, -1.60	-.10 ± .12i, 0, -1.60

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = .30 (rad/sec²)/in		$Z_{\delta T}$ = 12.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE (60-2)	SATISFACTORY	TOO SMALL	TOO SMALL	TOO SMALL
RESPONSE (44-2)	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (60-2)	MODERATE	MODERATE	GREAT	MODERATE	GREAT	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS (60-2)	+15, -20 knots			fpm		
DIFFICULTY (44-2)	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (44-2)	±9 knots			±100 fpm		

COMMENTS:

60-2: THE INTERACTION BETWEEN VERTICAL VELOCITY AND AIRSPEED MADE BOTH AIRSPEED AND ALTITUDE CONTROL DIFFICULT. PULLING NOSE UP RESULTED IN RAPID LOSS OF ALTITUDE. MUCH TOO MUCH ATTENTION REQUIRED TO AIRSPEED CONTROL.

44-2: REASON FOR DIFFICULTY NOT KNOWN. POSSIBLY TURBULENCE, TURN COORDINATION AND CROSS-CHECK.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE (60-2)	PERIOD	DAMPING	AMPLITUDE (44-2)	PERIOD	DAMPING
PITCH	ZERO			ZERO		
HEAVE	ZERO			ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS:

44-2: PILOT-INDUCED PITCH-HEAVE OSCILLATION ON DOWNWIND LEG. COULD HAVE RETAINED CONTROL.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 60-2	Flight 44-2
CHANGE REQUIRED	SMALL	SOME
EASE OF COMPENSATION	MODERATE DIFFICULTY	MODERATE/SLIGHT DIFFICULTY

COMMENTS:

60-2: THRUST REQUIREMENTS WERE SMALL AS LONG AS THE AIRSPEED WAS MAINTAINED CONSTANT. THRUST REQUIREMENTS BECAME SURPRISINGLY LARGE WITH CHANGING AIRSPEED.

44-2: SOME THRUST REQUIRED IN TURNS BUT COULDN'T LEARN PHASING OF POWER REQUIREMENTS. REASON FOR DIFFICULTY UNKNOWN.

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY (60-2)	SLIGHT	SLIGHT	GREAT	MODERATE	MODERATE	GREAT
PRECISION (60-2)	POOR	POOR	POOR	POOR	V. POOR	V. POOR
DIFFICULTY (44-2)	NONE	>SLIGHT	NONE	NONE	SLIGHT	>NONE
PRECISION (44-2)	GOOD	FAIR	GOOD	GOOD	FAIR	FAIR/GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 60-2: 500; 44-2: (blank)

COMMENTS:

60-2: DIFFICULT TO CONTROL RATE OF DESCENT AS AIRSPEED AND POWER CHANGED.

44-2: SLIGHTLY REDUCED PERFORMANCE ON INITIAL TRACK DUE TO RAPID ROLL TO 20 DEG. BANK REQUIRED TO INTERCEPT LOCALIZER. SOME DIFFICULTY DUE TO WIND SHEAR AND CROSS-CHECK.

6 BREAKOUT AND FLARE

	Flight 60-2	Flight 44-2
EASE OF ARRESTING RATE OF DESCENT	MODERATE DIFFICULTY	MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	POOR	FAIR/GOOD

COMMENTS:

44-2: SOME P.I.O. TENDENCY JUST PRIOR TO TOUCHDOWN.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

60-2: THERE APPEARED TO BE LITTLE CORRELATION BETWEEN THRUST LEVER POSITION AND RATE OF CLIMB WHEN THE AIRSPEED DROPPED OFF.

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

44-2: NONE

9 LEAST OBJECTIONABLE FEATURES

44-2: GOOD CONTROL OF VERTICAL VELOCITY ON APPROACH. GOOD ATTENUATION OF HIGH FREQUENCY DISTURBANCES IN PITCH.

10 MOST OBJECTIONABLE FEATURES

60-2: INTERACTION BETWEEN AIRSPEED AND VERTICAL SPEED. AIRSPEED CONTROL REQUIRED MUCH TOO MUCH ATTENTION.

44-2: PITCH-HEAVE DIVERGENCE WHICH SEEMED TO BE A RESULT OF THE SIMULATION OF THE PILOT STATION AHEAD OF THE C.G. UNCERTAINTY OF POWER RESPONSE. PITCH LOOSE IN STEADY STATE.

11 MISCELLANEOUS

44-2: THE RATING OF 9C WAS MAINLY INFLUENCED BY A PITCH/HEAVE DIVERGENCE WHICH WAS INTENTIONALLY EXCITED ON THE DOWNWIND LEG. OTHERWISE A RATING OF 6C WOULD HAVE BEEN GIVEN.

CONFIGURATION	6-2L	WIND(knots)	5
FLIGHT NUMBER	103-1	WIND SHEAR	NEGLIGIBLE
PILOT	C	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	4½		

CHARACTERISTIC ROOTS

-.10 ±	.12i	0	-1.60

CONFIGURATION	8-2L	WIND(knots)	5
FLIGHT NUMBER	126-1	WIND SHEAR	SMALL
PILOT	C	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	4		

CHARACTERISTIC ROOTS

-.10 ±	.12i	0	-1.60

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = .3 (rad/sec²)/in		$Z_{\delta T}$ = 7.4 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = .3 (rad/sec²)/in		$Z_{\delta T}$ = 7.4 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	SLIGHT	SLIGHT	NONE	SLIGHT	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	EXCEPT ON FINAL, ±5 knots			fpm		

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	MODERATE	SLIGHT	SLIGHT	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	5 knots			fpm		

COMMENTS

ENGINE MANIFOLD PRESSURE VERY SENSITIVE TO AIRSPEED CHANGES HENCE THERE WAS A RELUCTANCE TO APPLY POWER INCREASE CORRECTIONS AT LARGE POWER SETTINGS. THE RESULT WAS A LOSS OF HEIGHT, PARTICULARLY ON BASE LEG.

DIFFICULTY CAUSED BY EFFECT OF AIRSPEED VARIATION ON THRUST REQUIRED.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION CONTROL		

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION CONTROL	NONE	

COMMENTS

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED	MODERATE	
EASE OF COMPENSATION	MODERATE	DIFFICULTY

CHANGE REQUIRED	SMALL	
EASE OF COMPENSATION	SLIGHT	DIFFICULTY

COMMENTS

THRUST REQUIREMENTS IN TURNS WERE PROBABLY OBSCURED BY THRUST SENSITIVITY TO AIRSPEED CHANGES.

DIFFICULTY ASSOCIATED WITH THRUST LEVER ACTION REQUIRED TO COMPENSATE FOR EFFECTS OF AIRSPEED VARIATIONS.

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	MODERATE	MODERATE
PRECISION	GOOD	GOOD	GOOD	GOOD	POOR	FAIR

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	MODERATE	SLIGHT	SLIGHT	NONE	SLIGHT	NONE
PRECISION	POOR	GOOD	GOOD	GOOD	FAIR	GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 300

COMMENTS

BROKE OFF AT 300 FEET BECAUSE AIRSPEED HAD FALLEN BELOW 50 KNOTS IN TRYING TO MAINTAIN GLIDE SLOPE AND LOCALIZER.

DIFFICULTY DUE TO LOSS OF 300 FEET ON BASE LEG PRIOR TO GLIDE PATH INTERCEPT. DIFFICULT TO MAINTAIN HEIGHT AT 1900 FEET WITH CORRECT AIRSPEED AND HEADING.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	MODERATE	DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR	

EASE OF ARRESTING RATE OF DESCENT	SLIGHT	DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR	

COMMENTS

ONLY DIFFICULTY WAS ASSOCIATED WITH RECOVERY OF 60 KNOT AIRSPEED DURING FLARE.

AIRSPEED INCREASED TO 57 KNOTS DURING FLARE DUE TO OVERCONTROLLING.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

SMALL. LATERAL FORCES SEEMED A LITTLE HIGH IN COMPARISON WITH LONGITUDINAL FORCES.

NONE.

9 LEAST OBJECTIONABLE FEATURES

NO OSCILLATORY CHARACTERISTICS AND BEHAVIOUR GENERALLY PREDICTABLE.

RELATIVELY PLEASANT MODEL V.M.C.

10 MOST OBJECTIONABLE FEATURES

NECESSITY TO MAKE LARGE POWER CHANGES IN ORDER TO CORRECT FOR THE EFFECTS OF SPEED CHANGES.

MAIN DIFFICULTY EXPERIENCED IN HOLDING 70 KNOTS AND MAINTAINING ALTITUDE ON BASE LEG WHILE DECELERATING TO 60 KNOTS.

11 MISCELLANEOUS

MIGHT HAVE RATED MODEL SLIGHTLY BETTER IF LESS CONCERNED WITH OVER BOOSTING ENGINE.

CONFIGURATION	8-2L	WIND (knots)	5
FLIGHT NUMBER	44-1	WIND SHEAR	MODERATE
PILOT	D	EXTERNAL TURBULENCE	MODERATE
PILOT-RATING	8		

CHARACTERISTIC ROOTS

-.10 ±	.12i	0	-1.60

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = .34	(rad/sec²)/in	$Z_{\delta T}$ = 11.9	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE	TOO GREAT	TOO GREAT	TOO SMALL	TOO GREAT

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	>MODERATE	GREAT	SLIGHT	MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	>10 knots			±200 fpm		

COMMENTS:

DIFFICULTY SEEMED TO BE CAUSED BY MODEL DRAG CHARACTERISTICS. SMALL CHANGES IN PITCH ATTITUDE PRODUCED LARGE AIRSPEED CHANGES. ALSO FELT AS IF THERE WAS A LAG IN THRUST LEVER RESPONSE.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

AIRCRAFT FELT A LITTLE "LOOSE" IN PITCH BUT DID NOT OSCILLATE UNDER OPEN-LOOP CONDITIONS. A SLIGHT TENDENCY TO P.I.O.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: MODERATE
EASE OF COMPENSATION: MODERATE DIFFICULTY

COMMENTS

DIFFICULTY PROBABLY DUE TO POOR AIRSPEED CONTROL.

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	>SLIGHT	SLIGHT	MODERATE	SLIGHT	GREAT	GREAT
PRECISION	FAIR	GOOD	POOR	FAIR	V. POOR	POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 400

COMMENTS

VERY HIGH ON GLIDE PATH AND HENCE HAD A HIGH RATE OF DESCENT (1500 F.P.M.). AIRSP[illegible] LOW (40-45 KTS) AND SO JUST HELD IT CONSTANT AND CONCENTRATED ON STOPPING DESCENT. ENDED UP SHORT OF TOUCHDOWN POINT.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: GREAT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: VERY POOR

COMMENTS:

DIFFICULTY DUE TO VERY HIGH RATE OF DESCENT.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE

9 LEAST OBJECTIONABLE FEATURES

PITCH DYNAMICS SEEMED FAIR WITH REASONABLE DAMPING.

10 MOST OBJECTIONABLE FEATURES

VERY POOR AIRSPEED CONTROL AND, AS A RESULT, POOR GLIDE PATH CONTROL WITH LARGE THRUST LEVER EXCURSIONS.

11 MISCELLANEOUS

FLICKER OF ROTOR SHADOW IN COCKPIT ANNOYING. MODEL RATING DUE MAINLY TO POOR APPROACH PRECISION BELOW 1000 FEET.

CONFIGURATION
FLIGHT NUMBER
PILOT
PILOT-RATING
WIND (knots)
WIND SHEAR
EXTERNAL TURBULENCE

CHARACTERISTIC ROOTS

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ =	(rad/sec²)/in	$Z_{\delta T}$ =	(ft/sec²)/in
Initial	Final	Initial	Final

Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
VMC	IMC	IMC	VMC	IMC	IMC
OUT	OUT	IN	OUT	OUT	IN
knots			fpm		

AMPLITUDE	PERIOD	DAMPING

SOURCE	DEGREE

DIFFICULTY

Intercept & initial track		Intermediate track		Final track	
Glide path	Localizer	Glide path	Localizer	Glide path	Localizer

DIFFICULTY

CONFIGURATION	8-2	WIND(knots)	5
FLIGHT NUMBER	35-1	WIND SHEAR	SMALL
PILOT	B	EXTERNAL TURBULENCE	LIGHT/MODERATE
PILOT-RATING	8½		

CHARACTERISTIC ROOTS			
-.10±	.121	0	-1.60

CONFIGURATION	8-2	WIND(knots)	5-10
FLIGHT NUMBER	43-3	WIND SHEAR	SMALL
PILOT	D	EXTERNAL TURBULENCE	MODERATE
PILOT-RATING	8		

CHARACTERISTIC ROOTS			
-.10±	.121	0	-1.60

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY:
RESPONSE:

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = .40	(rad/sec²)/in	$Z_{\delta T}$ = 12.0	(ft/sec²)/in
Initial	Final	Initial	Final

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = .35	(rad/sec²)/in	$Z_{\delta T}$ = 12.0	(ft/sec²)/in
Initial	Final	Initial	Final
SATISFACTORY	SATISFACTORY	TOO SMALL	TOO GREAT

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY						
MAXIMUM UNDESIRED FLUCTUATIONS	±8		knots			fpm

COMMENTS: MODERATE INTERACTION BETWEEN AIRSPEED AND VERTICAL SPEED. APPARENT HEAVE OSCILLATION.

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NO	SLIGHT	MODERATE	SLIGHT	MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	±10		knots	>500		fpm

SEEMED AS THOUGH HEIGHT DAMPING WAS EITHER ZERO OR NEGATIVE. ALL TROUBLES ASSOCIATED WITH HEIGHT CONTROL WORK LOAD. PITCH MOMENT CONTROL WAS REASONABLE.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH			
HEAVE			

	SOURCE	DEGREE
EXCITATION:		
CONTROL:		

COMMENTS: SEEMED LIKE AN OSCILLATION IN HEAVE BUT CHARACTERISTICS COULD BE DUE TO A LONG TIME CONSTANT IN RESPONSE TO ELEVATOR OR POWER LEVER. COULD PERHAPS BE CONTROLLED BY POWER LEVER BUT THIS WAS NOT PURSUED.

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO	MEDIUM	HIGH
HEAVE	MODERATE/LARGE	LONG	SLIGHTLY NEGATIVE

	SOURCE	DEGREE
EXCITATION:	POWER LEVER	FAIRLY EASILY
CONTROL:	POWER LEVER	SLIGHTLY AGGRAVATING

EXCURSIONS IN VERTICAL VELOCITY WERE VERY LARGE, EXPECIALLY ON FINAL APPROACH BELOW 1000 FEET.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: NEGLIGIBLE
EASE OF COMPENSATION: NO DIFFICULTY

COMMENTS:

CHANGE REQUIRED: MODERATE
EASE OF COMPENSATION: MODERATE DIFFICULTY

DIFFICULTY DUE TO LAG IN INITIAL RESPONSE TO POWER LEVER DEMANDS.

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY						
PRECISION						

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500

COMMENTS: AIRSPEED - VERTICAL VELOCITY COUPLING, TOGETHER WITH HEAVE OSCILLATION, GIVES POOR GLIDE PATH CONTROL.

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	MODERATE	>SLIGHT	MODERATE	MODERATE	GREAT	GREAT
PRECISION	FAIR	FAIR	POOR	POOR	V. POOR	V. POOR

AS TALAR SENSITIVITY INCREASED NEAR END OF APPROACH, REASONABLE TRACKING ACCURACY, PARTICULARLY OF GLIDE SLOPE, COULD NOT BE MAINTAINED.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: SLIGHT/MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: FAIR

COMMENTS: IF BREAKOUT SPEED IS LOW, IT IS HARD TO REGAIN IT BY LOWERING THE NOSE. IF AT CORRECT AIRSPEED AT BREAKOUT IT IS POSSIBLE TO MAINTAIN AIRSPEED BY NOT FLARING.

DIFFICULTY

CANNOT BE RATED AS I MISSED THE APPROACH - TOO HIGH AND TOO FAR TO THE LEFT.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER: HAD TO CONTROL VERTICAL SPEED BY MAKING USE OF THE COUPLING CHARACTERISTICS OF THE MODEL BETWEEN AIRSPEED AND VERTICAL SPEED, THE AIRSPEED ITSELF BEING THE MORE IMMEDIATELY RESPONSIVE.

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE

NONE

9 LEAST OBJECTIONABLE FEATURES

PITCH AXIS WAS WELL DAMPED AND REASONABLY RESPONSIVE TO PILOT INPUTS.

10 MOST OBJECTIONABLE FEATURES

HEAVE OSCILLATION; AIRSPEED - VERTICAL SPEED COUPLING, ELEVATOR AND POWER LEVER CONTROL RESPONSES.

HEIGHT CONTROL REQUIRED EXCESSIVE PILOT ATTENTION.

11 MISCELLANEOUS

MODEL SEEMED REASONABLE IN VFR FLIGHT AND IMC LEVEL FLIGHT. HOWEVER, WAS SURPRISED WITH GREAT DIFFICULTY ON IMC APPROACH AND RATING REFLECTS PILOT PERFORMANCE DURING THIS PART OF THE TASK.

CONFIGURATION 11-2L
FLIGHT NUMBER 104-2
PILOT A
PILOT-RATING 8

WIND (knots) 5 - 10 KNOTS
WIND SHEAR SMALL
EXTERNAL TURBULENCE NEGLIGIBLE

CHARACTERISTIC ROOTS

+.016±	.242i	-.78	-1.04

CONFIGURATION 11-2L
FLIGHT NUMBER 101-2
PILOT B
PILOT-RATING 7½ C

WIND (knots) 10 KNOTS
WIND SHEAR
EXTERNAL TURBULENCE

CHARACTERISTIC ROOTS

+.016± .242i		-.78	-1.04

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = .20 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = .20 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
Initial	Final	Initial	Final
SATISFACTORY	SATISFACTORY	SLIGHTLY SMALL	SLIGHTLY SMALL

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	GREAT	SLIGHT	MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	±10 knots			±600 fpm		

Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
VMC	IMC	IMC	VMC	IMC	IMC
OUT	OUT	IN	OUT	OUT	IN
>SLIGHT	>SLIGHT	>SLIGHT	>SLIGHT	>SLIGHT	>SLIGHT
±5 knots			fpm		

COMMENTS:

CHANGES IN AIRSPEED CAUSED THE VERTICAL VELOCITY TO CHANGE IN AN UNSTABLE SENSE. THAT IS WITH INCREASES IN AIRSPEED, POWER INCREASED AND THE AIRCRAFT CLIMBED. THIS CAUSED GREAT DIFFICULTY ON THE APPROACH WHERE AIRSPEED CHANGES MADE VERTICAL VELOCITY CONTROL DIFFICULT. TURBULENCE DISTURBED PITCH ATTITUDE GREATLY AND VERY 'LOOSE' CONTROL OVER LATTER MADE AIRSPEED CONTROL DIFFICULT.

DIFFICULTY CAUSED BY LONG PERIOD PITCHING OSCILLATION.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

AMPLITUDE	PERIOD	DAMPING
MODERATE	LONG	ZERO
?	LONG	?

	SOURCE	DEGREE
EXCITATION		
CONTROL		

SOURCE	DEGREE
ELEVATOR	EFFECTIVE

COMMENTS

THE PITCH ATTITUDE WANDERED AND INITIALLY FELT LIKE THE BEGINNING OF AN OSCILLATION, BUT IT RESULTED IN A PURE DIVERGENCE.

CANNOT BE SURE IF IT IS AN OSCILLATION IN HEAVE AS WELL. IF SO IT MAY BE PARTLY RESPONSIBLE FOR POOR HEIGHT CONTROL. THE OSCILLATION IS ALWAYS PRESENT.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: NEGLIGIBLE
EASE OF COMPENSATION: NO DIFFICULTY

SMALL/MODERATE
SLIGHT/MODERATE DIFFICULTY

COMMENTS

POOR HEIGHT CONTROL, ESPECIALLY IN THE PRESENCE OF APPRECIABLE COUPLING BETWEEN AIRSPEED AND VERTICAL VELOCITY.

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	MODERATE	SLIGHT	GREAT	SLIGHT	GREAT	SLIGHT
PRECISION	POOR	FAIR	VERY POOR	FAIR	VERY POOR	FAIR

Intercept & initial track		Intermediate track		Final track	
Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
> NONE	> NONE	SLIGHT	SLIGHT	SLIGHT	SLIGHT
FAIR/GOOD	FAIR/GOOD	FAIR/GOOD	FAIR/GOOD	FAIR/GOOD	FAIR/GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500

COMMENTS

AS PER SECTION 2 ABOVE.

DIFFICULTY CAUSED BY SOME WIND SHEAR NEAR THE SURFACE (WIND DECREASED WITH ALTITUDE). ALSO NEED TO INTENSIFY CROSS-CHECK IN THE PRESENCE OF POOR PITCH AND HEIGHT CHARACTERISTICS.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: GOOD

NO DIFFICULTY
GOOD

COMMENTS:

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: SMALL

NONE

9 LEAST OBJECTIONABLE FEATURES

SPEED, DESCENT CONTROL FOR FLARE SURPRISINGLY GOOD.

10 MOST OBJECTIONABLE FEATURES: AS PER SECTION 2 ABOVE.

UNDERLYING PITCHING OSCILLATION DEMANDED MORE ATTENTION TO SPEED RATHER THAN PITCH. SHOULD BE CAREFUL OF CONTROLS ADDING TO AN UNEXPECTED OSCILLATORY REVERSAL. POOR HEIGHT CONTROL TOO CAUSED BY LONG TIME CONSTANT AND AIRSPEED CHANGES. PITCH DIVERGES QUICKLY IN RESPONSE TO STEP ELEVATOR INPUT.

11 MISCELLANEOUS

CONFIGURATION	11-2	WIND(knots)	15 KNOTS"
FLIGHT NUMBER	29-2	WIND SHEAR	MODERATE
PILOT	C	EXTERNAL TURBULENCE	MODERATE
PILOT-RATING	7		

CHARACTERISTIC ROOTS

+.016 ± j .2421	-.78	-1.04

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ =.30	(rad/sec^2)/in	$Z_{\delta T}$ =15.0	(ft/sec^2)/in
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	TOO SMALL	TOO SMALL	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	MODERATE	SLIGHT	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	±15 knots			fpm		

COMMENTS: SLOW FINAL RESPONSE TO CONTROL INPUTS.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS:

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED:	SMALL	
EASE OF COMPENSATION	MODERATE	DIFFICULTY

COMMENTS: LARGE POWER LEVER MOVEMENTS REQUIRED.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	MODERATE	MODERATE	GREAT	GREAT
PRECISION						

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 400

COMMENTS: AIRSPEED AND VERTICAL VELOCITY CONTROL OUT OF HAND. SPEED RESPONSE TO CONTROL INPUTS TAKES TOO LONG.

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	GREAT	DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	VERY POOR	

COMMENTS: BREAKOUT AND FLARE NOT COMPLETED.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE

9. LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES

SLOW FINAL RESPONSE TO CONTROL INPUTS.

11. MISCELLANEOUS

STRONG WIND SHEAR COMPLICATED TASK. UNABLE TO CHECK FINAL DESCENT AS AIRSPEED FELL OFF TO 40 KNOTS.
THRUST LEVER DISPLACEMENTS TOO LARGE.

