Nr. 711 / 01.08.2000

FINAL REPORT

on

the ACCIDENT of the FALCON 900B

registered SX-ECH,

- 14 September 1999 -

CONTENTS

List of Annexes to the Final Report

GLOSSARY OF ABBREVIATIONS USED ON THIS REPORT

A.

AC	Alternating Current
ADC	Air Data Computer
AFM	Aircraft Flight Manual
AFS	Auto Flight System
AFU	Artificial Feel Unit
AFS	Auto Flight System
AOC	Air Operator Certificate
A/P	Auto Pilot
APU	Auxiliary Power Unit
ATC	Air Traffic Control

B.

BAT	Battery

C.

CAT	Clear Air Turbulence
CATS	Computerized Aids Trouble Shouting
CG	Centre of Gravity
CSN	Cycles Since New
CVR	Cockpit Voice Recorder

D.

DC	Direct Current
DAFCS	Digital Automatic Flight Control System
DFDR	Digital Flight Data Recorder

E.

EFIS	Electronic Flight Instruments System
EMF	Electro Motive Force
ENGs	Engines
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure

F.

FD	Flight Director
FFS	Flight Fault Summary
FGC	Flight Guidance Computer
FL	Flight Level
FMS	Flight Management System
F/O	Co-Pilot
FTIU	Flight Test Interface Unit

G.

GEN	Generator

H.

HCAA	Hellenic Civil Aviation Authority
HS	Horizontal Stabilizer

I.

IAS	Indicated Airspeed (kts)
ILS	Instrument Landing System
IRU	Inertial Reference Unit

J.

JAA	Joint Aviation Authority
JAR	Joint Aviation Requirements

K.

KIAS	Kts Indicated Airspeed

L.

L/G	Landing Gear
LGAT	Athens Airport
LH	Left Hand
LOC	Localizer
LROP	Bucharest-Otopeni Airport

M.

M	Mach
MEL	Minimum Equipment List
MMEL	Master MEL
MI	Indicated Mach
MMO	Maximum Operating Mach
MLE	Maximum Extended L/G
MLO	Maximum Operating L/G in transit
MTOW	Maximum Take-Off Weight
MZFW	Maximum Zero Fuel Weight

N.

NVRAM	Non-Volatile Random Acces Memory

O.

OA	Olympic Airways
OAL3838	Olympic Airways Flight 3838

P.

PIC	Pilot in Command
PIO	Pilot Induced Oscillations
PSU	Passenger Service Unit

R.

RAM	Random Access Memory
RH	Right hand
RWY	Runway

S.

SFC	Sub-Frame Counter
SPZ-8000	Honeywell Digital Integrated Flight Control System
S/N	Serial Number
SRC	Search and Rescue Centre
STAB	Horizontal