CONFIGURATION		WIND (knots)	
FLIGHT NUMBER		WIND SHEAR	
PILOT		EXTERNAL TURBULENCE	
PILOT-RATING			

CHARACTERISTIC ROOTS

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ =	(rad/sec^2)/in	$Z_{\delta T}$ =	(ft/sec^2)/in
Initial	Final	Initial	Final

Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
VMC	IMC	IMC	VMC	IMC	IMC
OUT	OUT	IN	OUT	OUT	IN
knots			fpm		

AMPLITUDE	PERIOD	DAMPING

SOURCE	DEGREE

	DIFFICULTY

Intercept & initial track		Intermediate track		Final track	
Glide path	Localizer	Glide path	Localizer	Glide path	Localizer

	DIFFICULTY

CONFIGURATION	14-1L	WIND (knots)	CALM
FLIGHT NUMBER	65-2	WIND SHEAR	SMALL
PILOT	A	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	7 1/2		

CHARACTERISTIC ROOTS: | .17± | .19i | +.15 | -1.60 |

CONFIGURATION	14-1	WIND (knots)	10
FLIGHT NUMBER	39-1	WIND SHEAR	SMALL
PILOT	B	EXTERNAL TURBULENCE	LIGHT
PILOT-RATING	7 1/2C		

CHARACTERISTIC ROOTS: | -.17± | .19i | +.15 | -1.60 |

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY / RESPONSE:

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = .20	(rad/sec²)/in	$Z_{\delta T}$ = 15.0	(ft/sec²)/in
Initial	Final	Initial	Final
SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = .40	(rad/sec²)/in	$Z_{\delta T}$ = 11.9	(ft/sec²)/in
Initial	Final	Initial	Final
TOO GREAT		TOO GREAT	

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	GREAT	GREAT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	+5, -10 knots			O.K. fpm		

COMMENTS: PITCH ATTITUDE WAS VERY LOOSE AND CONTINUALLY WANDERED WITH SMALL ELEVATOR INPUTS AND FROM THE EFFECT OF TURBULENCE. WORKED VERY HARD TO KEEP PITCH ATTITUDE DEVIATIONS SMALL, OTHERWISE FELT THAT CONTROL WOULD BE LOST.

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	> NONE	> NONE	> SLIGHT		SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	± 8 knots			fpm		

ELEVATOR SENSITIVITY REDUCED TO 0.3 SHOULD BE ALL RIGHT. NOT, HOWEVER, A FACTOR IN RATING. DIFFICULTY DUE TO PITCH ATTITUDE INSTABILITY AND TO TURBULENCE EFFECTS.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	LARGE	MEDIUM	ZERO
HEAVE			

	SOURCE	DEGREE
EXCITATION	ELEVATOR, TURBULENCE	EASILY
CONTROL	ELEVATOR	EFFECTIVE

COMMENTS: THE ELEVATOR WAS EFFECTIVE IN CONTROLLING THE OSCILLATION AS LONG AS EXACTLY THE RIGHT THING WAS DONE BUT THE STEADY STATE RESPONSE TO ERRONEOUS INPUTS WAS ENORMOUS.

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: SMALL
EASE OF COMPENSATION: NO DIFFICULTY

COMMENTS:

CHANGE REQUIRED: SMALL-MODERATE
EASE OF COMPENSATION: SLIGHT DIFFICULTY

SOME THRUST REQUIRED IN TURNS BUT NOT ABLE TO LEARN EXACT REQUIREMENTS. NOT ABLE TO ASSESS POSSIBLE AIRSPEED-VERTICAL VELOCITY INTER-RELATIONSHIPS, ETC.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	MODERATE	SLIGHT
PRECISION	FAIR	FAIR	FAIR	FAIR	POOR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500

COMMENTS: AS PER SECTION 2 ABOVE.

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	SLIGHT	SLIGHT	NONE	SLIGHT	SLIGHT
PRECISION	GOOD	GOOD	FAIR	GOOD	FAIR	FAIR

LOCALIZER INTERCEPT ANGLE OF 90° IS ALWAYS TOO GREAT.

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: GOOD

COMMENTS:

EASE OF ARRESTING RATE OF DESCENT: NONE-SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: FAIR

NO REAL DIFFICULTY.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

NONE

9. LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES

UNCERTAIN AS TO HEAVE RESPONSE. PITCH ATTITUDE INSTABILITY AGGRAVATED BY TURBULENCE UPSETS.

11. MISCELLANEOUS

CONTROLLABILITY OF THIS MODEL COULD BE IN QUESTION DUE TO PITCH ATTITUDE DIVERGENCE

CONFIGURATION	14-?	WIND(knots)	5	CONFIGURATION	14-?	WIND(knots)	10
FLIGHT NUMBER	39-2	WIND SHEAR	SMALL/MODERATE	FLIGHT NUMBER	47-3	WIND SHEAR	SMALL
PILOT	3	EXTERNAL TURBULENCE	LIGHT/MODERATE	PILOT	D	EXTERNAL TURBULENCE	MODERATE
PILOT-RATING	8E			PILOT-RATING	9 1/2		

CHARACTERISTIC ROOTS

-.?0 ±	.30i	?.21	-1.63
-.20 ±	.39i	?.23	-1.63

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY:

RESPONSE:

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = .40 (rad/sec²)/in		$Z_{\delta T}$ = 11.9? (ft/sec²)/in	
Initial	Final	Initial	Final
SATISFACTORY		TOO SMALL	TOO SMALL

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = .35 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
Initial	Final	Initial	Final
TOO GREAT	TOO GREAT	TOO SMALL	TOO SMALL

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	±10 knots			fpm		

COMMENTS: THRUST LEVER CONTROL UNCERTAIN [illegible] IN NEEDING MORE THAN ANTICIPATED. MODERATE PITCH ATTITUDE INSTABILITY. [illegible] IS SOME STIFFNESS, BUT THE TIME CONSTANT IS TOO SHORT.

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	GREAT	GREAT	MODERATE	GREAT	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	>15 knots			>500 fpm		

COMMENTS: FEELS AS IF OPERATING WAY BACK ON POWER REQUIRED CURVE, AND ALSO AS IF AIRCRAFT IS STATICALLY UNSTABLE.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	AMPLITUDE	PERIOD	DAMPING
PITCH	MODERATE		
HEAVE			

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS: P[illegible] TENDENCY QUITE PRONOUNCED, PROBABLY DUE TO NEGATIVE STATIC MARGIN.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED

EASE OF COMPENSATION — DIFFICULTY

COMMENTS: SOME THRUST CHANGE IS [illegible].

CHANGE REQUIRED: EXCESSIVE

EASE OF COMPENSATION: GREAT DIFFICULTY

COMMENTS: [illegible]SPEED CONTROL POOR. HENCE USED LARGE POWER LEVER INPUTS CONSTANTLY. [illegible] IF AIRSPEED IS CAREFULLY CONTROLLED, ESSENTIALLY NO POWER IS REQUIRED IN TURNS.

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	MODERATE	SLIGHT
PRECISION	GOOD	GOOD	FAIR	FAIR	VERY POOR	POOR

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	MODERATE	MODERATE	MODERATE	MODERATE	GREAT	GREAT
PRECISION	FAIR	GOOD	POOR/FAIR	FAIR	VERY POOR	VERY POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 550

COMMENTS: THRUST CONTROL DIFFICULT. PERHAPS SENSITIVITY TOO LOW [illegible] UNDERESTIMATED POWER LEVER REQUIREMENTS [illegible] [illegible] FULL POWER [illegible] DESCENT [illegible] [illegible] POOR PRECISION BELOW 1500 FEET.

COMMENTS: AIRSPEED CONTROL AS THE 800 FEET LEVEL WAS APPROACHED WAS VERY POOR. [illegible] UNABLE TO TRACK GLIDE PATH. UNSUCCESSFUL APPROACH; COULD NOT LAND.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT — & — DIFFICULTY

PRECISION OF ATTAINING TOUCHDOWN POINT — FAIR

COMMENTS: POOR, BUT SAFE, POSITIONING AND [illegible] ON BREAKOUT AT 800 FEET.

COMMENTS: CANNOT COMMENT. NOT IN A POSITION TO ATTEMPT LANDING.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

T[illegible] COMBINE POWER LEVER AND AIRSPEED TO CONTROL VERTICAL VELOCITIES. SOME SUCCESS, BUT DURING FINAL APPROACH UNABLE TO TRACK GLIDE PATH.

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: [illegible]

NONE

9 LEAST OBJECTIONABLE FEATURES

NONE

10 MOST OBJECTIONABLE FEATURES: TOTAL [illegible] DYNAMIC RESPONSE [illegible] SIGNIFICANT IN PITCH AND [illegible] [illegible] [illegible] AND DYNAMICS [illegible] SUFFICIENT [illegible] INPUTS INTO THE SYSTEM.

AIRSPEED CONTROL REQUIRES EXCESSIVE PILOT EFFORT AND THE CONSEQUENCES OF DEVIATING FROM THE TRIM AIRSPEED ARE [illegible] CONTROL PROBLEMS WHICH ARE UNACCEPTABLE AND COULD LEAD TO LOSS OF CONTROL.

11 MISCELLANEOUS: SOME PITCH ATTITUDE [illegible] BUT STILL IS SUFFICIENT [illegible] TURBULENCE [illegible] [illegible] ATTITUDE EXCURSIONS [illegible] [illegible] [illegible] [illegible] RESPONSE AND [illegible] CONTROL [illegible]

	Left	Right
CONFIGURATION	1-PL	1-PL
FLIGHT NUMBER	113-1	81-1
PILOT	A	B
PILOT RATING	6	5D
WIND (knots)		
WIND SHEAR	SMALL	MODERATE
EXTERNAL TURBULENCE	NEGLIGIBLE	NEGLIGIBLE
CHARACTERISTIC ROOTS	-.046 ± .308i, -.857 ± .338i	-.046 ± .308i, -.857 ± .338i

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	Elevator $M_{\delta E} = .25$ (rad/sec²/in) Initial	Elevator Final	Thrust lever $Z_{\delta T} = 11.9$ (ft/sec²/in) Initial	Thrust lever Final
RESPONSE (left)	SATISFACTORY	TOO GREAT	SATISFACTORY	TOO GREAT
RESPONSE (right)	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS) VMC	IMC	IMC	Vertical velocity (ḣ) VMC	IMC	IMC
FLIGHT CONDITION / TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (left)	MODERATE	GREAT	GREAT	SLIGHT	MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS (left)	+15, -10 knots			±300 fpm		
DIFFICULTY (right)	SLIGHT	SLIGHT	SLIGHT	NONE	NONE	NONE
MAXIMUM UNDESIRED FLUCTUATIONS (right)	+8, -5 knots			fpm		

COMMENTS

Left: PITCH ATTITUDE WOULD NOT SETTLE DOWN AND CONSEQUENTLY AIRSPEED CONTROL GAVE TOO MUCH DIFFICULTY.

Right: PITCH ATTITUDE DIFFICULT TO TRIM IN TURBULENCE AND WHEN MAKING POWER ADJUSTMENTS, MUST RETRIM PITCH ATTITUDE IN ORDER TO HOLD AIRSPEED.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH (left)	MODERATE	MEDIUM	LOW
HEAVE (left)	ZERO		
PITCH (right)			
HEAVE (right)			

	SOURCE	DEGREE
EXCITATION (left)	ELEVATOR, TURBULENCE	EASILY
CONTROL (left)	ELEVATOR	EFFECTIVE
EXCITATION (right)		
CONTROL (right)		

COMMENTS

Left: APPROXIMATELY 90% OF AVAILABLE ATTENTION HAD TO BE DEVOTED TO PITCH ATTITUDE CONTROL SINCE THE OSCILLATORY CHARACTERISTICS JUST KEPT IT MOVING.

Right: SOME P.I.O. TENDENCY DURING LANDING FLARE.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Left	Right
CHANGE REQUIRED	SMALL	NEGLIGIBLE
EASE OF COMPENSATION	SLIGHT DIFFICULTY	NO DIFFICULTY

COMMENTS:

5 FLIGHT PATH CONTROL

	Intercept & initial track Glide path	Localizer	Intermediate track Glide path	Localizer	Final track Glide path	Localizer
DIFFICULTY (left)	SLIGHT	SLIGHT	MODERATE	MODERATE	GREAT	GREAT
PRECISION (left)	FAIR	FAIR	POOR	POOR	VERY POOR	VERY POOR
DIFFICULTY (right)	NONE	NONE	>NONE	>NONE	SLIGHT	SLIGHT
PRECISION (right)	GOOD	GOOD	GOOD	GOOD	FAIR/GOOD	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 800 (left); 300 (right)

COMMENTS

Left: TOO MUCH ATTENTION REQUIRED TO PITCH ATTITUDE LEAVING LITTLE FOR OTHER PARAMETERS. OVER-ANTICIPATED THE AMOUNT OF WIND SHEAR AND HAD TO MAKE SOME GROSS HEADING CORRECTIONS TOWARDS THE END OF THE APPROACH.

Right: WIND SHEAR CONTRIBUTED TO DIFFICULTY BUT DID NOT AFFECT RATING. THE PITCHING MOMENT DUE TO POWER CHANGES ON THE APPROACH NECESSITATED A TIGHT CONTROL OVER PITCH ATTITUDE IN ORDER TO HOLD AIRSPEED.

6 BREAKOUT AND FLARE

	Left	Right
EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY	SLIGHT/MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR	FAIR

COMMENTS:

Right: SOME TENDENCY TOWARD P.I.O. NECESSITATED ATTAINING AND MAINTAINING SOME ACCEPTABLE RATE OF DESCENT WHICH COULD BE CARRIED RIGHT TO TOUCHDOWN. THAT IS, HAD TO MINIMISE CONTROL INPUTS PRIOR TO TOUCHDOWN.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: SMALL (left); NONE (right)

9 LEAST OBJECTIONABLE FEATURES

Right: REASONABLE ATTITUDE STABILITY BUT WAS NOT FULLY EFFECTIVE IN THE PRESENCE OF POWER CHANGES ON THE GLIDE PATH.

10 MOST OBJECTIONABLE FEATURES

Right: PITCH RESPONSE TO POWER CHANGES REQUIRES PILOT ATTENTION. PITCH RESPONSE TO TURBULENCE IS NOTICEABLE. P.I.O. TENDENCY NEAR GROUND REQUIRES CARE FOR FLARE AND LANDING. ALL CONTRIBUTE TO HIGH PILOT WORK LOAD.

11 MISCELLANEOUS

CONFIGURATION	1-P	WIND(knots)	10+
FLIGHT NUMBER	47-2	WIND SHEAR	SMALL
PILOT	D	EXTERNAL TURBULENCE	MODERATE
PILOT-RATING	6 1/2		

CHARACTERISTIC ROOTS: | -.046± | .308i | -.857± | .338i |

CONFIGURATION	1-N	WIND(knots)	5
FLIGHT NUMBER	108-1	WIND SHEAR	SMALL
PILOT	A	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	4		

CHARACTERISTIC ROOTS: | +.10 | -.153 | -.867± | .504i |

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

Configuration 1-P:

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = .30	(rad/sec²)/in	$Z_{\delta T}$ = 11.9	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE	TOO SMALL	TOO GREAT	TOO SMALL	TOO SMALL

Configuration 1-N:

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = .25	(rad/sec²)/in	$Z_{\delta T}$ = 11.9	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

Configuration 1-P:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	MODERATE	SLIGHT	MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	±5		knots	± >300		fpm

COMMENTS: AIRCRAFT FELT AS IF IT WAS OPERATING ON BACKSIDE OF POWER REQUIRED CURVE.

Configuration 1-N:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	MODERATE	NONE	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	±10		knots			fpm

COMMENTS: DIFFICULTY DUE TO NO PITCH ATTITUDE STIFFNESS. TURBULENCE DISTURBED PITCH SUFFICIENTLY TO CAUSE SIGNIFICANT AIRSPEED CHANGES. SOME PITCHING MOMENT WITH POWER LEVER IN THE STABLE SENSE WHICH CAUSED MINOR PROBLEMS.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

Configuration 1-P:

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS: NO OSCILLATORY TENDENCY

Configuration 1-N:

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	1-P	1-N
CHANGE REQUIRED	LARGE	NEGLIGIBLE
EASE OF COMPENSATION	MODERATE DIFFICULTY	NO DIFFICULTY

COMMENTS (1-P): DIFFICULTIES AROSE WHEN AIRSPEED DEVIATED FROM TRIM AND I THEN HAD TROUBLE CONTROLLING RATE OF DESCENT. HOWEVER, IT WAS MANAGEABLE.

5. FLIGHT PATH CONTROL

Configuration 1-P:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	MODERATE	>SLIGHT	>MODERATE	>MODERATE
PRECISION	GOOD	GOOD	FAIR	GOOD	POOR	POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: [ ]

COMMENTS: AIRSPEED HAD TO BE CONTROLLED PRECISELY OR THE RATE OF DESCENT AND HENCE GLIDE SLOPE TRACKING SUFFERED.

Configuration 1-N:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	MODERATE
PRECISION	FAIR	FAIR	FAIR	FAIR	FAIR	POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: [ ]

COMMENTS: WIND SHEAR IN LOWER 500 FEET CAUSED SOME LOCALISER PROBLEMS.

6. BREAKOUT AND FLARE

	1-P	1-N
EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY	NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR	GOOD

COMMENTS

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER: I DID USE AIRSPEED TO SOME EXTENT TO CONTROL RATE OF DESCENT. THAT IS RATHER THAN MAKE LARGE POWER LEVER CHANGES I JUST LET AIRSPEED CHANGE 5 KNOTS WHILE MAKING SMALL POWER LEVER CHANGES.

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE

(1-N): NONE, HOWEVER RUDDER PEDAL FORCES SEEMED HIGHER THAN USUAL.

9. LEAST OBJECTIONABLE FEATURES GOOD PITCH DYNAMICS.

10. MOST OBJECTIONABLE FEATURES LARGE POWER LEVER INPUTS REQUIRED AND AIRSPEED HAD TO BE CONTROLLED PRECISELY TO PREVENT LARGE VERTICAL VELOCITY EXCURSIONS.

(1-N): PITCH ATTITUDE CONTINUALLY INCREASED WITH SMALL OUT-OF-TRIM ELEVATOR DEFLECTIONS.

11. MISCELLANEOUS

(1-N): NOTE: RUDDER CONTROL SENSITIVITY HAD BEEN REDUCED FROM 0.6 TO 0.4 r/S²/in. AFTER FLIGHT #102.

CONFIGURATION	1-2P
FLIGHT NUMBER	129-2
PILOT	A
PILOT-RATING	8
WIND (knots)	8
WIND SHEAR	SMALL
EXTERNAL TURBULENCE	NEGLIGIBLE

CHARACTERISTIC ROOTS

-.019±	.36i	-.89±	.35i

CONFIGURATION	L-2PL
FLIGHT NUMBER	73-1
PILOT	A
PILOT-RATING	6
WIND (knots)	10
WIND SHEAR	MODERATE
EXTERNAL TURBULENCE	MODERATE

CHARACTERISTIC ROOTS

-.019±	.36i	-.89±	.35i

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY:
RESPONSE:

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = .25	(rad/sec²)/in	$Z_{\delta T}$ = 11.9	(ft/sec²)/in
Initial	Final	Initial	Final
SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = .25	(rad/sec²)/in	$Z_{\delta T}$ = 11.9	(ft/sec²)/in
Initial	Final	Initial	Final
SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	GREAT	SLIGHT	MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	±5 knots			±300 fpm		

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	GREAT	SLIGHT	MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	±10 knots			±200 fpm		

COMMENTS:

THE NOSE IS IN CONSTANT MOTION WITH THE TURBULENCE IN, BUT IT BOUNCES IN RESPONSE TO ELEVATOR INPUTS AS WELL. THE VERTICAL VELOCITY WANDERS TOO MUCH BECAUSE OF TURBULENCE INPUTS.

THE NOSE DID NOT SEEM TO WANT TO STAY WHERE IT WAS PUT WITH TURBULENCE IN, ALTHOUGH BEFORE THERE HAD BEEN MODERATELY GOOD PITCH STABILITY. EXTERNAL TURBULENCE BECAME A FACTOR BELOW 1200 FEET.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	SMALL	SHORT	LOW
HEAVE			

	SOURCE	DEGREE
EXCITATION	ELEVATOR/TURBULENCE	MODERATELY/EASILY
CONTROL	ELEVATOR	INEFFECTIVE

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

THE FREQUENCY OF THE BOUNCE WAS SUCH THAT IT WAS DIFFICULT TO CATCH WITH THE ELEVATOR CONSISTENTLY.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: MODERATE
EASE OF COMPENSATION: MODERATE DIFFICULTY

CHANGE REQUIRED: MODERATE
EASE OF COMPENSATION: NO DIFFICULTY

COMMENTS:

A SLOW DESCENT THAT WAS DIFFICULT TO DETECT CREPT IN DURING THE TURNS.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	MODERATE	MODERATE	MODERATE	GREAT	MODERATE	GREAT
PRECISION	FAIR	POOR	FAIR	POOR	POOR	VERY POOR

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	MODERATE	MODERATE	MODERATE	SLIGHT	GREAT
PRECISION	FAIR	POOR	POOR	POOR	FAIR	POOR/VERY POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500

COMMENTS:

THE TURBULENCE WAS KICKING THE NOSE AROUND IN BOTH PITCH AND YAW, REQUIRING TOO MUCH ATTENTION.

DIFFICULTY DUE TO THIS BEING THE FIRST MODEL OF THE DAY AND THE WIND SPEED AND DIRECTION VARYING QUITE A LOT DURING THE DESCENT.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: GOOD

EASE OF ARRESTING RATE OF DESCENT: SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: GOOD

COMMENTS

BROKE OUT WELL TO THE LEFT BUT WAS ABLE TO GET TO THE TOUCH DOWN POINT.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: MODERATE. TURBULENCE KICKING NOSE AROUND TOO MUCH.

SMALL.

9 LEAST OBJECTIONABLE FEATURES

10 MOST OBJECTIONABLE FEATURES AS PER SECTIONS 2, 3 AND 5 ABOVE.

11 MISCELLANEOUS TWO APPROACHES WERE MADE.

	Configuration 1-2PL	Configuration 1-2P
CONFIGURATION	1-2PL	1-2P
FLIGHT NUMBER	75-2	46-1
PILOT	B	D
PILOT-RATING	5 1/2 C	4 1/2
WIND (knots)	CALM	20
WIND SHEAR	SMALL/NEGLIGIBLE	MODERATE
EXTERNAL TURBULENCE	NEGLIGIBLE	MODERATE
CHARACTERISTIC ROOTS	-.019± .36i, -.89± .35i	-.019± .36i, -.89± .35i

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	Elevator Initial	Elevator Final	Thrust Lever Initial	Thrust Lever Final
CONTROL SENSITIVITY (1-2PL)	$M_{\delta E} = .30$ (rad/sec²)/in		$Z_{\delta T} = 15.0$ (ft/sec²)/in	
RESPONSE (1-2PL)	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY
CONTROL SENSITIVITY (1-2P)	$M_{\delta E} = .30$ (rad/sec²)/in		$Z_{\delta T} = 15.0$ (ft/sec²)/in	
RESPONSE (1-2P)	SLIGHTLY SMALL	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS) VMC	IMC	IMC	Vertical velocity (ḣ) VMC	IMC	IMC
1-2PL TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
1-2PL DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
1-2PL MAXIMUM UNDESIRED FLUCTUATIONS	±3 knots			± 200 fpm		
1-2P TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
1-2P DIFFICULTY	NONE	SLIGHT	>SLIGHT	SLIGHT	MODERATE	MODERATE
1-2P MAXIMUM UNDESIRED FLUCTUATIONS	±5 knots			±200 fpm		

COMMENTS

1-2PL: DIFFICULTIES DUE TO LEARNING PROCESS AND INSTRUMENT CROSS-CHECKS.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	Amplitude	Period	Damping
PITCH (1-2PL)	ZERO		
HEAVE (1-2PL)	ZERO		
PITCH (1-2P)	ZERO		HIGH
HEAVE (1-2P)	ZERO		MODERATE

	Source	Degree
EXCITATION: CONTROL		

COMMENTS

1-2PL: SMALL ELEVATOR AND POWER LEVER P.I.O. EXCITED IN THE FLARE.

1-2P: THE SHORT PERIOD SEEMS WELL DAMPED AND OF MODERATE FREQUENCY. HOWEVER, THE PHUGOID HAS A FAIRLY HIGH FREQUENCY (15 SECS. APPROX.) AND THIS CAUSES SOME P.I.O. TENDENCIES ESPECIALLY IN TURBULENCE.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	1-2PL	1-2P
CHANGE REQUIRED	SMALL	SMALL
EASE OF COMPENSATION	SLIGHT DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS

5 FLIGHT PATH CONTROL

	Intercept & initial track Glide path	Localizer	Intermediate track Glide path	Localizer	Final track Glide path	Localizer
DIFFICULTY (1-2PL)	NONE	NONE	NONE	NONE	SLIGHT	SLIGHT
PRECISION (1-2PL)	GOOD	GOOD	GOOD/FAIR	GOOD/FAIR	GOOD/FAIR	GOOD/FAIR
DIFFICULTY (1-2P)	SLIGHT	SLIGHT	>SLIGHT	>SLIGHT	MODERATE	MODERATE
PRECISION (1-2P)	FAIR	FAIR	FAIR	GOOD	GOOD	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

COMMENTS

1-2PL: WENT HIGH AT 250 FEET FOR NO APPARENT REASON. AVERAGE RATE OF DESCENT ON GLIDE PATH WAS 950-1000 FT/MIN. SUSPECT WIND SHEAR WITH GRADIENT AT 300-250 FEET CAUSED ME TO GO HIGH.

1-2P: OVERALL PERFORMANCE SEEMED GOOD. HAD TO WORK REASONABLY HARD BUT ALWAYS ABLE TO GET BACK ON TRACK. SEEMED TO BE LARGE EFFECT OF THRUST LEVER CONTROL ON PITCHING MOMENT.

6 BREAKOUT AND FLARE

	1-2PL	1-2P
EASE OF ARRESTING RATE OF DESCENT	MODERATE DIFFICULTY	NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	FAIR

COMMENTS

1-2PL: SMALL/MODERATE PITCH-HEAVE P.I.O. EXCITED AT TOUCH DOWN.

1-2P: AIRSPEED WAS LOW AND LEVELLED OFF HIGH.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

1-2P: NONE

9 LEAST OBJECTIONABLE FEATURES

1-2PL: VERY LITTLE TURBULENCE RESPONSE. REASONABLE ATTITUDE STIFFNESS, BUT DIFFICULT TO TRIM.

1-2P: GOOD PITCH DAMPING AND GOOD HEIGHT DAMPING.

10. MOST OBJECTIONABLE FEATURES

1-2PL: PITCH-HEAVE P.I.O. TENDENCY AT TOUCH DOWN.

1-2P: LARGE PITCHING MOMENT WITH THRUST LEVER APPLICATION. SOME TENDENCY TO P.I.O., PROBABLY DUE TO SHORT PHUGOID PERIOD. PHUGOID, HOWEVER IS POSITIVELY DAMPED.

11. MISCELLANEOUS

CONFIGURATION	1-2N	CONFIGURATION	1-2N
FLIGHT NUMBER	82-3	FLIGHT NUMBER	51-2
PILOT	A	PILOT	D
PILOT-RATING	9	PILOT-RATING	6
WIND (knots)		WIND (knots)	CALM
WIND SHEAR	SMALL	WIND SHEAR	NEGLIGIBLE
EXTERNAL TURBULENCE	MODERATE	EXTERNAL TURBULENCE	LIGHT

CHARACTERISTIC ROOTS				
Flight 82-3	+.10	-.10	-.89 ±	.54i
Flight 51-2	+.10	-.10	-.89 ±	.54i

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY / RESPONSE

	ELEVATOR		THRUST LEVER	
	$M_{\delta E}$ = .25 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

	ELEVATOR		THRUST LEVER	
	$M_{\delta E}$ = .25 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	TOO SMALL	SATISFACTORY	SATISFACTORY	TOO GREAT

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	GREAT	GREAT	GREAT	MODERATE	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	±12 knots			± 200 fpm		

COMMENTS: THE PITCHING MOMENT WITH AIRSPEED WAS IN THE UNSTABLE SENSE, CAUSING ALARMING EXCURSIONS IN ATTITUDE. THE TRIM WITH AIRSPEED, BEING REVERSED, SEEMED VERY STRANGE.

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	>MODERATE	GREAT	>SLIGHT	MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	± 10 knots			> 300 fpm		

COMMENTS: COULD NOT TELL WHAT THE PROBLEM WAS. DID NOT FEEL LIKE BACKSIDE OF POWER CURVE AS DID PREVIOUS MODEL (R1-3). STICK FELT AS IF IT HAD BOB-WEIGHT EFFECT. I COULD NOT CONTROL AIRSPEED VERY WELL.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH			
HEAVE			

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS: A SIMPLE PITCH ATTITUDE DIVERGENCE WAS THE OVER-RIDING FEATURE.

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE			

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS: PITCH AT FIRST APPEARED TO BE O.K. (ie. DAMPED SHORT PERIOD) BUT I HAD A LOT OF DIFFICULTY TRIMMING AS IS GENERALLY TRUE WITH A NEGATIVE STATIC MARGIN.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED	MODERATE	MODERATE/LARGE
EASE OF COMPENSATION	SLIGHT DIFFICULTY	MODERATE/GREAT DIFFICULTY

COMMENTS: I DON'T KNOW BUT IT ALMOST SEEMED AS THOUGH I NEEDED LESS POWER IN TURNS THAN IN LEVEL FLIGHT.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	MODERATE	SLIGHT	MODERATE	SLIGHT
PRECISION	FAIR/GOOD	FAIR/GOOD	POOR/FAIR	FAIR/GOOD	FAIR	FAIR

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	MODERATE	MODERATE	GREAT	GREAT	GREAT	GREAT
PRECISION	FAIR	FAIR	VERY POOR	VERY POOR	VERY POOR	VERY POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 700

COMMENTS: AS PER SECTION 2 ABOVE.

WHEN AIRSPEED INCREASED (ESPECIALLY) I HAD GREAT DIFFICULTY IN REDUCING IT AND THEN I USUALLY OVERCONTROLLED AND GOT TOO SLOW. WHILE THIS WAS OCCURRING MY RATE OF DESCENT SUFFERED AND HENCE GLIDE SLOPE TRACKING WAS VERY POOR.

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY	NONE/SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR	FAIR

COMMENTS:

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: SMALL

NONE

9. LEAST OBJECTIONABLE FEATURES

NO OSCILLATORY TENDENCY. PRECISION OF ATTITUDE SEEMED O.K.

10. MOST OBJECTIONABLE FEATURES: AS PER SECTION 2 ABOVE.

AIRSPEED CONTROL VERY POOR. FOR SMALL CHANGES IN PITCH ATTITUDE, THE AIRSPEED SEEMED TO DIVERGE.

11. MISCELLANEOUS: EXTERNAL TURBULENCE BECOMING BORDERLINE.

THIS WAS A DIFFICULT CONFIGURATION TO FLY ON FINAL APPROACH AND I COULD NOT BE CERTAIN ABOUT WHAT WAS ACTUALLY CAUSING THE DIFFICULTY.

CONFIGURATION	1-3P	WIND (knots)	5
FLIGHT NUMBER	114-1	WIND SHEAR	NEGLIGIBLE
PILOT	A	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	7		

CHARACTERISTIC ROOTS: +.024 ± .44i ; -.93 ± .36i

CONFIGURATION	1-3P	WIND (knots)	10
FLIGHT NUMBER	26-1	WIND SHEAR	SMALL/MODERATE
PILOT	B	EXTERNAL TURBULENCE	MODERATE
PILOT-RATING	8 1/2		

CHARACTERISTIC ROOTS: +.024 ± .44i ; -.93 ± .36i

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E} = .25$	(rad/sec²)/in	$Z_{\delta T} = 11.9$	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E} = .4$	(rad/sec²)/in	$Z_{\delta T} = 11.9$	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	SATISFACTORY	NOT ASSESSABLE	NOT ASSESSABLE

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	GREAT	NONE	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	±10		knots	±200		fpm

COMMENTS: DIFFICULTY DUE TO: TURBULENCE CONTINUALLY KNOCKING NOSE AROUND IN PITCH. AIRSPEED EFFECT ON NORMAL FORCE TOO MUCH FOR COMFORT. (INCREASE IN AIRSPEED INCREASES NORMAL FORCE). PITCH CONTROL "LOOSE". ATTITUDE CONTINUOUSLY INCREASES WITH SMALL OUT-OF-TRIM ELEVATOR.

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	> NONE	> NONE	> NONE	> SLIGHT	> SLIGHT	> SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	±4		knots	±300		fpm

HAD TO CLOSELY MONITOR PITCH ATTITUDE TO KEEP VERTICAL VELOCITY UNDER CONTROL DUE TO WHAT APPEARED TO BE HIGH AIRSPEED - VERTICAL VELOCITY COUPLING AND PERHAPS TO THE VERTICAL DAMPING CHARACTERISTICS.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION CONTROL		

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION CONTROL		

COMMENTS

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: NEGLIGIBLE
EASE OF COMPENSATION: NO DIFFICULTY

COMMENTS: AIRSPEED REMAINED AT 60 KNOTS THROUGHOUT MANOEUVRES, AND HENCE HEAVE PROBLEMS EXPECTED FROM AIRSPEED CHANGES DID NOT ARISE.

CHANGE REQUIRED: SMALL/MODERATE
EASE OF COMPENSATION: SLIGHT/MODERATE DIFFICULTY

STILL HAD NOT LEARNT AMOUNT REQUIRED. USED ENGINE MANIFOLD PRESSURE AS THRUST CUE WHILE HOLDING AIRSPEED PRECISELY AT 60 KNOTS.

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	MODERATE	SLIGHT	GREAT	SLIGHT	MODERATE	SLIGHT
PRECISION	FAIR	FAIR/GOOD	POOR	FAIR	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 600

COMMENTS: AIRSPEED EFFECT ON GLIDE SLOPE GAVE PROBLEMS AND PITCH ATTITUDE DIFFICULTY OCCUPIED TOO MUCH TIME FOR ADEQUATE MONITORING OF ALL OTHER PARAMETERS

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	NONE	SLIGHT	> NONE	SLIGHT	SLIGHT
PRECISION	FAIR	GOOD	FAIR/GOOD	FAIR/GOOD	FAIR/GOOD	FAIR/GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500

AIRSPEED CONTROL TOO DEMANDING.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: GOOD

COMMENTS: WENT SURPRISINGLY WELL.

EASE OF ARRESTING RATE OF DESCENT: MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: GOOD

UNCERTAIN OF WHAT TO DO. HAD TO MAINTAIN SPEED, BUT DIFFICULT TO PREVENT PITCHING THE NOSE, WHICH I DID AT TOUCHDOWN, INDUCING A VERY HIGH BUT NOT UNSAFE VERTICAL VELOCITY JUST PRIOR TO TOUCHDOWN.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

STARTED WITH CONVENTIONAL CONTROL TECHNIQUE BUT THEN CHANGED TO CONSERVATIVE MIXTURE OF METHODS USING ±4 KNOTS TO ADJUST VERTICAL VELOCITY FOR GLIDE PATH CONTROL. GLIDE SLOPE TRACKING O.K. BUT PRECISE PITCH ATTITUDE - AIRSPEED CONTROL TOO TIRING

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE

NONE

9 LEAST OBJECTIONABLE FEATURES

10 MOST OBJECTIONABLE FEATURES

PITCH DISTURBANCES ON I.M.C. APPROACH. AIRSPEED EFFECT ON NORMAL FORCE DURING V.M.C. FLYING.

HIGH AIRSPEED - VERTICAL SPEED COUPLING EFFECT. APPARENT LARGE TIME CONSTANT IN POWER LEVER CONTROL.

11 MISCELLANEOUS

THIS MODEL SIMILAR TO #19-3N FLOWN PREVIOUSLY AND SO EXPERIENCE OF IT USED FOR LEARNING. HENCE PERFORMANCE WITH THIS MODEL MUCH BETTER.

CONFIGURATION	1-3N	WIND(knots)	
FLIGHT NUMBER	107-I	WIND SHEAR	
PILOT	A	EXTERNAL TURBULENCE	LIGHT
PILOT-RATING	8½		

CHARACTERISTIC ROOTS

.04±	.16i	-.931±	.568i

CONFIGURATION	1-3N	WIND (knots)	CALM
FLIGHT NUMBER	92-3	WIND SHEAR	SMALL/MODERATE
PILOT	B	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	8D		

CHARACTERISTIC ROOTS

.04±	.16i	-.931±	.568i

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$=.25	(rad/sec²)/in	$Z_{\delta T}$=11.9	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = .25	(rad/sec²)/in	$Z_{\delta T}$=11.9	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	GREAT	GREAT	SLIGHT	MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	±10		knots	± 200		fpm

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	MODERATE	GREAT	MODERATE	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	±10		knots	±300		fpm

COMMENTS:

DIFFICULTY DUE TO: TURBULENCE BOUNCING NOSE AROUND SEVERELY PITCHING WITH CHANGE OF VERTICAL SPEED BOTHERSOME. PITCH CONTROL "SLOPPY". POWER CHANGES WITH AIRSPEED VERY BOTHERSOME AND CAUSED REAL DIFFICULTIES STAYING ON AIRSPEED AND VERTICAL SPEED DURING APPROACH.

FEELS LIKE A LOT OF CROSS-COUPLING. PARTICULARLY AIRSPEED-VERTICAL VELOCITY INTERACTION AND POSSIBLY NEGATIVE PITCHING MOMENT-AIRSPEED INTERACTION.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	AMPLITUDE	PERIOD	DAMPING
PITCH			
HEAVE			

	SOURCE	DEGREE
EXCITATION:		
CONTROL		

	SOURCE	DEGREE
EXCITATION:		
CONTROL		

COMMENTS:

COULD BE AN UNDERLYING PITCHING OSCILLATION. SEEM TO BE DELAYED PITCH DISTURBANCES.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED:	SMALL	
EASE OF COMPENSATION	SLIGHT	DIFFICULTY

CHANGE REQUIRED:		
EASE OF COMPENSATION		DIFFICULTY

COMMENTS

NEED TO HOLD SPEED PRECISELY AND ALTITUDE CONTROL IS DIFFICULT.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE
PRECISION	FAIR	FAIR	POOR	POOR	FAIR	POOR

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	MODERATE	SLIGHT	MODERATE	SLIGHT	MODERATE	SLIGHT
PRECISION	FAIR	FAIR	FAIR	FAIR	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500 | 300

COMMENTS

AS PER SECTION 2 ABOVE.

S-TURNS TO STAY ON LOCALIZER DUE TO DISPLAY DEFICIENCY. GLIDE SLOPE CONTROL POOR DUE TO AIRCRAFT CHARACTERISTICS AND PROBABLE TAILWIND. 1400 F.P.M. DESCENT RATE REQUIRED ONCE - MEAN 900 F.P.M.

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	SLIGHT	DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR	

EASE OF ARRESTING RATE OF DESCENT	SLIGHT	DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR	

COMMENTS:

NEED TO HOLD SPEED PRECISELY AND NOT TO FLARE.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

AGGRESSIVE LARGE CONTROL INPUTS WERE USED. THIS RESULTED IN LARGE AIRCRAFT RESPONSES.

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: SMALL

NONE

9. LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES

INTERACTION OF AIRSPEED AND POWER REQUIREMENTS IN UNSTABLE SENSE. (i.e. AS AIRSPEED INCREASES THE POWER INCREASES WHICH CAUSES AIRSPEED TO INCREASE.)

LARGE LOSS-OF-HEIGHT WITH DECREASING SPEED. ATTITUDE, SPEED, AND HEIGHT ERRORS WERE DIVERGENT. SEEMED TO BE A LARGE NEGATIVE EFFECT OF PITCHING MOMENT DUE TO FORWARD SPEED.

11. MISCELLANEOUS

CLOUD BASE DOWN TO 1800 FEET PREVENTED FLYING FURTHER MODELS. ALSO TURBULENCE PICKING UP.

NEED TO PAY CLOSE ATTENTION TO PITCH ATTITUDE AS IT DIVERGES QUICKLY. NEED BETTER PITCH ATTITUDE DISPLAY. ALSO NEED HEADING ERROR INFORMATION ON DISPLAY.

CONFIGURATION	2-2PL	WIND(knots)	
FLIGHT NUMBER	87-3	WIND SHEAR	NEGLIGIBLE
PILOT	A	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	7		

CHARACTERISTIC ROOTS

+.021±	.381	-.48	-1.37

CONFIGURATION	2-2PL	WIND (knots)	CALM
FLIGHT NUMBER	94-1	WIND SHEAR	SMALL
PILOT	B	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	8B		

CHARACTERISTIC ROOTS

+.021±	.381	-.48	-1.37

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = .25 (rad/sec²)/in		$Z_{\delta T}$ = 11.90 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = .25 (rad/sec²)/in		$Z_{\delta T}$ = 11.90 (ft/sec²)/in	
Initial	Final	Initial	Final
SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (h)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	GREAT	NONE	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	±5 knots			O.K. fpm		

COMMENTS

THE NOSE WAS IN CONSTANT MOTION DUE TO THE LIGHTLY DAMPED, MODERATE FREQUENCY OSCILLATION EXCITED BY BOTH ELEVATOR AND TURBULENCE. ALTHOUGH THIS DID NOT PRODUCE LARGE AIR-SPEED CHANGES A DEFINITE DISCOMFORT OF NOT HAVING FULL CONTROL OF AIRCRAFT MOTION PREVAILED.

Longitudinal velocity (IAS)			Vertical velocity (h)		
VMC	IMC	IMC	VMC	IMC	IMC
OUT	OUT	IN	OUT	OUT	IN
SLIGHT	SLIGHT	SLIGHT	NONE	SLIGHT	SLIGHT
+8, -2 knots			fpm		

DIFFICULTY DUE TO PITCH OSCILLATION AND TURBULENCE UPSETS IN PITCH.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	MODERATE	MEDIUM	ZERO
HEAVE			

	SOURCE	DEGREE
EXCITATION	ELEVATOR, TURBULENCE	EASILY
CONTROL:	ELEVATOR	EFFECTIVE

COMMENTS: AS PER SECTION 2 ABOVE.

AMPLITUDE	PERIOD	DAMPING
SMALL/MODERATE	LONG (10 SECS)	LOW
ZERO/SMALL		

SOURCE	DEGREE
UNKNOWN	EASILY
ELEVATOR	EFFECTIVE

WEAK OSCILLATION THROUGH ABOUT 4 DEGREES NOT BOTHER-SOME AND ONLY NOTICEABLE DURING TIGHT TRACKING TASK APPROACH.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED:	SMALL
EASE OF COMPENSATION:	NO DIFFICULTY

COMMENTS

NEGLIGIBLE
NO DIFFICULTY

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	SLIGHT	SLIGHT	SLIGHT	SLIGHT
PRECISION						

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500

COMMENTS: AS PER SECTION 2 ABOVE.

Intercept & initial track		Intermediate track		Final track	
Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
NONE	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
GOOD	GOOD	GOOD	GOOD	FAIR	FAIR

300

DIFFICULTY DUE TO CROSS-CHECK REQUIRED TO CONTROL PITCH ATTITUDE UPSETS CAUSED BY OSCILLATION AND TURBULENCE. SOME WIND SHEAR WAS ALSO PRESENT.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD

COMMENTS:

MODERATE DIFFICULTY
FAIR

DIFFICULTY DUE TO:

1. PITCH OSCILLATION WHICH TENDS TOWARDS A P.I.O. NEAR GROUND, ESPECIALLY WHEN POWER COORDINATION IS ATTEMPTED AS WELL.
2. LARGE TRANSIENT WHICH OCCURRED WHEN THE BLIND WAS RAISED (PROBABLY IN MIDDLE OF A PITCH ATTITUDE REVERSAL AT THIS TIME).

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

SMALL

NONE

9 LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES

AS PER SECTION 2 ABOVE.

PITCH OSCILLATION DURING I.M.C. PITCH SENSITIVE TO TURBU-LENCE. TENDENCY TO P.I.O. NEAR GROUND. HAVE TO SMOOTH THINGS OUT AND THEN HOLD IT. SOME AIRSPEED - VERTICAL VELOCITY COUPLING NOTICEABLE.

11 MISCELLANEOUS

CONFIGURATION 2-2PL
FLIGHT NUMBER 104-3
PILOT C
PILOT-RATING 4

WIND(knots) 5 KNOTS
WIND SHEAR
EXTERNAL TURBULENCE

CHARACTERISTIC ROOTS

+.021±	.381	-.48	-1.37

CONFIGURATION
FLIGHT NUMBER
PILOT
PILOT-RATING

WIND (knots)
WIND SHEAR
EXTERNAL TURBULENCE

CHARACTERISTIC ROOTS

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = .25 (rad/sec²)/in		$Z_{\delta T}$ = 11.90 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	TOO SMALL	TOO SMALL	SATISFACTORY	SATISFACTORY

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = (rad/sec²)/in		$Z_{\delta T}$ = (ft/sec²)/in	
Initial	Final	Initial	Final

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	MODERATE	NONE	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	±6 knots			fpm		

Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
VMC	IMC	IMC	VMC	IMC	IMC
OUT	OUT	IN	OUT	OUT	IN
knots			fpm		

COMMENTS HARD TO CHECK SPEED CHANGES SUFFICIENTLY QUICKLY. LOW DAMPING AND RATHER LOW CONTROL POWER.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	SMALL	LONG	LOW
HEAVE			

	SOURCE	DEGREE
EXCITATION	ELEVATOR/TURBULENCE	EASILY
CONTROL	ELEVATOR	EFFECTIVE

AMPLITUDE	PERIOD	DAMPING

SOURCE	DEGREE

COMMENTS RATHER SLOPPY LONGITUDINAL BEHAVIOUR.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED NEGLIGIBLE
EASE OF COMPENSATION DIFFICULTY

CHANGE REQUIRED
EASE OF COMPENSATION DIFFICULTY

COMMENTS

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	SLIGHT	NONE	MODERATE	SLIGHT
PRECISION	GOOD	FAIR	GOOD	GOOD	FAIR	GOOD

Intercept & initial track		Intermediate track		Final track	
Glide path	Localizer	Glide path	Localizer	Glide path	Localizer

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET O.K.

COMMENTS LOST ABOUT 10 KNOTS IN MAINTAINING GLIDE PATH ON FINAL, BUT RECOVERED IT DURING THE FLARE.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT GOOD

DIFFICULTY

COMMENTS:

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT NONE

9 LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES

LONGITUDINAL BEHAVIOUR LACKS CRISPNESS. (HEAVE BEHAVIOUR NO PROBLEM).

11 MISCELLANEOUS

IF PITCH BEHAVIOUR WERE A BIT MORE POSITIVE THIS WOULD BE A GOOD MODEL. ELEVATOR FORCES WERE LOW.

	Flight 110-2	Flight 92-2
CONFIGURATION	4-2PL	4-2PL
FLIGHT NUMBER	110-2	92-2
PILOT	A	B
PILOT-RATING	8 1/2	7 1/2 D
WIND (knots)	10 KNOTS	5 KNOTS
WIND SHEAR		SMALL
EXTERNAL TURBULENCE		NEGLIGIBLE

CHARACTERISTIC ROOTS

Flight 110-2	+.074 ±	.37i	-.30	-1.66
Flight 92-2	+.074 ±	.37i	-.30	-1.66

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E} = 25$ (rad/sec²)/in		$Z_{\delta T} = 11.9$ (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE (110-2)	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY
RESPONSE (92-2)	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

Flight 110-2:

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	MODERATE	GREAT	SLIGHT	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	±5 TO 8 knots			±200 fpm		

Flight 92-2:

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	MODERATE	SLIGHT	SLIGHT	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	+10, -0 knots			±200 fpm		

COMMENTS

110-2: THE DESIRED PITCH ATTITUDE COULD NEVER BE FOUND FOR LONG. THE TURBULENCE AND THE ENORMOUS RESPONSE TO ELEVATOR CAUSED A GREAT WORK LOAD IN CONTROLLING PITCH ATTITUDE.

92-2: DIFFICULTY CAUSED BY AN UNDERLYING PITCHING OSCILLATION. REACHED 1300 F.P.M. ON DESCENT AND ALTHOUGH IT WAS NEEDED, NOT SURE HOW IT AROSE.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH (110-2)	MODERATE	LONG	NEGATIVE
HEAVE (110-2)			
PITCH (92-2)	SMALL/MODERATE	LONG (10 SECS)	ZERO
HEAVE (92-2)	SMALL	LONG	ZERO

	SOURCE	DEGREE
EXCITATION (110-2)	ELEVATOR, TURBULENCE	EASILY
CONTROL (110-2)	ELEVATOR	EFFECTIVE
EXCITATION (92-2)	UNKNOWN	EASILY
CONTROL (92-2)	ELEVATOR	EFFECTIVE

COMMENTS

110-2: THE OSCILLATION WAS SEEN TO BE DIVERGENT BY LETTING IT BUILD UP FOR ABOUT THREE CYCLES. THROUGHOUT EVALUATION OSCILLATION WAS PRESENT

92-2: VERY BOTHERSOME TO HAVE TO CONTROL THE OSCILLATION.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	110-2	92-2
CHANGE REQUIRED	NEGLIGIBLE	SMALL
EASE OF COMPENSATION	NO DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS:

110-2: THE AIRSPEED GOT HIGH AND THE CORRECTION PRODUCED A VERY LARGE PITCH RATE AND AN UNEXPECTEDLY LARGE NOSE-UP ATTITUDE.

92-2: UNDERLYING PITCH OSCILLATION DEMANDS TOO MUCH ATTENTION.

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY (110-2)	SLIGHT	MODERATE	SLIGHT	MODERATE	SLIGHT	MODERATE
PRECISION (110-2)	FAIR	VERY POOR	FAIR	FAIR	FAIR	POOR
DIFFICULTY (92-2)	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
PRECISION (92-2)	FAIR	FAIR	FAIR	FAIR	GOOD	GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 110-2: 800; 92-2: 300

COMMENTS

110-2: TIGHT CONTROL OVER LOCALIZER AND GLIDE SLOPE ERRORS WAS NECESSARY TO OBTAIN A "FAIR" PERFORMANCE, RESULTING IN TOO HIGH A WORK LOAD. PREOCCUPATION WITH PITCH ATTITUDE CAUSED THE "VERY POOR" LOCALIZER INTERCEPT.

92-2: GREATER DIFFICULTY WAS EXPERIENCED WITH THE LOCALISER ON THE FIRST HALF OF THE APPROACH DURING S-TURNS. THIS WAS A DISPLAY CROSS-CHECK PROBLEM WITH NOT ENOUGH HEADING INFORMATION.

6 BREAKOUT AND FLARE

	110-2	92-2
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR/GOOD	FAIR

COMMENTS:

92-2: DIFFICULT TO HOLD AIRSPEED. AT 75 FEET NOTICED TENDENCY TO FLARE. PUSHED NOSE DOWN AND "BALLOONED", UPSETTING FLIGHT PATH.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

110-2: NONE

92-2: NONE, BUT STILL DIFFICULT TO TRIM. NEED SOME RUDDER APPLICATION IN 20 DEGREE BANK TURNS.

9 LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES

92-2: PITCHING OSCILLATION DEMANDS TOO MUCH ATTENTION TO CONTROL ATTITUDE AND HENCE AIRSPEED. RATE OF DESCENT AND GLIDE SLOPE NOT PRECISELY UNDER CONTROL.

11. MISCELLANEOUS

92-2: SENSITIVE TO TURBULENCE IN PITCH.

CONFIGURATION	19-P	WIND(knots)	10
FLIGHT NUMBER	119-1	WIND SHEAR	SMALL
PILOT	A	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	9		

CHARACTERISTIC ROOTS

.10±	.444i	-.47	-.81

CONFIGURATION	19-P	WIND(knots)	10
FLIGHT NUMBER	17-1	WIND SHEAR	MODERATE
PILOT	B	EXTERNAL TURBULENCE	MODERATE
PILOT-RATING	8		

CHARACTERISTIC ROOTS

.10±	.444i	-.47	-.81

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY:

RESPONSE

Flight 119-1:

ELEVATOR		THRUST LEVER	
$M_{\delta E} = 0.3$ (rad/sec²)/in		$Z_{\delta T} = 11.9$ (ft/sec²)/in	
Initial	Final	Initial	Final
SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

Flight 17-1:

ELEVATOR		THRUST LEVER	
$M_{\delta E} = 0.2$ (rad/sec²)/in		$Z_{\delta T} = 11.9$ (ft/sec²)/in	
Initial	Final	Initial	Final
SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

Flight 119-1:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION:	V.M.C.	I.M.C.	I.M.C.	V.M.C.	I.M.C.	I.M.C.
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	GREAT	GREAT	SLIGHT	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	±10 knots			±100 fpm		

COMMENTS: NOSE CONSTANTLY BOBBING UP AND DOWN DUE TO A DIVERGENT OSCILLATION PLUS A LARGE STEADY STATE RESPONSE FROM ELEVATOR.

Flight 17-1:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION:	V.M.C.	I.M.C.	I.M.C.	V.M.C.	I.M.C.	I.M.C.
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	V. SLIGHT	V. SLIGHT	V. SLIGHT	NONE	NONE	NONE
MAXIMUM UNDESIRED FLUCTUATIONS	+5, -5 knots			OK. fpm		

COMMENTS: SOME DIFFICULTY WITH SPEED CONTROL IN TURNS ESPECIALLY WITH TURBULENCE IN. PROBABLY DUR TO CHANGING ATTITUDE REFERENCE AT HIGHER BANK ANGLES. ALSO PITCH CHARACTERISTICS REQUIRED GREATER ATTENTION TO PITCH ATTITUDE ON INSTRUMENT CROSS-CHECKS.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

Flight 119-1:

	AMPLITUDE	PERIOD	DAMPING
PITCH:	LARGE	MEDIUM	NEGATIVE
HEAVE			

	SOURCE	DEGREE
EXCITATION:	ELEVATOR, TURBULENCE	EASILY
CONTROL	ELEVATOR	INEFFECTIVE

COMMENTS: THIS OSCILLATION WAS THE MAIN SOURCE OF DIFFICULTY

Flight 17-1:

	AMPLITUDE	PERIOD	DAMPING
PITCH:	>SMALL	>MEDIUM	LOW
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION:	ELEVATOR, TURBULENCE	MODERATE
CONTROL	ELEVATOR	EFFECTIVE

COMMENTS: WOULDN'T NOTICE IT OCCURRING NORMALLY (LIKE AN EASILY CONTROLLED PHUGOID), BUT IN I.M.C. AND TURBULENCE, THE EFFECTS ARE EASY TO SEE.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 119-1	Flight 17-1
CHANGE REQUIRED:	MODERATE	MODERATE/SMALL
EASE OF COMPENSATION	MODERATE DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS (Flight 119-1): FIRST TURN WENT WELL, BUT THE SECOND AND THIRD CAUSED PROBLEMS IN HEIGHT HOLD. PROBABLY DUE TO AMOUNT OF ATTENTION REQUIRED IN PITCH CONTROL.

(Flight 17-1): IN I.M.C. CONDITIONS WITH TURBULENCE, IT IS DIFFICULT TO NOTE PITCH ATTITUDE REFERENCE - NEED TO STABILIZE PITCH ATTITUDE IN TURNS.

5. FLIGHT PATH CONTROL

Flight 119-1:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:						
PRECISION						

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 800

COMMENTS: THE APPROACH PERFORMANCE WAS QUITE GOOD BUT THE WORKLOAD WAS ENORMOUS. ALL WENT WELL UNTIL ABOUT 500 FT. WHEN THE WINDSHEAR STARTED TO COME IN IN THE OPPOSITE DIRECTION TO THAT OF PREVIOUS TESTS.

Flight 17-1:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	NONE	NONE	NONE	NONE	SLIGHT	SLIGHT
PRECISION	GOOD	GOOD	GOOD	GOOD	>FAIR	>FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: (blank)

6. BREAKOUT AND FLARE

	Flight 119-1	Flight 17-1
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT		FAIR/GOOD

COMMENTS: (Flight 17-1) SURPRISINGLY, THE PITCH OSCILLATIONS WERE MORE PRONOUNCED DURING THIS MANOEUVRE AND COULD CAUSE AS MUCH DIFFICULTY HERE AS WHEN I.M.C.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

(Flight 17-1): A LOT OF ATTENTION TO PITCH ATTITUDE WAS REQUIRED. AS A RESULT THE AIRSPEED WAS HELD AT 60KTS. SURPRISINGLY WELL.

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE (Flight 119-1); NONE (Flight 17-1)

9. LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES: OSCILLATORY CHARACTERISTICS (Flight 119-1); PITCH OSCILLATIONS (Flight 17-1)

11. MISCELLANEOUS

(Flight 17-1): ENGINE MANIFOLD PRESSURE WAS USED AS A CUE FOR THRUST REQUIREMENTS DURING APPROACH.
NOTE: THE MANIFOLD PRESSURE GAUGE WAS PARTIALLY COVERED AFTER FLIGHT #28 TO ELIMINATE THIS CUE.

	Configuration 19-2PL	Configuration 19-2P
CONFIGURATION	19-2PL	19-2P
FLIGHT NUMBER	106-3	33-2
PILOT	A	B
PILOT-RATING	8	9 1/2
WIND (knots)		
WIND SHEAR	MODERATE	SMALL
EXTERNAL TURBULENCE	LIGHT	LIGHT
CHARACTERISTIC ROOTS	.102 ± .441, -.47, -.81	.102 ± .441, -.47, -.81

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

Configuration 19-2PL:

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = -.20	(rad/sec²)/in	$Z_{\delta T}$ = 11.9	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

Configuration 19-2P:

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = -.30	(rad/sec²)/in	$Z_{\delta T}$ = 15.0	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE	TOO GREAT		NOT ASSESSABLE	NOT ASSESSABLE

2. EASE OF MAINTAINING DESIRED VELOCITIES

Configuration 19-2PL:

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	GREAT			
MAXIMUM UNDESIRED FLUCTUATIONS	+10, -10 knots			+100, -100 fpm		

COMMENTS: TURBULENCE BOUNCED NOSE AROUND TOO MUCH AND THE STEADY STATE RESPONSE TO PITCH CONTROL IS SO ENORMOUS THAT STABLE CONDITIONS IN PITCH-ATTITUDE/AIRSPEED ARE IMPOSSIBLE

Configuration 19-2P:

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	>SLIGHT	>SLIGHT			
MAXIMUM UNDESIRED FLUCTUATIONS	+5, -5 knots			+400, -400 fpm		

COMMENTS: HEAVE/PITCH OSCILLATION. TIME CONSTANT OF VERTICAL VELOCITY CONTROL (≈30 SECS) IS LONGER THAN THAT OF LONGITUDINAL VELOCITY.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

Configuration 19-2PL:

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION CONTROL		

COMMENTS

Configuration 19-2P:

	AMPLITUDE	PERIOD	DAMPING
PITCH	MODERATE	LONG	ZERO/LOW
HEAVE	LARGE	LONG	ZERO/LOW

	SOURCE	DEGREE
EXCITATION CONTROL	ELEVATOR	AGGRAVATING

COMMENTS: 'ALONG FOR THE RIDE'

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	19-2PL	19-2P
CHANGE REQUIRED	NEGLIGIBLE	NEGLIGIBLE
EASE OF COMPENSATION	NO DIFFICULTY	NO DIFFICULTY

COMMENTS

5. FLIGHT PATH CONTROL

Configuration 19-2PL:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	SLIGHT	MODERATE	MODERATE	MODERATE	SLIGHT
PRECISION	GOOD	FAIR	FAIR	POOR	POOR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500

COMMENTS: AS PER SECTION 2 ABOVE

Configuration 19-2P:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	MODERATE	> SLIGHT	MODERATE	> SLIGHT	>MODERATE	>SLIGHT
PRECISION		> FAIR		> FAIR	GOOD	> FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: NONE

COMMENTS: THIS MODEL NOT SUITABLE FOR I.M.C. FLIGHT. DID NOT TRY TO FOLLOW GLIDE SLOPE TOO CLOSELY, BUT AIMED TO PICK IT UP AT APPROXIMATELY 800 FEET. ONCE ON GLIDE SLOPE, TRACKING NOT TOO BAD. LOST 500 FEET IN TURN TO BASE AND FINAL.

6. BREAKOUT AND FLARE

	19-2PL	19-2P
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR	POOR

COMMENTS:

19-2PL: THE AIRCRAFT FELT AS THOUGH IT HAD TO BE HANDLED GENTLY TO PREVENT OVER-CONTROLLING.

19-2P: DIFFICULTY IN CONTROLLING PERCEIVED VERTICAL VELOCITY WITH CORRECT PHASING OF THE THRUST LEVER. DIFFICULTY IN LONGITUDINAL SENSE DUE TO LARGE VERTICAL VELOCITY AT TOUCHDOWN. POSITIONING AT BREAKOUT WAS GOOD.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: NONE (19-2PL); NONE (19-2P)

9. LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES

19-2PL: AS PER SECTION 2 ABOVE

19-2P: OSCILLATION; THIS LED TO DISORIENTATION, CONSERVATIVE CONTROL APPLICATION AND TOUCHDOWN PROBLEMS.

11. MISCELLANEOUS

19-2P: AN AFT ELEVATOR STEP INPUT, ACCELERATES THE COCKPIT DOWN AND THEN UP (LIKE FLYING FROM THE TAIL END OF A STRETCHED DC-8). CONFUSING AND DISORIENTATING RESPONSE FOR HIGH FREQUENCY ELEVATOR INPUTS.

CONFIGURATION	19-2NL	WIND(knots)	
FLIGHT NUMBER	74-3	WIND SHEAR	SMALL
PILOT	A	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	7		

CHARACTERISTIC ROOTS

-.183	.104	-.489 ±	.0851

CONFIGURATION	19-2NL	WIND(knots)	8
FLIGHT NUMBER	94-3	WIND SHEAR	
PILOT	B	EXTERNAL TURBULENCE	NONE
PILOT-RATING	7C		

CHARACTERISTIC ROOTS

-.183	.104	-.489 ±	.0851

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY / RESPONSE (Flight 74-3)

ELEVATOR $M_{\delta E} = .20$ (rad/sec²)/in		THRUST LEVER $Z_{\delta T} = 15.0$ (ft/sec²)/in	
Initial	Final	Initial	Final
SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

CONTROL SENSITIVITY / RESPONSE (Flight 94-3)

ELEVATOR $M_{\delta E} = .20$ (rad/sec²)/in		THRUST LEVER $Z_{\delta T} = 15.0$ (ft/sec²)/in	
Initial	Final	Initial	Final
SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

(Flight 74-3)

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	MODERATE	GREAT	SLIGHT	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	+12, -12 knots			+200, -200 fpm		

(Flight 94-3)

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	>MODERATE	SLIGHT		
MAXIMUM UNDESIRED FLUCTUATIONS	+10, -10 knots			fpm		

COMMENTS

THE PITCH ATTITUDE WAS CONSTANTLY CHANGING SINCE A PITCH RATE APPARENTLY RESULTED FROM A STEADY STATE ELEVATOR CONTROL INPUT. THE TURBULENCE ADDED TO THIS DIFFICULTY.

DIFFICULTY DUE TO: 1. CROSSCHECK, 2. INTERACTION BETWEEN LONGITUDINAL AND VERTICAL VELOCITIES, 3. PITCH CHARACTERISTICS.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

(Flight 74-3)

	AMPLITUDE	PERIOD	DAMPING
PITCH	MODERATE	MEDIUM	LOW
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION:	ELEVATOR, TURBULENCE	EASILY
CONTROL:	ELEVATOR	AGGRAVATING

(Flight 94-3)

	AMPLITUDE	PERIOD	DAMPING
PITCH			
HEAVE			

	SOURCE	DEGREE
EXCITATION:		
CONTROL:		

COMMENTS:

THE PITCH ATTITUDE SEEMED TO BOUNCE BACK AFTER A DISTURBANCE, BUT UPON CLOSER EXAMINATION IT APPEARS THAT THIS WAS PILOT-INDUCED THROUGH THE ELEVATOR.

IT WAS NOT POSSIBLE TO EXCITE A PITCH OSCILLATION THAT COULD BE OBSERVED OVER ONE OR MORE CYCLES. HOWEVER I SENSED SEVERAL UNDERLYING PITCH REVERSALS THAT WERE QUITE BOTHERSOME. IN RESPONSE TO SMALL STEP ELEVATOR INPUTS, I WAS ONLY ABLE TO SEE A PITCH DIVERGENCE.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 74-3	Flight 94-3
CHANGE REQUIRED:	SMALL	SMALL
EASE OF COMPENSATION:	NO DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS

NEED TO HOLD AIRSPEED DUE TO INTERACTION BETWEEN VERTICAL SPEED AND AIRSPEED.

5 FLIGHT PATH CONTROL

(Flight 74-3)

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	SLIGHT	SLIGHT	MODERATE	MODERATE	MODERATE	SLIGHT
PRECISION	FAIR	FAIR	POOR	POOR	POOR	FAIR

(Flight 94-3)

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	NONE	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
PRECISION	GOOD	GOOD	FAIR	FAIR	POOR	FAIR/POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

Flight 74-3	Flight 94-3
600	300

COMMENTS

THE CONTROL OF AIRSPEED THROUGH PITCH ATTITUDE REQUIRED TOO MUCH ATTENTION, LEAVING TOO LITTLE TIME FOR APPROACH MONITORING.

DIFFICULTY DUE TO:

1. S-TURNS TO STAY ON THE LOCALISER - INSTRUMENT DISPLAY AND CROSSCHECK PROBLEMS
2. VERY POOR SPEED CONTROL (±10 KNOTS REGULARLY) MADE GLIDE PATH CONTROL MORE DIFFICULT.

6 BREAKOUT AND FLARE

	Flight 74-3	Flight 94-3
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	FAIR

COMMENTS

LOW AT BREAKOUT.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

CONTROL TECHNIQUE VERY ROUGH ON THIS APPROACH - LARGE AGGRESSIVE INPUTS TO CORRECT GENERALLY LARGE AMPLITUDE ERRORS.

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

SMALL: THE YAWING CHARACTERISTICS ARE RATHER DEMANDING IN THAT A LARGE SIDESLIP ANGLE DEVELOPS FROM A VERY SMALL RUDDER INPUT, (APPROX. 15°β FOR 0.5 INS. δ_r

SMALL: S - TURNS TO STAY ON THE LOCALISER DUE TO INSTRUMENT DISPLAY/CROSS CHECK PROBLEMS.

9 LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES

EXPERIENCED APPARENT PITCH REVERSALS AFTER PITCH CONTROL INPUTS, MAKING SPEED AND ATTITUDE CONTROL VERY DIFFICULT. GENERALLY UNSTABLE IN PITCH (MORE SO THAN USUAL).

11. MISCELLANEOUS

SOME PITCH UPSETS DUE TO TURBULENCE COULD BE THE CAUSE OF APPARENT REVERSALS.

NOTE: PILOT CONTROL INPUTS LARGE TO CORRECT LARGE AMPLITUDE ERRORS. NO SIMULATED TURBULENCE FOR THIS EVALUATION.

CONFIGURATION 19-3P
FLIGHT NUMBER 3-1
PILOT A
PILOT-RATING 7 1/2
WIND(knots)
WIND SHEAR
EXTERNAL TURBULENCE ZERO

CHARACTERISTIC ROOTS

.101±	.4211	-.47	-.80

CONFIGURATION 19-3P
FLIGHT NUMBER 115-2
PILOT B
PILOT-RATING 8 1/2 D
WIND(knots) 10
WIND SHEAR SMALL
EXTERNAL TURBULENCE LIGHT

CHARACTERISTIC ROOTS

.101±	.4211	-.47	-.80

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = .20	(rad/sec²)/in	$Z_{\delta T}$ = 12.0	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE:	GOOD	TOO GREAT	TOO SMALL	TOO SMALL

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = .20	(rad/sec²)/in	$Z_{\delta T}$ = 15.0	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	TOO GREAT		SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY		MODERATE	MODERATE		GREAT	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	±2		knots	±400		fpm

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	±10		knots			fpm

COMMENTS

PITCH ATTITUDE SEEMED DIFFICULT TO SELECT AND HOLD. (SOMEWHAT OSCILLATORY).
LONG FREQUENCY WANDER IN VERTICAL VELOCITY CHANGED RATE OF DESCENT FROM 900 TO 400 F.P.M. ON APPROACH. RESULT: HIGH ON GLIDE PATH. TURBULENCE HAD LARGE EFFECT ON VERTICAL VELOCITY.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	LARGE	MEDIUM	LOW
HEAVE	SMALL		

	AMPLITUDE	PERIOD	DAMPING
PITCH	MODERATE	LONG	NEGATIVE
HEAVE	MODERATE	LONG	?

	SOURCE	DEGREE
EXCITATION	ELEVATOR	EASILY
CONTROL	ELEVATOR	EFFECTIVE

	SOURCE	DEGREE
EXCITATION	UNKNOWN	EASILY
CONTROL	ELEVATOR	EFFECTIVE

COMMENTS

VERY ANNOYING. ANY SIMILAR HEAVE OSCILLATION WAS MASKED BY ENGINE POWER SURGING LIMITATIONS WHICH RESULTED IN WHAT MIGHT HAVE LOOKED LIKE A THRUST CONTROL P.I.O. ON RECORDINGS.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED	LARGE	
EASE OF COMPENSATION	GREAT	DIFFICULTY

CHANGE REQUIRED		
EASE OF COMPENSATION		DIFFICULTY

COMMENTS

THRUST SENSITIVITY AT BEGINNING OF FLIGHT WAS TOTALLY INADEQUATE EVEN WITHOUT TURBULENCE. AN INCREASE OF 60% IMPROVED THE SITUATION BUT STILL PROVED TOO LOW TO ARREST THE LANDING FLARE ADEQUATELY.

PITCH ATTITUDE AND AIRSPEED HAD TO BE MONITORED CLOSELY AS IN MOST MODELS.

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY			MODERATE	SLIGHT		
PRECISION			POOR	FAIR		

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	V. SLIGHT	V.SLIGHT	V. SLIGHT	V. SLIGHT	V. SLIGHT	V. SLIGHT
PRECISION	FAIR/GOOD	FAIR/GOOD	FAIR/GOOD	FAIR/GOOD	FAIR/GOOD	FAIR/GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: (first flight blank) 300

COMMENTS

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	GREAT	DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	POOR	

EASE OF ARRESTING RATE OF DESCENT	SLIGHT	DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR	

COMMENTS

TENDENCY FOR A PITCH-HEAVE P.I.O. NEAR THE GROUND.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT SMALL; LOW RUDDER PEDAL FORCES

9 LEAST OBJECTIONABLE FEATURES

10 MOST OBJECTIONABLE FEATURES

PITCH-HEAVE, DIVERGENT OSCILLATION.

11 MISCELLANEOUS

ELEVATOR AND RUDDER FORCES LOW
THRUST LEVER SENSITIVITY CHANGED FROM 7.5 to 12.0

	Flight 15-1	Flight 25/26-1
CONFIGURATION	19-3N	19-3N
FLIGHT NUMBER	15-1	25/26-1
PILOT	A	B
PILOT-RATING	9	10
WIND (knots)	10-15	8
WIND SHEAR		?
EXTERNAL TURBULENCE		VERY LIGHT
CHARACTERISTIC ROOTS	.077 / -.106 / -.514± / .0851	.077 / -.106 / -.514± / .0851

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	Flight	ELEVATOR Initial	ELEVATOR Final	THRUST LEVER Initial	THRUST LEVER Final
CONTROL SENSITIVITY	15-1	$M_{\delta E} = .20$ (rad/sec²)/in		$Z_{\delta T} = 15.0$ (ft/sec²)/in	
RESPONSE	15-1	SATISFACTORY	TOO GREAT	TOO SMALL	TOO GREAT
CONTROL SENSITIVITY	25/26-1	$M_{\delta E} = .20$ (rad/sec²)/in		$Z_{\delta T} = 12.0$ (ft/sec²)/in	
RESPONSE	25/26-1	SATISFACTORY	SATISFACTORY		NOT ASSESSABLE

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Flight	Longitudinal velocity (IAS) VMC	IMC	IMC	Vertical velocity ($\dot{h}$) VMC	IMC	IMC
TURBULENCE	15-1	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	15-1	MODERATE	GREAT	GREAT	SLIGHT	MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	15-1	±7 knots			+300, -200 fpm		
TURBULENCE	25/26-1	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	25/26-1	MODERATE	MODERATE	MODERATE	GREAT	GREAT	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	25/26-1	±20 knots			+100, -1000 fpm		

COMMENTS

15-1: PITCH ATTITUDE CONSTANTLY WANDERS AND SEEMS TO BOUNCE BACK AFTER BEING PUT AT A DESIRED POSITION. THE HEAVE WANDERS AS WELL AND IN SOME CASES THE CONTROL INPUT SEEMED TO AGGRAVATE THE SITUATION.

25/26-1: LARGE AIRSPEED/VERTICAL SPEED INTERACTION. POWER LEVER CHARACTERISTICS CANNOT BE ASSESSED IN THE PRESENCE OF THIS INTERACTION.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	Flight	AMPLITUDE	PERIOD	DAMPING
PITCH	15-1	MODERATE	LONG	LOW
HEAVE	15-1	MODERATE	LONG	LOW
PITCH	25/26-1	ZERO		
HEAVE	25/26-1	ZERO		

	Flight	SOURCE	DEGREE
EXCITATION	15-1	ELEVATOR, TURBULENCE	EASILY
CONTROL	15-1	ELEVATOR, THRUST LEVER	INEFFECTIVE
EXCITATION	25/26-1		
CONTROL	25/26-1		

COMMENTS

15-1: AS PER SECTION 2 ABOVE.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	15-1	25/26-1
CHANGE REQUIRED	SMALL	
EASE OF COMPENSATION	NO DIFFICULTY	GREAT DIFFICULTY

COMMENTS

25/26-1: MUST MAINTAIN AIRSPEED. MUST ADD SOME POWER BUT NEVER KNEW HOW MUCH.

5 FLIGHT PATH CONTROL

	Flight	Intercept & initial track Glide path	Localizer	Intermediate track Glide path	Localizer	Final track Glide path	Localizer
DIFFICULTY	15-1	MODERATE	SLIGHT	MODERATE	SLIGHT	MODERATE	SLIGHT
PRECISION	15-1	POOR	GOOD	VERY POOR	GOOD	VERY POOR	GOOD
DIFFICULTY	25/26-1		SLIGHT		MODERATE		
PRECISION	25/26-1		FAIR		FAIR/POOR		

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 15-1: 500; 25/26-1: (blank)

COMMENTS

15-1: INTENDED TO STAY SLIGHTLY LOW ON GLIDE PATH BUT AT ABOUT 500 FEET WENT BELOW THE BOTTOM OF THE BEAM WHICH WAS UNCOMFORTABLE. RECOVERED THE BEAM BY 100 FEET, BUT NOT COMFORTABLE.

25/26-1: NOT SUITABLE FOR IFR FLIGHT. LOST CONTROL AT 800 FEET.

6 BREAKOUT AND FLARE

	15-1	25/26-1
EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY	DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR	

COMMENTS

25/26-1: LOST CONTROL AT 800 FEET.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

25/26-1: TRIED TO CONTROL VERTICAL SPEED WITH AIRSPEED.

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

15-1: NONE

25/26-1: NONE

9 LEAST OBJECTIONABLE FEATURES

10 MOST OBJECTIONABLE FEATURES

25/26-1:

1. GREAT INTERACTION OF VERTICAL SPEED WITH AIRSPEED VARIATION.
2. LOW HEAVE DAMPING, THUS POWER CONTROL REQUIREMENTS CONFUSING.

11 MISCELLANEOUS

25/26-1: THRUST CONTROL SENSITIVITY CHANGED FROM 12.0 TO 15.0.

	Left	Right
CONFIGURATION	8-PL	8-PL
FLIGHT NUMBER	66-1	48-2
PILOT	A	D
PILOT-RATING	5½	6½
WIND (knots)	CALM	10
WIND SHEAR	SMALL	SMALL
EXTERNAL TURBULENCE	NEGLIGIBLE	LIGHT
CHARACTERISTIC ROOTS	.032± / .341 / -.22 / -1.65	.032± / .341 / -.22 / -1.65

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	Elevator Initial	Elevator Final	Thrust Lever Initial	Thrust Lever Final
CONTROL SENSITIVITY (left)	$M_{\delta E}$ = .30 (rad/sec²)/in		$Z_{\delta T}$ = 7.5 (ft/sec²)/in	
RESPONSE (left)	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY
CONTROL SENSITIVITY (right)	$M_{\delta E}$ = .35 (rad/sec²)/in		$Z_{\delta T}$ = 7.5 (ft/sec²)/in	
RESPONSE (right)	TOO GREAT	TOO GREAT	TOO SMALL	TOO SMALL

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS) VMC	IMC	IMC	Vertical velocity (ḣ) VMC	IMC	IMC
TURBULENCE (left)	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (left)	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (left)	±5 knots			fpm		
TURBULENCE (right)	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (right)	SLIGHT	SLIGHT	MODERATE	SLIGHT	>SLIGHT	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS (right)	±10 knots			±300 fpm		

COMMENTS:

Left: SEE SECTION #10.

Right: DIFFICULTY DUE TO OPERATION ON BACK-SIDE OF POWER REQUIRED CURVE AND TO A SLIGHTLY NEGATIVELY DAMPING PHUGOID OF MODERATELY SHORT PERIOD.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	Amplitude (left)	Period (left)	Damping (left)	Amplitude (right)	Period (right)	Damping (right)
PITCH	ZERO			MODERATE		
HEAVE	ZERO					

	Source (left)	Degree (left)	Source (right)	Degree (right)
EXCITATION				
CONTROL				

COMMENTS:

Right: CLOSED-LOOP TENDENCY TO P.I.O.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Left	Right
CHANGE REQUIRED	MODERATE	MODERATE/LARGE
EASE OF COMPENSATION	SLIGHT DIFFICULTY	MODERATE DIFFICULTY

COMMENTS:

Left: INCREASING RATE OF SINK WITH BANK ANGLE IS EASILY COMPENSATED FOR BY SLIGHT POWER LEVER INPUTS.

Right: LARGE POWER CHANGES REQUIRED FOR MODERATE CHANGES OF AIRSPEED. HOWEVER, NOT AS BAD AS WITH SOME PREVIOUS CONFIGURATIONS.

5. FLIGHT PATH CONTROL

	Intercept & initial track Glide path	Localizer	Intermediate track Glide path	Localizer	Final track Glide path	Localizer
DIFFICULTY (left)	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
PRECISION (left)	FAIR	FAIR	FAIR	FAIR	FAIR	FAIR
DIFFICULTY (right)	SLIGHT	SLIGHT	>SLIGHT	>SLIGHT	MODERATE	MODERATE
PRECISION (right)	GOOD	FAIR	FAIR	FAIR	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: (left) — ; (right) —

COMMENTS:

Right: CONSTANT ATTENTION REQUIRED TO AIRSPEED THROUGH ATTITUDE CONTROL, WITH A TENDENCY TOWARD P.I.O. WHEN CLOSING THE ATTITUDE LOOP VERY TIGHTLY.

6. BREAKOUT AND FLARE

	Left	Right
EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY	VERY SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	FAIR

COMMENTS:

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

Right: IF LARGE CHANGES WERE REQUIRED IN RATE OF DESCENT, A CHANGE OF AIRSPEED IN THE RIGHT DIRECTION HELPED ADJUST THE RATE OF DESCENT WITHOUT EXCESSIVE THRUST LEVER OPERATION.

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

Right: NONE

9. LEAST OBJECTIONABLE FEATURES

Right: SHORT PERIOD SEEMED WELL DAMPED.

10. MOST OBJECTIONABLE FEATURES

Left: THE PITCH ATTITUDE SEEMED SLOPPY, ESPECIALLY WHEN THE TURBULENCE WAS SWITCHED IN, AND REQUIRED MUCH TOO MUCH ATTENTION. THE APPROACH WENT WELL BUT THE WORK LOAD WAS FAIRLY HIGH.

Right: CONSTANT ATTENTION TO AIRSPEED, AND MUCH POWER LEVER ACTIVITY REQUIRED. A P.I.O. TENDENCY, PARTICULARLY WITH TURBULENCE IN UNDER I.M.C. CONDITIONS.

11. MISCELLANEOUS

Right: FROM A PASSENGER COMFORT STANDPOINT THIS CONFIGURATION WOULD DEFINITELY BE UNACCEPTABLE.

	Flight 71-1		Flight 127-3
CONFIGURATION	8-2PL		8-2PL
FLIGHT NUMBER	71-1		127-3
PILOT	A		B
PILOT RATING	5½		8D
WIND (knots)	5		5
WIND SHEAR	MODERATE		NEGLIGIBLE
EXTERNAL TURBULENCE	NEGLIGIBLE		NEGLIGIBLE

CHARACTERISTIC ROOTS

.028±	.35i	-.20	-1.67

.028±	.35i	-.20	-1.67

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY / RESPONSE:

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = 0.35 (rad/sec²)/in		$Z_{\delta T}$ = 8.9 (ft/sec²)/in	
Initial	Final	Initial	Final
SATISFACTORY	SATISFACTORY	TOO SMALL	TOO GREAT

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = .25 (rad/sec²)/in		$Z_{\delta T}$ = 7.4 (ft/sec²)/in	
Initial	Final	Initial	Final
TOO GREAT		TOO SMALL	TOO GREAT

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	SLIGHT	SLIGHT	NONE	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	-10, -5 knots			±200 fpm		

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	NONE	NONE	MODERATE	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	±5 knots			fpm		

COMMENTS:

TURBULENCE UPSETTING PITCH ATTITUDE AND MAKING IT DIFFICULT TO MAINTAIN AIRSPEED. POWER LEVER SEEMED TO HAVE LONG TIME CONSTANT RESULTING IN STEADY STATE LEVELS OF VERTICAL VELOCITY DIFFERENT FROM THOSE DESIRED.

MODEL HAD LOW HEIGHT RATE DAMPING AND THIS COUPLED WITH LOW POWER LEVER SENSITIVITY CAUSED SOME DIFFICULTY.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: SMALL
EASE OF COMPENSATION: NO DIFFICULTY

CHANGE REQUIRED:
EASE OF COMPENSATION: DIFFICULTY

COMMENTS

COORDINATION IMPORTANT BECAUSE OF COUPLING EFFECT OF AIRSPEED WITH VERTICAL VELOCITY. LONG RESPONSE TIME FOR POWER LEVER CHANGES MAKE IT NECESSARY TO ANTICIPATE POWER REQUIREMENTS WHEN AIRSPEED ERRORS DEVELOP.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	MODERATE	SLIGHT	MODERATE
PRECISION	FAIR	FAIR	FAIR	POOR	FAIR	POOR

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	NONE	SLIGHT	NONE	SLIGHT	NONE
PRECISION	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500

COMMENTS

FIRST MODEL OF DAY AND WIND SHEAR HAD NOT BEEN DETERMINED. ONLY ABOUT 400 FPM WAS REQUIRED FOR MAJOR PORTION OF APPROACH.

HAD TO LEARN TO ANTICIPATE THRUST REQUIREMENTS REQUIRED TO CONTROL VERTICAL VELOCITY. POTENTIAL FOR LARGE HEIGHT RATE EXCURSIONS EXISTS.

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: GOOD

EASE OF ARRESTING RATE OF DESCENT: SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: GOOD

COMMENTS

WAS WELL SET UP AT BREAKOUT AND JUST HAD TO MAINTAIN CONDITIONS UNTIL TOUCHDOWN. THE LONG TIME CONSTANT IN THE THRUST LEVER CONTROL WAS SENSED JUST PRIOR TO TOUCHDOWN AND POTENTIALLY COULD LEAD TO DIFFICULTY.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

SMALL. AIRCRAFT SEEMED TO HAVE LOW WEATHERCOCK STABILITY. LARGE SIDESLIP RESULTS FROM SMALL MOVEMENT OF RUDDER PEDALS.

NONE

9. LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES

LONG RESPONSE TIME AFTER THRUST LEVER CHANGES. MODERATE COUPLING BETWEEN AIRSPEED AND VERTICAL VELOCITY.

11. MISCELLANEOUS

VERY WEAK PITCH STABILITY APPEARS TO EXIST BUT IT IS INEFFECTIVE BECAUSE OF THE RAPID INITIAL RESPONSE TO ELEVATOR. DIFFICULT TO TRIM. FREQUENT PITCH UPSETS DUE TO TURBULENCE. ELEVATOR CONTROL SENSITIVITY CHANGED FROM 0.3 TO 0.2 AND FINALLY TO 0.25.

CONFIGURATION	8-2P	WIND(knots)	10-15
FLIGHT NUMBER	130-1	WIND SHEAR	NEGLIGIBLE
PILOT	A	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	6½		

CHARACTERISTIC ROOTS: | .028 ± | .35i | -.20 | -1.67 |

CONFIGURATION	8-2P	WIND(knots)	5
FLIGHT NUMBER	36-2	WIND SHEAR	NEGLIGIBLE
PILOT	B	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	8E-F		

CHARACTERISTIC ROOTS: | .028 ± | .35i | -.20 | -1.67 |

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = .30	(rad/sec²)/in	$Z_{\delta T}$ = 7.4	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = .35	(rad/sec²)/in	$Z_{\delta T}$ = 7.4	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE	TOO GREAT	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	MODERATE	NONE	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	+10, -5 knots			±200 fpm		

COMMENTS

ATTITUDE CONTROL DIFFICULT SINCE SMALL OUT OF TRIM ELEVATOR GIVES CONTINUOUSLY CHANGING ATTITUDE. AIRSPEED EFFECT ON POWER REQUIRED CAUSES HEIGHT CONTROL PROBLEMS. AS AIRSPEED INCREASES, POWER SETTING REQUIRED, DECREASES.

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	> NONE	> NONE	> NONE
MAXIMUM UNDESIRED FLUCTUATIONS	±5 knots			fpm		

MODERATELY HIGH APPARENT COUPLING BETWEEN AIRSPEED AND VERTICAL VELOCITY, REQUIRING CLOSE CONTROL OVER PITCH ATTITUDE.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	SMALL	LONG	LOW
HEAVE			

	SOURCE	DEGREE
EXCITATION	TURBULENCE	EASILY
CONTROL		

COMMENTS

ONLY DETECTED OSCILLATION WHILE PUTTING AIRBORNE DOUBLET INPUTS IN. THE NOSE DID START TO DIVERGE, HOWEVER, AS A RESULT OF TURBULENCE AND ELEVATOR INPUTS.

	AMPLITUDE	PERIOD	DAMPING
PITCH	SMALL	LONG	LOW
HEAVE	SMALL	LONG	LOW

	SOURCE	DEGREE
EXCITATION		
CONTROL		

ONLY A SLIGHT TRACE OF OSCILLATION WAS APPARENT.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: SMALL
EASE OF COMPENSATION: NO DIFFICULTY

COMMENTS

NO PROBLEM AS LONG AS AIRSPEED WAS MAINTAINED. BUT THIS TYPE OF CONFIGURATION CAN CAUSE PROBLEMS IN HEIGHT HOLD WHEN THE AIRSPEED CHANGES.

CHANGE REQUIRED:
EASE OF COMPENSATION: SLIGHT DIFFICULTY

SEEMED TO NEED SOME ADDITIONAL THRUST EVEN THOUGH 60 KNOT AIRSPEED WAS HELD PRECISELY.

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	MODERATE	SLIGHT	MODERATE	SLIGHT
PRECISION	FAIR	GOOD	FAIR	GOOD	FAIR	GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500

COMMENTS

THE RATE OF CLIMB BLED OFF AS THE AIRSPEED INCREASED TO 70 KNOTS DUE TO OPERATION ON THE "BACK-SIDE" OF THE POWER REQUIRED CURVE.

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	NONE	NONE	NONE	NONE
PRECISION	GOOD	GOOD	GOOD	GOOD	FAIR/GOOD	FAIR/GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET:

HIGH WORK LOAD DUE TO NECESSITY TO TIGHTEN CONTROL OF PITCH ATTITUDE IN ORDER TO ENSURE GOOD VERTICAL SPEED CONTROL.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: GOOD

COMMENTS:

EASE OF ARRESTING RATE OF DESCENT: MODERATE DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: FAIR/GOOD

BROKE OUT AT 55 KNOTS AND MAINTAINED 55 KNOTS TO THE FLARE. PITCHED AIRCRAFT JUST PRIOR TO TOUCHDOWN AND APPLIED A LOT OF THRUST LEVER IN ANTICIPATION OF THRUST REQUIREMENTS BUT THRUST DID NOT COME ON AS MUCH AS NEEDED.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: SMALL — NONE

9 LEAST OBJECTIONABLE FEATURES

10 MOST OBJECTIONABLE FEATURES

ROUGH RIDE IN TURBULENCE, POSSIBLE DISORIENTATION. LARGE-MODERATE COUPLING BETWEEN AIRSPEED AND VERTICAL SPEED REQUIRING TIGHT CONTROL OF PITCH ATTITUDE.

11 MISCELLANEOUS

NOTE. ELECTRICAL CONTROL DISTURBANCES WERE INTRODUCED AT BEGINNING OF EVALUATION FOR VALIDATION PURPOSES.

NEED FOR BETTER DISPLAY DURING CONDITIONS REQUIRING RAPID AND THOROUGH CROSS-CHECK, PARTICULARLY IN ROUGH TURBULENCE. THE INITIAL NORMAL ACCELERATION RESPONSE TO ELEVATOR WAS SHARP AND POTENTIALLY DISORIENTATING.

CONFIGURATION	8-2NL	WIND (knots)	5
FLIGHT NUMBER	64-2	WIND SHEAR	MODERATE
PILOT	A	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	7		

CHARACTERISTIC ROOTS

-.15±	.13i	.10	-1.59

CONFIGURATION
FLIGHT NUMBER
PILOT
PILOT-RATING
WIND (knots)
WIND SHEAR
EXTERNAL TURBULENCE
CHARACTERISTIC ROOTS

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = .30 (rad/sec²)/in		$Z_{\delta T}$ = 7.4 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	GREAT	GREAT	MODERATE	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	±10 TO 12 knots			±200 TO 300 fpm		

COMMENTS:

DIFFICULTY DUE TO INTERACTION BETWEEN AIRSPEED AND VERTICAL SPEED - AS AIRSPEED DECREASED RATE OF DESCENT INCREASED. THIS MADE AIRSPEED AND ALTITUDE CONTROL VERY DIFFICULT.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED:	MODERATE
EASE OF COMPENSATION:	MODERATE DIFFICULTY

COMMENTS:

DIFFICULT TO HOLD AIRSPEED IN TURNS AND HENCE THE RATE OF CLIMB CHANGED RATHER RAPIDLY. (SEE SECTION 2 ABOVE).

DIFFICULTY

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	SLIGHT	MODERATE	SLIGHT	MODERATE	SLIGHT
PRECISION	FAIR	FAIR	POOR	FAIR	POOR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500

COMMENTS

THE STRONG INTERACTION BETWEEN PITCH ATTITUDE, AIRSPEED, AND RATE OF DESCENT CAUSES A HIGH PILOT WORK LOAD.

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR

COMMENTS:

DIFFICULTY

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I A S WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT SMALL

9. LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES

11. MISCELLANEOUS

CONFIGURATION 11-1P
FLIGHT NUMBER 36-3
PILOT B
PILOT-RATING 8 1/2

WIND (knots)
WIND SHEAR
EXTERNAL TURBULENCE

CHARACTERISTIC ROOTS

+.041±	.361	-.83	-1.06

CONFIGURATION
FLIGHT NUMBER
PILOT
PILOT-RATING

WIND (knots)
WIND SHEAR
EXTERNAL TURBULENCE

CHARACTERISTIC ROOTS

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = .30	(rad/sec²)/in	$Z_{\delta T}$ = 15.0	(ft/sec²)/in
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ =	(rad/sec²)/in	$Z_{\delta T}$ =	(ft/sec²)/in
Initial	Final	Initial	Final

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	±5 knots			fpm		

Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
VMC	IMC	IMC	VMC	IMC	IMC
OUT	OUT	IN	OUT	OUT	IN
knots			fpm		

COMMENTS NEED TO CLOSELY MONITOR PITCH ATTITUDE.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	LARGE	LONG (≈10 SECS)	ZERO
HEAVE	SMALL	LONG	ZERO

AMPLITUDE	PERIOD	DAMPING

	SOURCE	DEGREE
EXCITATION		
CONTROL	ELEVATOR	EFFECTIVE

SOURCE	DEGREE

COMMENTS A TRACE OF HEAVE ONLY MIXED WITH PITCH ATTITUDE. NEED TO TIGHTEN UP ON PITCH ATTITUDE CONTROL. NOT A P.I.O. BUT LIKE A SHORT-PERIOD PHUGOID WHICH IS CONTROLLABLE BY THE PILOT. THE OSCILLATION IS ALWAYS PRESENT.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: SOME
EASE OF COMPENSATION: SLIGHT DIFFICULTY

DIFFICULTY

COMMENTS SOME THRUST REQUIRED, BUT NO PROBLEM. IT IS JUST DIFFICULT TO MAINTAIN GOOD ATTITUDE REFERENCE IN TURNS.

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	SLIGHT	NONE	NONE	NONE	SLIGHT	SLIGHT
PRECISION	FAIR	FAIR	FAIR	FAIR	FAIR	FAIR

Intercept & initial track		Intermediate track		Final track	
Glide path	Localizer	Glide path	Localizer	Glide path	Localizer

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE
IF GREATER THAN 200 FEET

COMMENTS GLIDE SLOPE WITHIN 1 1/2 DOTS THROUGHOUT AND LOCALISER WITHIN 2 DOTS. BETTER RESULTS THAN EXPECTED, ESPECIALLY WITH LOCALISER CONTROL.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: SOME DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: FAIR/GOOD

DIFFICULTY

COMMENTS NOT SURE WHY SOME DIFFICULTY WAS EXPERIENCED. AIRSPEED WAS O.K., JUST COULD NOT BE SURE WHAT WAS GOING TO HAPPEN AT TOUCHDOWN. RATE OF DESCENT WAS O.K. THROUGH.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT NONE

9 LEAST OBJECTIONABLE FEATURES TURBULENCE RESPONSE WAS O.K.

10 MOST OBJECTIONABLE FEATURES RELATIVELY LARGE AMPLITUDE PITCHING OSCILLATION. PITCH ATTITUDE DEMANDS CLOSE ATTENTION.

11 MISCELLANEOUS NEED FOR BETTER, INTEGRATED INSTRUMENT DISPLAY TO MINIMISE PILOT WORK LOAD IN MONITORING ATTITUDES.

	Flight 82-2	Flight 97-1
CONFIGURATION	14-P	14-P
FLIGHT NUMBER	82-2	97-1
PILOT	4	3
PILOT-RATING	8½	7½ C
WIND (knots)		
WIND SHEAR	NEGLIGIBLE	
EXTERNAL TURBULENCE	LIGHT	

CHARACTERISTIC ROOTS

Flight				
82-2	+.10 ±	.30i	-.40	-1.60
97-1	+.10 ±	.30i	-.40	-1.60

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY:
RESPONSE:

Flight	ELEVATOR		THRUST LEVER	
	$M_{\delta E}$ = .30 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
82-2	SATISFACTORY	TOO GREAT		SATISFACTORY
	$M_{\delta E}$ = .20 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
97-1	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (82-2)	GREAT	GREAT	GREAT	MODERATE	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS (82-2)	± 5 knots			± 200 fpm		
DIFFICULTY (97-1)	>SLIGHT	>SLIGHT	>SLIGHT	>SLIGHT	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS (97-1)	± 7 knots			fpm		

COMMENTS

82-2: THE LONG PERIOD DIVERGENT PITCH OSCILLATION OVERRODE EVERYTHING ELSE. THE APPROACH TURNED OUT FAIRLY WELL BUT THE WORK LOAD WAS ENORMOUS.

97-1: SPEED ERRORS ARE A RESULT OF THE PITCH OSCILLATION, AND SOMETIMES THE INITIAL AND FINAL RESPONSES TO ELEVATOR WERE TOO GREAT IF ON THE WRONG SIDE OF THE PITCH ATTITUDE OSCILLATION.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

Flight		AMPLITUDE	PERIOD	DAMPING
82-2	PITCH	LARGE	LONG	NEGATIVE
82-2	HEAVE			
97-1	PITCH	MODERATE	LONG	ZERO
97-1	HEAVE	ZERO/SMALL	LONG	

Flight		SOURCE	DEGREE
82-2	EXCITATION	ELEVATOR, TURBULENCE	EASILY
82-2	CONTROL	ELEVATOR	EFFECTIVE
97-1	EXCITATION	UNKNOWN	EASILY
97-1	CONTROL	ELEVATOR	EFFECTIVE

COMMENTS

82-2: THE AIRCRAFT NOSE WAS IN CONSTANT MOTION AT LOW FREQUENCY. THE TURBULENCE ADDED ENORMOUSLY TO THE DIFFICULTY AND ABOUT 1½ TO THE RATING.

97-1: AIRCRAFT OSCILLATION SEEMED TO HAVE A 10 SEC. PERIOD, BUT OCCASIONALLY, DURING TIGHT ATTITUDE OR SPEED TRACKING ON THE APPROACH, THE FREQUENCY COULD BE INCREASED (TO 1 cps) TO RESULT IN A P.I.O.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	82-2	97-1
CHANGE REQUIRED:	MODERATE	NEGLIGIBLE
EASE OF COMPENSATION	SLIGHT DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS:

97-1: MUST TRACK PITCH ATTITUDE DURING TURNS. PARTICULARLY DIFFICULT BECAUSE OF UNDERLYING PITCH ATTITUDE OSCILLATION.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY (82-2)	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE
PRECISION (82-2)	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD
DIFFICULTY (97-1)	SLIGHT	SLIGHT	>SLIGHT	MODERATE	MODERATE	MODERATE
PRECISION (97-1)	FAIR	FAIR	FAIR	FAIR	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 82-2: 700; 97-1: 300

COMMENTS:

82-2: PRECISION WAS GOOD BECAUSE I DID NOT DARE LET AN ERROR BUILD UP. HENCE THE WORK LOAD WAS TREMENDOUS. FORTUNATELY THERE WAS NOT MUCH WIND SHEAR OTHERWISE THERE WOULD NOT HAVE BEEN TIME TO COPE WITH THE CHANGES.

97-1: PITCH OSCILLATION DEMANDS CLOSE ATTENTION.

6 BREAKOUT AND FLARE

	82-2	97-1
EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY	SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	POOR	FAIR

COMMENTS:

82-2: WOULD HAVE MISSED LANDING BY AT LEAST 500 FEET SINCE CAUTION WAS REQUIRED.

97-1: PITCH OSCILLATION CAUSES SOME CONCERN BUT CAN BE SUPPRESSED FOR THE FLARE O.K.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

82-2: SMALL BECAUSE HEADING WAS WELL HELD.

97-1: SMALL. THE PITCH, SPEED, HEIGHT TASK RESULTED IN THE NEED FOR SOME S-TURNING TO STAY ON THE LOCALISER.

9 LEAST OBJECTIONABLE FEATURES

82-2: CONTROL WAS NOT LOST.

10. MOST OBJECTIONABLE FEATURES

82-2: AS PER SECTIONS 2, 3 AND 5 ABOVE.

97-1: MODERATE TO LARGE AMPLITUDE PITCH ATTITUDE OSCILLATION. MUST BE CAREFUL OF OSCILLATION ADDING TO ELEVATOR INPUTS TO GIVE TOO LARGE A RESPONSE. ALSO MUST BE CAREFUL OF DELAYED RESPONSES AS OSCILLATION SWINGS BACK.

11. MISCELLANEOUS

82-2: ELEVATOR CONTROL SENSITIVITY INCREASED FROM 0.2 TO 0.3 r/s²/in.

CONFIGURATION 14-IN
FLIGHT NUMBER 46-[illegible]
PILOT D
PILOT-RATING 7

WIND (knots) [illegible] KNOTS
WIND SHEAR MODERATE
EXTERNAL TURBULENCE MODERATE

CHARACTERISTIC ROOTS

-.15 ±	.15i	-.11	-1.60

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY	$M_{\delta E}$ = .25 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE	TOO SMALL	TOO GREAT	TOO SMALL	TOO SMALL

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	MODERATE	>MODERATE	MODERATE	MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	±10 knots			±200 fpm		

COMMENTS

VERY LARGE POWER LEVER CHANGES TO OBTAIN RELATIVELY SMALL CHANGES IN VERTICAL VELOCITY. ALSO POWER LEVER HAD LARGE EFFECT ON PITCH ATTITUDE.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		LOW
HEAVE	ZERO		HIGH

	SOURCE	DEGREE
EXCITATION-CONTROL		

COMMENTS

SEEMED TO HAVE A NEGATIVE STATIC MARGIN WITH A QUITE RAPID DIVERGENCE IN PITCH, BUT HEIGHT STABILITY WAS QUITE [illegible]. DIFFICULT TO SET UP 500 F.P.M. DESCENT BECAUSE OF REQUIRED LARGE POWER LEVER CHANGES TO OBTAIN SMALL CHANGES IN VERTICAL VELOCITY.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: SMALL, NEGLIGIBLE
EASE OF COMPENSATION: MODERATE DIFFICULTY

COMMENTS

SOMEWHAT CONFUSING AS I COULD MAKE A 15-20 DEGREES BANKED TURN THROUGH 90 DEGREES WITHOUT CHANGING THRUST BUT ON ROLL-OUT THERE WOULD SUDDENLY BE A 200-300 F.P.M. DESCENT

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	GREAT	NO				
PRECISION	VERY POOR	GOOD		AIR		FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

COMMENTS

COULD NOT RATE GLIDE PATH TRACKING AS I WAS LATE STARTING DESCENT AND DID NOT CATCH GLIDE PATH EVEN THOUGH DESCENDING AT 1000 F.P.M. WITH VERY LITTLE POWER. FEEL THAT IF PROPER INTERCEPT HAD BEEN MADE, TRACKING WOULD HAVE BEEN ADEQUATE.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: VERY POOR

COMMENTS

TOO HIGH ON GLIDE PATH ALL THE WAY AND COULD NOT CATCH UP. SEEMED AS THOUGH I COULD NOT EXCEED 1000 F.P.M. DESCENT REGARDLESS OF POWER SETTING.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT NONE

9 LEAST OBJECTIONABLE FEATURES GOOD HEIGHT DAMPING. HOWEVER, IT MAY HAVE BEEN TOO MUCH.

10. MOST OBJECTIONABLE FEATURES CONSTANT ATTENTION TO PITCH ATTITUDE REQUIRED, ESPECIALLY IN TURBULENCE. HENCE, AIRSPEED CONTROL WAS QUITE POOR UNLESS THE PILOT WORKED HARD TO CONTROL IT.

11 MISCELLANEOUS

BASICALLY THIS CONFIGURATION REQUIRES TOO MUCH PILOT EFFORT TO OBTAIN PRECISION, AND THE HEIGHT RESPONSE HAS TOO MUCH LAG.

CONFIGURATION
FLIGHT NUMBER
PILOT
PILOT-RATING

WIND (knots)
WIND SHEAR
EXTERNAL TURBULENCE

CHARACTERISTIC ROOTS

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = (rad/sec²)/in		$Z_{\delta T}$ = (ft/sec²)/in	
Initial	Final	Initial	Final

Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
VMC	IMC	IMC	VMC	IMC	IMC
OUT	OUT	IN	OUT	OUT	IN
knots			fpm		

AMPLITUDE	PERIOD	DAMPING

SOURCE	DEGREE

DIFFICULTY

Intercept & initial track		Intermediate track		Final track	
Glide path	Localizer	Glide path	Localizer	Glide path	Localizer

DIFFICULTY

CONFIGURATION	15-2[illegible]	WIND (knots)	[illegible]
FLIGHT NUMBER	50-2	WIND SHEAR	NEGLIGIBLE
PILOT	D	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	$9\frac{1}{2}$		

CHARACTERISTIC ROOTS

[illegible].10±	.38i	-.35	-2.66

CONFIGURATION		WIND (knots)	
FLIGHT NUMBER		WIND SHEAR	
PILOT		EXTERNAL TURBULENCE	
PILOT-RATING			

CHARACTERISTIC ROOTS

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = .25 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	TOO GREAT	TOO GREAT	TOO SMALL	TOO GREAT

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = (rad/sec²)/in		$Z_{\delta T}$ = (ft/sec²)/in	
Initial	Final	Initial	Final

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	MODERATE	MODERATE	GREAT	MODERATE	MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	±10 knots			±500 fpm		

Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
VMC	IMC	IMC	VMC	IMC	IMC
OUT	OUT	IN	OUT	OUT	IN
knots			fpm		

COMMENTS

NEGATIVE STATIC MARGIN, AND SEEMS [illegible] OPERATING ON BACK OF POWER CURVE. POWER APPLICATIONS PRODUCE LARGE PITCHING MOMENTS. [illegible] BE JUST BACK OF PITCH STABILITY.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	LARGE		LOW
HEAVE			

	SOURCE	DEGREE
EXCITATION	ELEVATOR, THRUST, TURBULENCE	[illegible]
CONTROL	ELEVATOR	AGGRAVATING

AMPLITUDE	PERIOD	DAMPING

SOURCE	DEGREE

COMMENTS

ALMOST CONTINUOUS [illegible] OSCILLATION, [illegible] [illegible] OSCILLATION [illegible] AND ANY [illegible] INPUT SETS IT OFF.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED	SMALL [illegible] MODERATE	
EASE OF COMPENSATION	MODERATE	DIFFICULTY

	DIFFICULTY

COMMENTS

AIRSPEED CONTROL DIFFICULT AND CONSTANT [illegible] CHANGES ARE NECESSARY, [illegible] SPEED [illegible].

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	>SLIGHT	SLIGHT	>MODERATE	MODERATE	GREAT	GREAT
PRECISION	FAIR	GOOD	>POOR	FAIR	VERY POOR	VERY POOR

Intercept & initial track		Intermediate track		Final track	
Glide path	Localizer	Glide path	Localizer	Glide path	Localizer

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET

COMMENTS:

AIRSPEED EXCURSIONS BUILD UP TOO MUCH (10-1[illegible] KNOTS) AND SO VERTICAL VELOCITY GETS OUT OF BAND AND, COUPLED WITH A LARGE [illegible], IT ACTUALLY SATURATED SYSTEM, NECESSITATING DISENGAGEMENT AND RE-ENGAGEMENT AT 1500 FEET.

6 BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	SLIGHT	DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	VERY POOR	

	DIFFICULTY

COMMENTS:

OVERSHOT TOUCHDOWN DUE TO POOR GLIDE SLOPE [illegible] TOO [illegible] ON SLOPE.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

COUPLED THRUST AND AIRSPEED TO CONTROL VERTICAL VELOCITY. NOT TOO SUCCESSFUL [illegible] DIFFICULTY IN MAINTAINING PITCH ATTITUDE.

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT NONE

9 LEAST OBJECTIONABLE FEATURES [illegible] [illegible] [illegible] UNACCEPTABLE.

10 MOST OBJECTIONABLE FEATURES [illegible] [illegible] [illegible] [illegible] CHARACTERISTICS.

11 MISCELLANEOUS

[illegible] NOT [illegible] TO [illegible] AND [illegible] AIRSPEED AND [illegible] [illegible] [illegible].

CONFIGURATION	1-21L	WIND (knots)	5
FLIGHT NUMBER	113-2	WIND SHEAR	NEGLIGIBLE
PILOT	A	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	6		

CHARACTERISTIC ROOTS: -.019 ± .19 i, -.89 ± .48 i

CONFIGURATION	1-21L	WIND (knots)	5
FLIGHT NUMBER	127-2	WIND SHEAR	NEGLIGIBLE
PILOT	B	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	3 1/2 B		

CHARACTERISTIC ROOTS: -.019 ± .19 i, -.89 ± .48 i

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = .25 (rad/sec²)/in		$Z_{\delta T}$ = 11.90 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = (rad/sec²)/in		$Z_{\delta T}$ = (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	GREAT	SLIGHT	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS	+12, -10 knots			± 200 fpm		

COMMENTS: VERY "LOOSE" PITCH CONTROL WHICH TOGETHER WITH TURBULENCE GAVE REAL PROBLEMS IN AIRSPEED CONTROL.

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	NONE	NONE	NONE	NONE	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	± 5 knots			fpm		

SMALL COUPLING EFFECT BETWEEN AIRSPEED AND VERTICAL VELOCITY.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS:

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED: SMALL
EASE OF COMPENSATION: NO DIFFICULTY

COMMENTS:

SMALL-NEGLIGIBLE
NO DIFFICULTY

MUST OF COURSE HOLD AIRSPEED.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	SLIGHT	MODERATE	SLIGHT	GREAT	MODERATE
PRECISION	GOOD	FAIR	POOR	FAIR	VERY POOR	POOR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500

COMMENTS:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY	NONE	NONE	NONE	NONE	NONE	NONE
PRECISION	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD

O.K.

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT: NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT: GOOD

COMMENTS:

NO DIFFICULTY
GOOD

MUST BE CAREFUL TO HOLD AIRSPEED IN FLARE HOWEVER, TO AVOID COUPLING EFFECT OF AIRSPEED WITH VERTICAL VELOCITY.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: SMALL

NONE

9. LEAST OBJECTIONABLE FEATURES

GOOD AMOUNT OF ATTITUDE STABILITY. EASY TO CONTROL YET ADEQUATELY STABLE. EASY TO TRIM ATTITUDE AND AIRSPEED. RESPONSE TO TURBULENCE LOW.

10. MOST OBJECTIONABLE FEATURES: AS PER SECTION 2 ABOVE

MODERATE COUPLING EFFECT OF PITCHING MOMENT WITH POWER. NOTICEABLE, BUT NOT DANGEROUS AMOUNT OF AIRSPEED-VERTICAL VELOCITY COUPLING.

11. MISCELLANEOUS

	Flight 112-2		Flight 102-2	
CONFIGURATION	1-22L		1-22L	
FLIGHT NUMBER	112-2		102-2	
PILOT	A		B	
PILOT-RATING	6		7C	
WIND (knots)			10	
WIND SHEAR	MODERATE		SMALL	
EXTERNAL TURBULENCE	NEGLIGIBLE		LIGHT	

CHARACTERISTIC ROOTS

Flight				
112-2	-.010 ±	.19 i	-.89 ±	.48i
102-2	-.010 ±	.19 i	-.89 ±	.48i

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY: ELEVATOR $M_{\delta E} = .25$ (rad/sec²)/in; THRUST LEVER $Z_{\delta T} = 11.9$ (ft/sec²)/in

RESPONSE	Elevator Initial	Elevator Final	Thrust lever Initial	Thrust lever Final
Flight 112-2	SATISFACTORY	TOO GREAT	SATISFACTORY	
Flight 102-2	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE:	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (112-2)	NONE	MODERATE	MODERATE	NONE	MODERATE	MODERATE
MAXIMUM UNDESIRED FLUCTUATIONS (112-2)	± 10 - -12 knots			± 300 fpm		
DIFFICULTY (102-2)	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (102-2)	+8, -4 knots			fpm		

COMMENTS:

MODERATE INFLUENCE OF AIRSPEED ON NORMAL FORCE MADE IT DIFFICULT TO SETTLE ON EITHER THE DESIRED AIRSPEED OR VERTICAL SPEED. THE ATTITUDE WOULD NOT SETTLE DOWN TO HOLD AN AIRSPEED. SEEMED LITTLE CORRELATION BETWEEN POWER LEVER POSITION AND RATE OF DESCENT.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE (112-2)	PERIOD	DAMPING	AMPLITUDE (102-2)	PERIOD	DAMPING
PITCH	ZERO			ZERO		
HEAVE	ZERO			ZERO		

	SOURCE	DEGREE
EXCITATION:		
CONTROL:		

COMMENTS

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 112-2	Flight 102-2
CHANGE REQUIRED:	SMALL	NEGLIGIBLE/SMALL
EASE OF COMPENSATION	NO DIFFICULTY	NO/SLIGHT DIFFICULTY

COMMENTS

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY (112-2)	SLIGHT	SLIGHT	MODERATE	MODERATE	SLIGHT	GREAT
PRECISION (112-2)	FAIR	FAIR	POOR	FAIR	POOR	VERY POOR
DIFFICULTY (102-2)	>NONE	>NONE	> NONE	>NONE	> NONE	> NONE
PRECISION (102-2)	FAIR/GOOD	FAIR/GOOD	FAIR/GOOD	FAIR GOOD	FAIR/GOOD	FAIR/GOOD

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500 (112-2); 300 (102-2)

COMMENTS

WIND SHEAR CAME IN SUDDENLY AROUND 700 FEET. AIRSPEED WENT HIGH AND KILLED THE DESCENT RATE DURING THE INTERMEDIATE PART. WIND DIRECTION 300°M AT ALTITUDE AND [illegible] AT GROUND.

TENDENCY TO PUSH NOSE DOWN IF HIGH ON GLIDE SLOPE.

6 BREAKOUT AND FLARE

	Flight 112-2	Flight 102-2
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	SLIGHT/NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	FAIR

COMMENTS:

WAS SLIGHTLY HIGH AT BREAKOUT.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT [illegible]

NONE

9 LEAST OBJECTIONABLE FEATURES

NOT RESPONSIVE TO TURBULENCE UPSETS.

10 MOST OBJECTIONABLE FEATURES

NO ATTITUDE STABILITY BUT WAS NOT BAD.
PITCHING MOMENT DUE TO POWER CHANGES NOTICEABLE BUT NOT TOO MUCH OF A PROBLEM ON APPROACH AS THRUST LEVER NOT USED TOO MUCH.

11 MISCELLANEOUS

[illegible]

SATISFACTORY HEIGHT CONTROL.
MODEL RATING MAINLY ON BASIS OF PITCH INSTABILITY.

	FLIGHT 89-1	FLIGHT 100-2
CONFIGURATION	R1-21L	R1-21L
FLIGHT NUMBER	89-1	100-2
PILOT	A	B
PILOT-RATING	5	4C
WIND (knots)	10	CALM
WIND SHEAR	SMALL	NEGLIGIBLE
EXTERNAL TURBULENCE	NEGLIGIBLE	NEGLIGIBLE
CHARACTERISTIC ROOTS	-.09, -.31, -1.04 ± 1.03i	-.09, -.31, -1.04 ± 1.03i

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY (89-1)	$M_{\delta E}$ = .35 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
CONTROL SENSITIVITY (100-2)	$M_{\delta E}$ = .35 (rad/sec²)/in		$Z_{\delta T}$ = 11.3 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE (89-1)	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY
RESPONSE (100-2)	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (89-1)	SLIGHT	MODERATE	GREAT	NONE	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (89-1)	± 10 knots			± 200 fpm		
DIFFICULTY (100-2)	SLIGHT	SLIGHT	SLIGHT	SLIGHT	> SLIGHT	> SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (100-2)	± 8 knots			± 200 fpm		

COMMENTS

89-1: THE NOSE WOULD NOT STAY PUT. IN FACT IT SEEMED TO RESPOND AS THOUGH IT WERE OBEYING ATTITUDE COMMANDS AT FIRST BUT THEN THE ATTITUDE WOULD CONTINUE AFTER HAVING SLOWED OR EVEN STOPPED FOR A CONSTANT INPUT.

100-2: DIFFICULTY DUE TO TENDENCY TO PUT NOSE DOWN IF HIGH ON GLIDE SLOPE.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH (89-1)	SMALL	MEDIUM	MODERATE
HEAVE (89-1)			
PITCH (100-2)	ZERO		
HEAVE (100-2)	ZERO		

	SOURCE	DEGREE
EXCITATION (89-1)	ELEVATOR	MODERATELY
CONTROL (89-1)	ELEVATOR	EFFECTIVE
EXCITATION (100-2)		
CONTROL (100-2)		

COMMENTS

89-1: THE OSCILLATION DID NOT ACTUALLY PRODUCE A MOTION IN OPPOSITE DIRECTION BUT MERELY A HESITATION THAT WAS MIS-LEADING.

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	89-1	100-2
CHANGE REQUIRED	MODERATE	SMALL
EASE OF COMPENSATION	NO DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY (89-1)	NONE	SLIGHT	SLIGHT	SLIGHT	NONE	SLIGHT
PRECISION (89-1)	GOOD	FAIR	FAIR	FAIR	FAIR	FAIR
DIFFICULTY (100-2)	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
PRECISION (100-2)	GOOD	FAIR	FAIR	FAIR	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: 500 (89-1); 300 (100-2)

COMMENTS

89-1: AS PER SECTION 2 ABOVE.

100-2: BROKE OUT AT 300 FEET BECAUSE VERTICAL VELOCITY WAS 1000 F.P.M. TOO UNCOMFORTABLE NEAR GROUND. VERTICAL VELOCITY INCREASED ONCE TO 1200 F.P.M. MOMENTARILY.

6 BREAKOUT AND FLARE

	89-1	100-2
EASE OF ARRESTING RATE OF DESCENT	NO DIFFICULTY	SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	FAIR

COMMENTS

100-2: HIGHER THAN USUAL GROUND SPEED (60 KNOTS) REDUCES TIME ON APPROACH.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: SMALL (89-1); NONE (100-2)

9 LEAST OBJECTIONABLE FEATURES

100-2: ATTITUDE STABILITY SATISFACTORY.

10 MOST OBJECTIONABLE FEATURES

89-1: AS PER SECTION [illegible] ABOVE.

100-2: POWER LEVER SENSITIVITY STILL A LITTLE HIGH FOR POWER CHANGES ON GLIDE PATH. (AFTER BEING REDUCED 25%)

11 MISCELLANEOUS

100-2: IF RATE OF DESCENT GETS UP TO 1000 F.P.M. NEAR GROUND IT FEELS UNCOMFORTABLE ESPECIALLY IF HEAVE RESPONSE IS SLOW, AND IF THERE IS ANY AIRSPEED-VERTICAL VELOCITY COUPLING.

CONFIGURATION	R1-22L	WIND (knots)	10
FLIGHT NUMBER	103-3	WIND SHEAR	SMALL
PILOT	A	EXTERNAL TURBULENCE	NEGLIGIBLE
PILOT-RATING	3		

CHARACTERISTIC ROOTS

-.10	-.28	-1.03 ±	1.01i

CONFIGURATION	R1-22L	WIND (knots)	10
FLIGHT NUMBER	91-3	WIND SHEAR	
PILOT	B	EXTERNAL TURBULENCE	
PILOT-RATING	4 1/2 C		

CHARACTERISTIC ROOTS

-.10	-.28	-1.03 ±	1.01i

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY: / RESPONSE:

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = .35 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
Initial	Final	Initial	Final
SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = .35 (rad/sec²)/in		$Z_{\delta T}$ = 15.0 (ft/sec²)/in	
Initial	Final	Initial	Final
SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	-10, +5 knots			± 100 fpm		

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	>NONE	>NONE	>NONE	>NONE	>NONE	>NONE
MAXIMUM UNDESIRED FLUCTUATIONS	± 5 knots			fpm		

COMMENTS

DIFFICULTY PROBABLY MOSTLY DUE TO LACK OF RECENT PRACTICE. ATTITUDE CONTROL WAS A BIT "SOFT". A NEW STEADY-STATE ATTITUDE DID NOT RESULT FROM A STEADY-STATE ELEVATOR POSITION.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION:		
CONTROL:		

	SOURCE	DEGREE
EXCITATION:	ELEVATOR	HARDLY
CONTROL:		

COMMENTS:

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

CHANGE REQUIRED	NEGLIGIBLE	
EASE OF COMPENSATION	NO	DIFFICULTY

CHANGE REQUIRED	SMALL	
EASE OF COMPENSATION	SLIGHT	DIFFICULTY

COMMENTS

NOT PRECISELY SURE OF WHAT THE HEIGHT CONTROL CHARACTERISTICS ARE.

5. FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	MODERATE	MODERATE	SLIGHT	SLIGHT	SLIGHT	MODERATE
PRECISION	POOR	POOR	FAIR	FAIR	FAIR	POOR

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	NONE	NONE	NONE	NONE	SLIGHT	SLIGHT
PRECISION	GOOD	FAIR	GOOD	FAIR	GOOD	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE (IF GREATER THAN 200 FEET): (Pilot A) — ; (Pilot B) O.K.

COMMENTS

THE INITIAL RATE OF DESCENT RESULTING FROM THE POWER DECREASE AT GLIDE PATH INTERCEPTION WAS SURPRISINGLY HIGH AT 1500 F.P.M., AND WIND SHEAR CAUSED LOCALIZER PROBLEMS. MOST OF THIS COULD BE DUE TO LONG LAY-OFF PERIOD.

DIFFICULTIES DUE TO S-TURNS TO STAY ON THE LOCALIZER AND WIND EFFECTS ON THE GLIDE PATH.

6. BREAKOUT AND FLARE

EASE OF ARRESTING RATE OF DESCENT	NO	DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	GOOD	

EASE OF ARRESTING RATE OF DESCENT	MODERATE	DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	POOR	

COMMENTS

LOST 15 KNOTS AFTER BREAKOUT. NOT SURE WHY. COULD HAVE BEEN UNCONSCIOUS FLARE OR WIND EFFECTS ETC.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: SMALL.

NONE EXCEPT FOR S-TURNS TO STAY ON LOCALIZER.

9. LEAST OBJECTIONABLE FEATURES

GOOD STABILITY.
TURBULENCE NOT BAD.

10. MOST OBJECTIONABLE FEATURES: SOME PROBLEMS IN MAINTAINING PITCH ATTITUDE, BUT ACCEPTABLE.

HEIGHT CONTROL TAKES SOME GETTING USED TO BUT NOT BAD.

11. MISCELLANEOUS

	Flight 115-1	Flight 124-1
CONFIGURATION	2-21L	2-21L
FLIGHT NUMBER	115-1	124-1
PILOT	A	B
PILOT-RATING	8	7D
WIND (knots)	5	5
WIND SHEAR	NEGLIGIBLE	NEGLIGIBLE
EXTERNAL TURBULENCE	NEGLIGIBLE	NEGLIGIBLE
CHARACTERISTIC ROOTS	-.014 ± .145i, -.50, -1.26	-.014 ± .145i, -.50, -1.26

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY:
RESPONSE:

Flight 115-1:

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = 0.25 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
Initial	Final	Initial	Final
SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

Flight 124-1:

ELEVATOR		THRUST LEVER	
$M_{\delta E}$ = 0.25 (rad/sec²)/in		$Z_{\delta T}$ = 11.9 (ft/sec²)/in	
Initial	Final	Initial	Final
SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

Flight 115-1:

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION:	V.M.C.	I.M.C.	I.M.C.	V.M.C.	I.M.C.	I.M.C.
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	GREAT	GREAT	SLIGHT	MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	+12, -10 knots			± 300 fpm		

Flight 124-1:

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION:	V.M.C.	I.M.C.	I.M.C.	V.M.C.	I.M.C.	I.M.C.
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	± 8 knots			fpm		

COMMENTS:

(115-1) PITCH CONTROL "LOOSE" AND THE ATTITUDE DISTURBED BY THE TURBULENCE. AIRSPEED EFFECT ON THE POWER REQUIRED WAS QUITE A PROBLEM ESPECIALLY ON I.M.C. APPROACH.

(124-1) LARGE PITCHING MOMENT WITH POWER BUT IT PRESENTED NO PROBLEM. JUST NEED TO RETRIM IN PITCH WHEN MAKING POWER CHANGES. SOME COUPLING BETWEEN AIRSPEED AND VERTICAL VELOCITY.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE (115-1)	PERIOD (115-1)	DAMPING (115-1)	AMPLITUDE (124-1)	PERIOD (124-1)	DAMPING (124-1)
PITCH	ZERO			ZERO		
HEAVE	ZERO			ZERO		

	SOURCE (115-1)	DEGREE (115-1)	SOURCE (124-1)	DEGREE (124-1)
EXCITATION:				
CONTROL:				

COMMENTS:

(124-1) SLOW PITCH DIVERGENCE.

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	115-1	124-1
CHANGE REQUIRED	MODERATE	SMALL
EASE OF COMPENSATION:	MODERATE DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS:

(115-1) O.K. AS LONG AS THE AIRSPEED WAS NOT ALLOWED TO WANDER, BUT WHEN IT DROPPED TO 55 KNOTS A SIGNIFICANT POWER CHANGE WAS REQUIRED.

(124-1) THERE WOULD BE A NEED TO MONITOR PITCH AND AIRSPEED IN THE TURN, ESPECIALLY IF USING POWER. NO PROBLEM ENCOUNTERED HOWEVER.

5. FLIGHT PATH CONTROL

Flight 115-1:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	SLIGHT	SLIGHT	MODERATE	MODERATE	MODERATE	SLIGHT
PRECISION	FAIR	FAIR	POOR	POOR	FAIR	FAIR

Flight 124-1:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	NONE	NONE	NONE	NONE	SLIGHT	SLIGHT
PRECISION	GOOD	GOOD	GOOD	GOOD	FAIR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: (115-1) 800; (124-1) O.K.

COMMENTS:

(115-1) AS PER SECTION 2 ABOVE.

(124-1) THE BREAKOUT WAS O.K. BECAUSE THE POSITIONING TURNED OUT WELL, BUT POWER ADJUSTMENTS USED TO CONTROL RATE OF DESCENT, FORCE ATTENTION TO MAINTAIN AND RETRIM PITCH ATTITUDE AND AIRSPEED ON THE APPROACH.

6. BREAKOUT AND FLARE

	115-1	124-1
EASE OF ARRESTING RATE OF DESCENT	MODERATE DIFFICULTY	SLIGHT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	POOR	GOOD

COMMENTS:

(115-1) INSTEAD OF LEVELLING, THE AIRCRAFT STARTED TO CLIMB AGAIN AFTER DESIRED TOUCHDOWN.

(124-1) ATTENTION NEEDED TO HOLD AIRSPEED AND PITCH ATTITUDE WHILE FLYING DUE TO PITCHING MOMENTS CAUSED BY THRUST CHANGES.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: (115-1) SMALL; (124-1) NONE

9. LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES

(124-1) LARGER THAN NORMAL (OR DESIRABLE) PITCHING MOMENTS WITH THRUST CHANGES.
PITCH DIVERGENCE.
SENSITIVITY IN PITCH TO TURBULENCE.
NOTICEABLE, BUT NOT BOTHERSOME AIRSPEED-VERTICAL VELOCITY COUPLING.

11. MISCELLANEOUS

(124-1) CONTROL ACTIVITY ON APPROACH WAS SURPRISINGLY LOW. APPROACH WAS EASY TO FLY EXCEPT THAT SOME LOCALIZER S-TURNS RESULTED BELOW 500 FEET DUE TO DISPLAY/APPROACH AID DEFICIENCIES.

	Flight 79-3	Flight 85-2
CONFIGURATION	2-22L	2-22L
FLIGHT NUMBER	79-3	85-2
PILOT	A	B
PILOT-RATING	7	8D
WIND (knots)	5-10	CALM
WIND SHEAR	SMALL	NEGLIGIBLE
EXTERNAL TURBULENCE	MODERATE	NEGLIGIBLE
CHARACTERISTIC ROOTS	-.014± .145i, -.50, -1.26	-.014± .145i, -.50, -1.26

1. AIRCRAFT RESPONSE TO CONTROL INPUTS

Flight 79-3:

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = .30 (rad/sec²)/in		$Z_{\delta T}$ = 11.90 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

Flight 85-2:

	ELEVATOR		THRUST LEVER	
CONTROL SENSITIVITY:	$M_{\delta E}$ = .25 (rad/sec²)/in		$Z_{\delta T}$ = 11.90 (ft/sec²)/in	
	Initial	Final	Initial	Final
RESPONSE:	SATISFACTORY	SATISFACTORY	SATISFACTORY	SATISFACTORY

2. EASE OF MAINTAINING DESIRED VELOCITIES

Flight 79-3:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	MODERATE	GREAT	SLIGHT	MODERATE	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS	± 10 knots			± 300 fpm		

Flight 85-2:

	Longitudinal velocity (IAS)			Vertical velocity (ḣ)		
FLIGHT CONDITION:	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY	SLIGHT	SLIGHT	MODERATE	SLIGHT	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS	± 8 knots			± 300 fpm		

COMMENTS:

Flight 79-3: PITCH ATTITUDE CONTROL WAS MUCH TOO EFFECTIVE AND REQUIRED CONSTANT ATTENTION. THERE SEEMED TO BE SOME EFFECT OF AIRSPEED ON VERTICAL SPEED TO PRODUCE A DESCENT AS AIRSPEED INCREASED AND VICE VERSA.

Flight 85-2: LARGE SPEED-VERTICAL VELOCITY COUPLING CAUSING VERTICAL VELOCITY FLUCTUATIONS DUE TO AIRSPEED CHANGES.

3. RESIDUAL OSCILLATORY CHARACTERISTICS

Flight 79-3:

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

Flight 85-2:

	AMPLITUDE	PERIOD	DAMPING
PITCH	ZERO		
HEAVE	ZERO		

	SOURCE	DEGREE
EXCITATION		
CONTROL		

COMMENTS:

4. CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Flight 79-3	Flight 85-2
CHANGE REQUIRED	SMALL	SMALL
EASE OF COMPENSATION	SLIGHT DIFFICULTY	SLIGHT DIFFICULTY

COMMENTS:

Flight 85-2: MAINTAINING AIRSPEED IS MOST IMPORTANT.

5. FLIGHT PATH CONTROL

Flight 79-3:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:	SLIGHT	SLIGHT	MODERATE	SLIGHT	MODERATE	SLIGHT
PRECISION	FAIR	FAIR	POOR	FAIR	POOR	FAIR

Flight 85-2:

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY:						
PRECISION						

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: Flight 79-3: 500; Flight 85-2: 400

COMMENTS:

Flight 79-3: DURING THE INTERMEDIATE STAGE THE AIRSPEED INCREASED TO 70 KNOTS AND THE RATE OF DESCENT DECREASED CONSIDERABLY. ONLY GROSS USE OF THE POWER LEVER KEPT THE AIRCRAFT ON THE GLIDE PATH.

Flight 85-2: NOT ENOUGH HEADING CROSS-CHECKS RESULTING IN A LOT OF S-TURNING TO STAY ON LOCALIZER. VERTICAL VELOCITY INTERACTION WITH EVEN SMALL AIRSPEED CHANGES MADE IT DIFFICULT TO STAY ON GLIDE PATH, AND INVOLVED THE USE OF POWER TO TRY TO COMPENSATE.

6. BREAKOUT AND FLARE

	Flight 79-3	Flight 85-2
EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY	MODERATE/GREAT DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR	FAIR

COMMENTS:

Flight 85-2: NEED TO HOLD AIRSPEED PRECISELY AND THEN CONTROL RATE OF DESCENT WITH POWER. IF AIRSPEED VARIES, NOT SURE HOW TO CONTROL PRECISE RATE OF DESCENT.

7. CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM I.A.S. WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

Flight 85-2: ONLY WAY IS TO PRECISELY CONTROL AIRSPEED, THEN TO CONTROL VERTICAL VELOCITY WITH THRUST. IF AIRSPEED VARIES IN THE "RIGHT" DIRECTION CORRECTION CAN BE DELAYED FOR A WHILE

8. LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT

Flight 79-3: SMALL

Flight 85-2: NONE

9. LEAST OBJECTIONABLE FEATURES

Flight 85-2: SOME ATTITUDE STIFFNESS BUT TURBULENCE DID CAUSE SOME PITCH ATTITUDE UPSETS.

10. MOST OBJECTIONABLE FEATURES

Flight 85-2:
AIRSPEED-VERTICAL VELOCITY COUPLING
PITCH ATTITUDE UPSETS WITH TURBULENCE.
NEED TO STABILISE SPEED PRECISELY AND TIGHTEN CONTROL ON IT.

11. MISCELLANEOUS

Flight 79-3: THE EASE WITH WHICH THE AIRSPEED COULD BE HELD ON THE FIRST MODEL OF THE DAY ([illegible]), WHICH HAD ATTITUDE STABILITY, PRESENTED QUITE A COMPARISON WITH THIS AND THE PREVIOUS MODEL.

Flight 85-2: COULD GET INTO A PROBLEM AT TOUCHDOWN UNLESS AIRSPEED HELD WELL.

	Left	Right
CONFIGURATION	2-23B	2-23C
FLIGHT NUMBER	102-3	106-1
PILOT	A	A
PILOT-RATING	7 1/2	6
WIND (knots)	5-10	5
WIND SHEAR	SMALL	SMALL
EXTERNAL TURBULENCE	LIGHT	NEGLIGIBLE
CHARACTERISTIC ROOTS	-.014 ± .1451, -.50, -1.26	-.014 ± .1451, -.50, -1.26

1 AIRCRAFT RESPONSE TO CONTROL INPUTS

CONTROL SENSITIVITY:

RESPONSE:

	ELEVATOR $M_{\delta E} = .25$ (rad/sec²)/in		THRUST LEVER $Z_{\delta T} = 11.9$ (ft/sec²)/in	
	Initial	Final	Initial	Final
Left	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY
Right	SATISFACTORY	TOO GREAT	SATISFACTORY	SATISFACTORY

2 EASE OF MAINTAINING DESIRED VELOCITIES

	Longitudinal velocity (IAS)			Vertical velocity ($\dot{h}$)		
FLIGHT CONDITION	VMC	IMC	IMC	VMC	IMC	IMC
TURBULENCE	OUT	OUT	IN	OUT	OUT	IN
DIFFICULTY (Left)	SLIGHT	SLIGHT	GREAT	SLIGHT	SLIGHT	GREAT
MAXIMUM UNDESIRED FLUCTUATIONS (Left)	±10 knots			±100 fpm		
DIFFICULTY (Right)	SLIGHT	MODERATE	MODERATE	NONE	SLIGHT	SLIGHT
MAXIMUM UNDESIRED FLUCTUATIONS (Right)	+5, -10 knots			±100 fpm		

COMMENTS

Left: PULLING POWER LEVER AFT MOVES NOSE UP CAUSING AIRSPEED TO DECREASE AND THE AIRCRAFT TO DESCEND. THE RAPIDITY WITH WHICH THE NOSE RESPONDED TO POWER LEVER MOVEMENTS INDICATED THAT IT WAS NOT AN ANGLE-OF-ATTACK EFFECT.

Right: DIFFICULTY DUE TO:
NO PITCH ATTITUDE STABILITY - ATTITUDE KEEPS MOVING FOR SMALL OUT-OF-TRIM ELEVATOR INPUTS.
STRONG COUPLING BETWEEN THRUST LEVER AND PITCH (NOSE UP FOR REDUCTION IN THRUST).
TURBULENCE CAUSED NOSE TO DIVERGE. COULD BE WELL ARRESTED INITIALLY WITH GOOD INITIAL CONTROL SENSITIVITY. BUT STEADY STATE CAUSED PROBLEMS.

3 RESIDUAL OSCILLATORY CHARACTERISTICS

	AMPLITUDE (Left)	PERIOD	DAMPING	AMPLITUDE (Right)	PERIOD	DAMPING
PITCH	ZERO			ZERO		
HEAVE	ZERO			ZERO		

	SOURCE	DEGREE
EXCITATION:		
CONTROL:		

COMMENTS

4 CHANGE IN THRUST REQUIRED FOR 20° BANKED TURNS

	Left	Right
CHANGE REQUIRED:	NEGLIGIBLE	SMALL
EASE OF COMPENSATION	NO DIFFICULTY	NO DIFFICULTY

COMMENTS:

5 FLIGHT PATH CONTROL

	Intercept & initial track		Intermediate track		Final track	
	Glide path	Localizer	Glide path	Localizer	Glide path	Localizer
DIFFICULTY (Left)	SLIGHT	SLIGHT	MODERATE	MODERATE	MODERATE	MODERATE
PRECISION (Left)	FAIR	FAIR	POOR	FAIR	POOR	FAIR
DIFFICULTY (Right)	NONE	SLIGHT	SLIGHT	SLIGHT	MODERATE	SLIGHT
PRECISION (Right)	GOOD	FAIR	FAIR	FAIR	POOR	FAIR

MINIMUM ACCEPTABLE BREAKOUT ALTITUDE IF GREATER THAN 200 FEET: Left 800; Right 500

COMMENTS

Left: AS PER SECTION 2 ABOVE.

Right: TURBULENCE CAUSED AIRSPEED CONTROL PROBLEMS.

6 BREAKOUT AND FLARE

	Left	Right
EASE OF ARRESTING RATE OF DESCENT	SLIGHT DIFFICULTY	NO DIFFICULTY
PRECISION OF ATTAINING TOUCHDOWN POINT	FAIR	GOOD

COMMENTS:

Left: THE AIRSPEED STARTED TO RISE AS THE AIRCRAFT CROSSED THE TOUCHDOWN MARKERS BUT NOT CONSIDERED SERIOUS.

Right: THE PITCHING MOMENT WITH THRUST APPLICATION COULD CAUSE PROBLEMS.

7 CONTROL TECHNIQUE

COMMENTS IF DIFFERENT FROM IAS WITH ELEVATOR AND VERTICAL SPEED WITH THRUST LEVER

8 LATERAL DIRECTIONAL CHARACTERISTICS

EFFECT ON FINAL ASSESSMENT: Left SMALL; Right NONE

9 LEAST OBJECTIONABLE FEATURES

10. MOST OBJECTIONABLE FEATURES AS PER SECTION 2 ABOVE.

11. MISCELLANEOUS

APPENDIX A: EQUATIONS GOVERNING SIMULATOR AND MODEL MOTION

In this section, the simulator and model equations of motion are considered. The autopilot loop closures required to ensure that the simulator motion corresponded to that demanded by the model equations of motion are then described.

A.1 BRIEF DESCRIPTION OF SIMULATOR

The simulator utilized (based on the Bell 47G-3B1 helicopter) is characterized by four independent force and moment motivators: the main rotor collective and longitudinal and lateral cyclic controls, and the tail rotor collective control. These motivators are used to control the normal force and the pitching, rolling and yawing moments of the simulator respectively. The fore-and-aft and transverse forces of the simulator cannot be controlled independently and the motions along these axes are governed by the inherent characteristics of the simulator as modified by crosscoupling terms resulting from the closure of the four controlled loops.

A.1.1. Equations Governing Longitudinal Motion of the Simulator

To implement a linear-velocity sensing system for the simulator, it was assumed that the latter's motion could be adequately represented by the following equations of motion:

$$\dot{U}_H = A_{x_H} - g\ \Theta_H - Q_H W_{MIX} + R_H V_{MIX} \qquad A1$$

$$\dot{V}_H = A_{y_H} + g\left[1 - \frac{\Theta_H^2}{2}\right]\Phi_H - R_H\, U_{MIX} + P_H\, W_{MIX} \qquad A2$$

$$\dot{W}_H = A_{z_H} + g\left[1 - \frac{\Theta_H^2}{2} - \frac{\Phi_H^2}{2}\right] + Q_H\, U_{MIX} - P_H\, V_{MIX} \qquad A3$$

The suffix MIX indicates that the velocity is the composite of high frequency inertial data and low frequency air-mass data.

Furthermore, in order that the longitudinal velocity response of the simulator to disturbances could be predicted, the longitudinal acceleration was, for small perturbations about the operating point, divided into a component due to the main rotor and another arising from the remaining fuselage X-force and pitching moment derivatives, that is,

$$a_{x_H} = a_{x_R} + a_{x_F} = - K_3\dot{q}_H + X_F F\ , \qquad A4$$

where $K_3 = \frac{B}{mh_R} = 3.0$

and $X_F = K_3 M_f + X_f$

For small perturbations, equation A1 could thus be rewritten as

$$\dot{u}_H = - K_3\dot{q}_H - W_o q_H - g\theta_H - Q_o w_H + R_o v_H + a_{x_F} \qquad A5$$

The form of this equation differs from the more general form of Equation A1 through the introduction of a second-order lead term in the longitudinal velocity response to pitching motions which accounts for the closed-loop variability, and thereby allows the remaining component of the longitudinal acceleration to be described by the more conventional constant coefficient X-force derivatives arising, for this simulator, entirely from the fuselage.

The second-order lead term results in a notch filter in longitudinal responses to pitching motions at a natural frequency given, to good approximation for the prevailing levels of X-force derivatives, by

$$\omega \approx \sqrt{\frac{g}{K_3}} = 3.3 \text{ rad/sec}$$

The bandwidth of the filter is established principally by

$$\zeta = \frac{W_o}{2K_3\omega} = .05\ W_o$$

A.1.2 Evaluation of the Equivalent Open-Loop X-Force Derivatives

Analysis of flight data, utilizing an analogue matching technique, was undertaken to obtain the equivalent open loop X-force derivatives. The identity matched was

$$a_{x_H} - X_F.F = - K_3\ \dot{q}_H$$

Good fidelity was obtained with the following values for K_3 and X-force derivatives about the flight-operating condition of U = 60 knots, $\dot{h} = 0$.

$$K_3 = 3.0$$

$$X_{u_F} = -.04$$

$$X_{w_F} = -.03$$

$$X_{\dot{w}_F} = 0$$

$$X_{q_F} = -.022$$

$$X_{\theta_F} = 0$$

$$X_{\delta e_F} = 0$$

$$X_{\delta c_F} = 0$$

The negligible values obtained for the equivalent force derivatives $X_{\dot{w}_F}$, X_{θ_F}, $X_{\delta e_F}$, $X_{\delta c_F}$ were achieved through the removal of the horizontal stabilizer of the simulator, an action which markedly reduced the interaction between the simulator's control displacements and the fuselage forces and moments.

A.2 EQUATIONS GOVERNING THE LONGITUDINAL MOTION OF THE MODEL

The equations utilized in the mathematical model to be followed by the autopilot loops were:

Z-Force

$$\dot{w}_M = U_o q_M + a_{z_M} + g\left(1 - \frac{\Theta_H^2}{2} - \frac{\Phi_H^2}{2}\right) - P_H V_{MIX} \qquad A6$$

Available on the simulator was the quantity $\dot{W}_H$ of Equation A3 calculated from inertial and mixed inertial - air data velocity. Equation A6 was thus rewritten as

$$\dot{w}_M = \dot{W}_H + (a_{z_M} - A_{z_H}) + U_o q_M - U_{MIX} Q_H \; . \qquad A7$$

For perturbations about the operating point Equation A7 was further simplified to:

$$\dot{w}_M = \dot{W}_H + (a_{z_M} - A_{z_H}) + U_o(q_M - Q_H) \qquad A8$$

This was the form utilized in the calculation of the model equations of motion. The error term $U_o(q_M - Q_H)$ was, however, not passed to the heave autopilot for reasons discussed in Section A.3.2.

The normal velocity obtained from Equation A8 was that for the centre of gravity. The simulation of a pilot's station ahead of the centre of gravity was achieved in the longitudinal plane by a direct feed forward term to the heave autopilot loop.

The commanded normal acceleration was composed of

$$a_{z_M} = Z_{u_M} u_H + Z_{w_M} w_M + Z_{q_M} q_M + Z_{\theta_M} \theta_M + Z_{\delta e_M} \delta e_M + Z_{\delta T_M} \delta_{T_M} + Z_{u_M} u_{g_M} + Z_{w_M} w_{g_M} \qquad A9$$

M-Moment

$$\dot{q}_M = \frac{\Delta M}{B} \qquad A10$$

All other inertial terms were considered to be negligible in this moment equation.

The angular acceleration was composed of:

$$\dot{q}_M = M_{u_M} u_H + M_{\dot{w}_M} \dot{w}_M + M_{w_M} w_M + M_{q_M} q_M + M_{\theta_M} \theta_M + M_{\delta e_M} \delta e_M + M_{\delta T_M} \delta T_M + M_{u_M} u_{g_M} + M_{w_M} w_{g_M} \qquad A11$$

The commanded pitch attitude was obtained from the expression,

$$\theta_M = \theta_H + \int (q_M - q_H)dt \ .$$

This compares with the exact expression

$$\theta_M = \theta_H + \int (q_M - q_H)\cos\phi \ dt \ . \qquad \text{A12}$$

The error $\int (q_M - q_H)dt$ was forced to be small by the autopilot through the use of a low frequency lag-lead pair on this signal, and the error which resulted from the assumption

$$\int (q_M - q_H)\cos\phi \ dt = \int (q_M - q_H)dt$$

was considered to be negligible in view of the quality of model following achieved at low frequencies.

X-Force

No independent means is available for controlling the X-forces but model calculations to obtain modal parameters utilized the identity

$$\dot{u}_M = - K_3\dot{q}_M - W_o q_M - g\ \theta_M + a_{x_{F_M}} - Q_o w_H + R_o v_H \qquad \text{A13}$$

$$= \dot{u}_H + K_3(\dot{q}_H - \dot{q}_M) + W_o(q_H - q_M) + g(\theta_H - \theta_M) + (a_{x_{F_M}} - a_{x_{F_H}}) \ . \qquad \text{A14}$$

Providing that the pitch-loop model-following is of sufficient fidelity in the frequency range of interest for the control of longitudinal perturbations, and that the equivalent fuselage X-force derivatives are accurately estimated, one may write

$$\dot{u}_M \simeq \dot{u}_H \ . \tag{A15}$$

Equation A15 is that which was assumed to govern the longitudinal velocity of the simulator, and the feedback consequently used in the model equations of motion during the simulations was u_H.

Kinematic Relationship

The relationship utilized to transform the normal, body axes system velocity to that in an earth fixed system is

$$\dot{h} = - w + U_o\theta + \theta_o u \ . \tag{A16}$$

The Collected Model Equations of Motion

The small-perturbation, longitudinal equations of motion, used to calculate the model characteristics for the conditions of zero disturbances in the lateral-directional degrees of freedom and $P_o = Q_o = R_o = \Phi_o = V_o = 0$, are collected below,

$$\begin{bmatrix} s - X_{u_F} & - X_{w_F} & K_3 s^2 + (W_o - X_{q_F})s + g \\ - Z_u & (1 - Z_{\dot{w}})s - Z_w & -(U_o + Z_q)s + g\theta_o - Z_\theta \\ - M_u & - M_{\dot{w}}s - M_w & s^2 - M_q s - M_\theta \end{bmatrix} \begin{bmatrix} u \\ w \\ \theta \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 0 & 0 & 0 \\ Z_{\delta e} & Z_{\delta T} & Z_u & Z_w \\ M_{\delta e} & M_{\delta T} & M_u & M_w \end{bmatrix} \begin{bmatrix} \delta e \\ \delta T \\ u_g \\ w_g \end{bmatrix} \tag{A17}$$

A.3 AUTOPILOT LOOP CLOSURES FOR LONGITUDINAL MODES OF MOTION

The major effort expended on the autopilot loop closures was aimed at improving the low frequency fidelity without compromising the crossover frequency.

A.3.1 Pitch Loop

The removal of the horizontal stabilizer and the desire to achieve better low frequency fidelity required changes to the inner-loop control law.

The pitch loop was closed with longitudinal cyclic on an error signal of the form, $F_q\,(s).\left[(q_M - q_H) + \frac{Ks}{s - Z_{w_H}}\,\delta_{c_H}\right].$

The high-passed crosscoupling lead term from collective to cyclic, which was small, was introduced to allow increased loop gains without instability occurring when large simultaneous collective and cyclic movements were demanded during the control of some configurations.

The resulting loop exhibited frequency response characteristics which could be well represented in the frequency range of interest to the pilot by

$$\frac{q_H}{q_M}(s) = \frac{36}{s^2 + 2(.5)(6)s + 6^2}$$

The loop remained insensitive to disturbances originating from the other controls and external gusts.

A.3.2 Heave Loop

When heave-loop closure had been employed on the simulator in the past, the primary error signal had been generated from $F_{a_z}(s)(a_{z_M} - a_{z_H})$. This had led to low frequency drift problems. To avoid these, the error signal employed in this investigation to drive the main rotor collective was changed to

$$F_w(s)\left[(w_{M_{cg}} - w_{H_{cg}}) - \frac{U_o(q_M - q_H)}{s - Z_{w_M}} - LQ_H\right] .$$

The pitch loop error included in the calculation of the commanded normal velocity in Equation A8 was removed to prevent the heave loop from attempting to respond to pitch loop errors. The term LQ_H was added to allow the simulation of a pilot's station ahead of the centre of gravity in the longitudinal plane.

The resulting heave loop exhibited frequency response characteristics which could be well represented in the frequency range of interest to the pilot by

$$\frac{w_H}{w_M}(s) = \frac{100}{s^2 + 2(.5)10 + 10^2}$$

The drift problem disappeared with the new form of loop closure.

Probably the major limitation imposed on the heave loop arose from the demands on engine power required to maintain constant main rotor r.p.m. during manoeuvres requiring large normal accelerations.

The strategy employed to alleviate this problem was to climb to circuit height at the best lift to drag ratio under visual conditions without the introduction of artificial turbulence. Only when sufficient power reserves were available, during level flight and descent, were the more challenging tasks of flying under instrument conditions in the presence of artificial turbulence imposed on the pilot.

Although only having indirect control over the power output of the engine, the evaluation pilots felt the need for an indication of engine manifold pressure when operating near power limits. To prevent this indication from becoming an additional motion cue in the normal plane, only the final 18% of available power was displayed to the pilot after Flight No. 28. For the task being evaluated, the mean manifold pressures during climb, cruise and descent were 85-88%, 76-79% and 48-55% respectively. The evaluation pilot was thus able to perceive his mean manifold pressure only during the climb.

When a tight loop is closed along the Z-axis on normal velocity, $w_{H_{C.G.}}$, the damping in heave, $-Z_w$, is augmented significantly. If the normal velocity feedback information is obtained directly from an angle of attack vane, the heave response to gusts becomes accentuated. The low frequency data in this experiment was derived from an angle of attack vane but, to ensure that the effect of external turbulence was attenuated, the vane data were low-passed by a second-order filter with a crossover frequency of 0.5 rad/sec. The required complementary, high-frequency information was provided by an on-board, six degree of freedom, mixed inertial and air-data calculation. The mixed normal velocity information thereby obtained was characterized by a high signal-to-noise ratio which allowed high loop gains without structural modes being excited. In heave, the simulator, in general, responded only to those external gusts characterizing convective instabilities with long wave lengths and, to minimize the effects of this class of disturbance, flying was restricted to conditions notable for their absence.

APPENDIX B: PILOT'S CONTROL FEEL SYSTEM

The simulator has, since 1971, been equipped with electro-hydraulic feel systems for the evaluation pilot's elevator, aileron and rudder controls. This facility allows the simulation of a wide range of force-displacement characteristics through the adjustment of the electric gain of various feedback paths.

In the present experiment, the feel characteristics were adjusted to lie in the centre of the limits specified for Level 1 operation in MIL-F-83300. Adjustments about these conditions were then made by one of the evaluation pilots to give what he considered to be good, unobtrusive characteristics. These settings, tabulated in Figure 2, were maintained for the duration of the experiment.

In general, both a preload force and a slightly smaller dry friction reaction were desired in addition to the second-order, linear velocity and displacement feedback. (This allows quickened and absolute centring of the controls.)

The level of forces chosen remained within the Level 1 range of the above requirements for elevator and aileron but were high and just in the Level 2 range for the rudder pedals in both spring gradient and total breakout force.

The dynamic response has been specified in Figure 2 only in terms of the basic, linear second-order system but it should be recognized that the dynamic response of the system is markedly and non-linearly affected both by the preload and the friction. The former increases the stiffness and thus the natural frequency of the controller system, particularly near the trim position, whereas the latter provides resistance to system motion which is independent of velocity.

The elevator and aileron were each provided with a thumb-wheel force trim and, after starting with a trim rate of twice that tabulated, the pilots expressed satisfaction with the rate finally selected for all configurations other than those which were of the attitude stabilized, attitude command form. The elevator trim rate was considered to be slightly on the slow side for these configurations because of the greater steady state stick displacements required to change pitch attitude.

The only force feel provided on the thrust lever was mechanical dry friction which could be adjusted by the evaluation pilot to suit his desires.

APPENDIX C: ARTIFICIAL TURBULENCE GENERATION

In order to create a repeatable statistical disturbances environment for the evaluations, the output of three independent, random-noise, signal generators was shaped in such a manner that the model equations of motion were disturbed appropriately for turbulence components exhibiting Von Karman spectra and normal distributions.

The absence of independent control over either the fore-and-aft or transverse motions of the simulator meant that these artificial turbulence components could affect only the three rotary and the heave controls of the simulator. The pure Von Karman spectra were thus shaped to ensure that the simulator responses to artificially generated turbulence in heave, pitch roll and yaw were those that would result from external turbulence components of the same magnitude.

The output power-spectrum of a linear filter is related to the input power-spectrum by

$$\phi_{oo}(\omega) = |H(i\omega)|^2 \phi_{ii}(\omega)$$

The filter characteristics applied to the output of the random noise generators took the forms

$$H_u(s) = \frac{s}{s - X_{u_F}} H_{u_{VK}}(s) + \frac{X_{w_F}}{s - X_{u_F}} H_{w_{VK}}(s) ,$$

$$H_v(s) = \frac{s}{s - Y_{v_F}} H_{v_{VK}}(s) ,$$

$$H_w(s) = H_{w_{VK}}(s) .$$

The filters $H_{u_{VK}}(s)$, $H_{v_{VK}}(s)$, $H_{w_{VK}}(s)$ which were implemented, when applied to the output of the random signal generator, resulted in a close approximation to the Von Karman turbulence spectra given by

$$\phi_{uu}(\omega) = \frac{2\sigma^2}{\pi}\frac{L}{U}\left[\frac{1}{[1 + (1.339\frac{L}{U}\omega)^2]^{5/6}}\right] ,$$

$$\phi_{vv}(\omega) = \phi_{ww}(\omega) = \frac{\sigma^2}{\pi}\frac{L}{U}\left[\frac{1 + \frac{8}{3}(1.339\frac{L}{U}\omega)^2}{[1 + (1.339\frac{L}{U}\omega)^2]^{11/6}}\right] .$$

The characteristic scale length, L, of the turbulence was kept fixed, for reasons of limited computational capacity, at L = 400 ft for all three components, whereas the r.m.s. turbulence level for all components was held to 2.5 ft/sec.

The following filter characteristics were used to approximate the Von Karman spectra for these conditions:

$$H_{u_{VK}}(s) = 3.96\,\frac{(.641s + 1)}{(4.36s + 1)(.436s + 1)} ,$$

$$H_{v_{VK}}(s) = H_{w_{VK}}(s) = .707\,H_{u_{VK}} \cdot \frac{(8.63s + 1)}{(5.28s + 1)} .$$

APPENDIX D: VALIDATION OF X-FORCE SIMULATION

In order to determine if the estimates for the X-force derivatives were adequate to obtain the predicted model motions, a ground-based simulation of the longitudinal equations of motion using the assumed form for the X-force equation was undertaken for several configurations. The equations of motion of a particular configuration were disturbed by the pilot's inputs recorded during the flight evaluation of the same configuration. This allowed a comparison to be made between the responses so obtained and the actual in-flight helicopter responses. In particular, the correspondence between the longitudinal velocity responses is an indication of the adequacy of the X-force modelling.

The equations utilized in the ground-based simulation are as follows:

$$\dot{q}_M = M_u\, u_M + M_q\, q_M + M_w\, w_M + M_{\dot{w}}\, \dot{w}_M + M_\theta\, \theta_M + M_{\delta e}\delta e + M_{\delta T}\delta T \qquad \text{D1}$$

$$\dot{u}_M = -\,K_3\, \dot{q}_M - g\, \theta_M + a_{x_{F_M}} \qquad \text{D2}$$

$$\dot{w}_M = U_o q_M + a_{z_M} \qquad \text{D3}$$

$$\theta_M = \theta_{H_{S.C.}} + \int (q_M - q_H)dt \qquad \text{D4}$$

where, $\theta_{H_{S.C.}}$, is the signal-cancelled, helicopter pitch attitude, and the subscript M refers to the ground model.

These equations should be compared with equations, A11, A13, A6, and A12 respectively in Appendix A to show the possible sources of error originating from the initial conditions, unrecorded lateral-directional inputs, or external disturbances.

The following three configurations, with differing degrees of crossfeed from longitudinal velocity perturbations to the heave and pitch equations of motion, were selected for validation purposes:

Configuration 1 : $M_u = Z_u = 0$,

Good pitch stiffness and damping characteristics.

Configuration A14-1: $M_u = 0$, $Z_u = -.2$,

A pitch stabilized configurations with the attitude command form.

Configuration 1-2P : $M_u = .005$, $Z_u = -.2$,

Poorly damped, oscillatory phugoid characteristics.

Configuration 1

Because there is no crossfeed from the longitudinal velocity perturbations to the pitch and heave equations of motion, the pitch and heave responses remain independent of speed changes. Figure 4 shows the pitch rate, pitch attitude, normal velocity and longitudinal velocity responses of this configuration to a step reduction in thrust followed by elevator activity to constrain the pitch attitude perturbations.

The comparison between the helicopter and ground based simulation responses in this figure shows good correspondence between the various responses.

Configuration A14-1

Figure 5 illustrates the helicopter and ground-based simulation responses to a series of step like elevator inputs and a step reduction in thrust for this attitude stabilized configuration with longitudinal velocity perturbation crossfeed to the heave equation of motion. Again the correlation between the various responses is good. The drift in the ground-calculated longitudinal velocity starting after 90 seconds is probably due to a gentle turn initiated at this time by the pilot. Not all the relevant parameters necessary for an adequate ground simulation of this manoeuvre were recorded.

The time histories illustrate the good attitude-hold characteristics of the simulator.

Configuration 1-2P

Longitudinal velocity perturbations affected both the pitching moment and the heave equations of motion. The response of this configuration, because of the low stiffness and damping ratio of the phugoid mode, was very sensitive to initial conditions. To alleviate the problems associated with starting the integration, the term, $\int(q_M - q_H)dt$, was removed for the ground simulation. The resulting pitch attitude synchronization allowed a comparison to be made between the longitudinal velocity fluctuations due to attitude changes, which was not dominated by errors with long settling times that would otherwise arise from the initial conditions. It did mean, however, that a slight mismatch due to lateral-directional inputs could occur.

Figure 6 illustrates the responses to a thrust-lever step input and Figure 7 those for a forward elevator pulse.

In Figure 7 the elevator pulse has excited the phugoid. It is seen that the period and damping ratio of the oscillation are close to the estimated values of 17.3 seconds and .05 respectively for both the helicopter and the ground-simulation responses. This factor provides additional evidence of the adequacy of the X-force derivative estimates.

Concluding Remarks

It is seen from the good correlations above, between the various responses obtained in flight and on the ground, that the estimates for the X-force derivatives adequately defined the longitudinal velocity responses of the simulator to various disturbing influences.

APPENDIX E: STATISTICAL ANALYSIS OF THE PILOTS' CONTROL INPUTS

The measured pilots' control inputs of fifteen configurations were analyzed for their statistical properties during the IMC flight phase of the landing approach. The purpose of this was to supplement the control usage data for the STOL class of aircraft on the approach and to ascertain the sensitivity of the statistical characteristics to changes both in pilots and in handling qualities.

E.1 Analysis Procedure

The evaluations by one pilot of three configurations, 1, 2L and 5L were used to examine the effect of varying the stiffness of the short-period mode through M_w, as described in Sections 5.1.1.1 and 5.1.3.1. Three configurations, 7L, 2L and 11L, evaluated by the same pilot, were used to examine the effect of varying the basic pitch-control time-constant through Z_w while the short-period total damping was maintained at a constant level, as described in Sections 5.1.1.2 and 5.1.3.4. The remaining nine evaluations were used to study the effect of Z_u on the pitch-stabilized configurations with the rate-command form, R4, R4-2 and R4-3, and to examine the effect of inter-pilot variability.

The portion of the landing approach from the time that the pilot had established flight on the glideslope to the time just before reaching breakout was selected for analysis. Established flight was indicated by either a zero or a small and convergent tracking error after the glideslope had been intercepted. A record length of 51.2 seconds was selected from the middle part of this approach, and the quantities being investigated were digitized at the rate of 40 samples per second, giving a total of 2048 data points for each quantity.

Prior to being digitized the raw, recorded data was filtered for anti-aliasing purposes by a four-pole, low-pass Butterworth filter with a cutoff frequency of 10 Hz. The mean values of the data during the sample time were removed. The linear trend in the data, defined here arbitrarily as the slope of the straight line joining the mean values of the amplitudes of the first and last third of the data points, although calculated for each parameter, was not removed in the calculation of the power spectral and probability density distributions of the data. When it is large, the linear trend can have a pronounced effect both on the power spectral densities at low frequencies and on the amplitude probability distributions obtained for the data. The changes in amplitude resulting from the linear trend during the analyzed segments of the approaches for elevator and thrust lever displacements are presented in Table E1 together with the r.m.s. levels of control activity. In general, the amplitude change due to the linear trend in the time scales characterizing the dominant control activity, when compared with the r.m.s. levels, was small for elevator but often large for thrust lever. The significant linear trend for thrust lever probably resulted from the adjustments required of the pilot to compensate either for the effects of wind-shear or for incorrect energy dissipation rates during the portion of the approach being analyzed.

It was felt that if the statistical properties of the pilot's control usage were of significance as indicators of his workload, then this correlation would best be seen in those data that were relatively uncontaminated by such inputs as linear trends which have a significant effect on the statistical properties but little effect on workload. For this reason the power spectral and probability density distributions were calculated only for the elevator control, firstly because the characteristic frequencies associated with control difficulty were better separated from the frequencies associated with the trim task than they were for the thrust control, and secondly because the need for elevator trim adjustments was generally not significant when the pilot was established on the approach.

Probability density distributions, normalized by their mean zero-level density, and power spectra, normalized by their r.m.s. values, were computed for the elevator movement and are presented in Figures 30 to 35, together with the sample time histories of elevator and thrust lever activity. The r.m.s. values of commanded acceleration, $M_{\delta e} \cdot \delta e_{r.m.s.}$, are included in the figures.

The power spectra were calculated using the Fast Fourier Transform method and then smoothed by means of a low-pass filter having the characteristic,

$$x_{i_{LP}} = \frac{1}{m+1}\left[x_i + \frac{1}{2}\sum_{j=1}^{m}\left(1 + \cos\frac{j\pi}{m+1}\right)\left(x_{i-j} + x_{i+j}\right)\right],$$

where m is the number of points before and after the centre point. In this case, the values of m = 4 was chosen as a compromise between the suppression of high frequency noise and the retention of significant energy characteristics.

E.2 Results

E.2.1 The Effect of Changing Handling Qualities

Significant variations in handling qualities, due mainly to changing the pitch control characteristics, occurred for the two configuration groups in which the short-period stiffness and the pitch control time-constant were varied. The statistical properties of Pilot A's elevator control displacements are presented in Figures 30 and 31. From these evaluations and that for the pitch stabilized configuration of Figure 32, it is seen that the spectral forms of his elevator usage were relatively insensitive to the difficulty caused by the various pitch control characteristics of the configurations. In general, the spectra exhibited energy peaks at about 1.25 to 1.5 rads/sec and 3.5 to 4.5 rads/sec, the relative energy at these frequencies being affected somewhat by the configuration characteristics. The correlation between the spectra and the pilot's workload, obtained from his comments, was weak. The probability density distributions and r.m.s. levels showed greater variations with handling qualities but neither can be uniquely correlated with workload.

E.2.2 The Effect of Changing Pilots

In the last group of configurations, the short-term pitch control characteristics remained invariant, but the flight path control characteristics changed from operation on the frontside to that on the backside of the power-required curve.

Each pilot demonstrated a characteristic spectral form in his elevator control displacements which differed somewhat from those of the other pilots. The pilots' main concern, when $-Z_u$ was large, was with the coupling between longitudinal and vertical velocity but the increase in workload, arising from the need to control precisely long-term speed fluctuations with elevator in order to alleviate the speed-coupling effects, was not reflected in a significant change in the statistical properties of any pilot's elevator usage.

It is seen from the pilots' use of thrust modulation, that thrust was used primarily as a long-term control even when operating on the backside of the power-required curve.

In summary the analysis of this sample of evaluations indicates that the statistical properties of the pilot's elevator movement show some effect of changing pitch characteristics but the correlation with workload is, at best, weak. Modulation of thrust magnitude was primarily for long-term control even when operating on the backside of the power-required curve.

TABLE E1. STATISTICAL PROPERTIES OF PILOTS' CONTROL USAGE

R.M.S. Levels and Amplitude Change Due to Linear Trend

PARAMETER	CONFIG. NO.	FLIGHT NO.	PILOT	$M_{\delta e}\delta e_{rms}$	$\frac{dM_{\delta e}\delta e}{dt} \cdot \Delta T$	$Z_{\delta T}\delta T_{rms}$	$\frac{dZ_{\delta T}\delta T}{dt} \cdot \Delta T$
M_w	1	60-1	A	.0330	-.016		
	2L	69-1	A	.0222	-.002	0.186	-0.09
	5L	90-1	A	.0456	.025	1.24	-3.69
Z_w	7L	74-1	A	.0276	-.024	1.40	-1.79
	2L	69-1	A	.0222	-.002	0.19	-0.09
	11L	69-2	A	.0303	.009	1.45	4.07
Z_u	R4-3L	72-3	A	.0245	-.006	1.02	1.56
	R4L	38-1	B	.0324	.010	0.99	2.00
	R4-2L	45-3	B	.0415	.006	1.66	1.73
	R4-3L	97-2	B	.0690	-.008	1.98	2.73
	R4	48-1	C	.0415	.001	0.90	-3.10
	R4-2L	126-3	C	.0282	.008	1.03	-0.74
	R4-3L	121-3	C	.0394	-.003	1.36	-1.34
	R4L	40-1	D	.0456	.003	0.29	-0.79
	R4-3	47-1	D	.0420	-.002	2.24	5.83

Note: $\Delta T = 51.2$ secs, $\frac{dM_{\delta e}\delta e}{dt} \cdot \Delta T = \text{rad/sec}^2$

$\frac{dZ_{\delta T}\delta T}{dt} \cdot \Delta T = \text{ft/sec}^2$

REFERENCES

1. Anon. — Military Specifications: Flying Qualities of Piloted V/STOL Aircraft MIL-F-83300 DEC. 1970

2. Chalk, C.R.; Key, D.L.; Kroll, J.; Wasserman, R.; Radford, R.C. — Background Information and User Guide for MIL-F-83300 Military Specification - Flying Qualities of Piloted V/STOL Aircraft. AFFDL-TR-70-88 MAR. 1971

3. Doetsch, K-H, Jr. — The Influence of STOL Longitudinal Handling Qualities on Pilots' Opinions

   AGARD F.M.P. Symposium on 'Take off and Landing' Edinburgh APRIL 1974 Proceedings to be published.

4. Daw, D.F.; Lum, K.; McGregor, D.M. — Description of a Four Degrees of Freedom V/STOL Aircraft, Airborne Simulator. NRC/NAE LR-499 FEB. 1968

5. Doetsch, K-H, Jr.; Gould, D.G.; McGregor, D.M. — A Flight Investigation of Lateral-Directional Handling Qualities for V/STOL Aircraft in Low Speed Manoeuvring Flight. NRC/NAE LR-549 OCT. 1971

6. Neumark, S. — Problems of Longitudinal Stability below Minimum Drag Speed, and Theory of Stability under Constraint. R&M No. 2983 JULY 1953

7. Chalk, C.R.; Neal, T.P.; Harris, T.M.; Pritchard, F.E.; Woodcock, R.J. — Background Information and User Guide for MIL-F-8785B(ASG), "Military Specification - Flying Qualities of Piloted Airplanes" AFFDL-TR-69-72 AUG. 1969

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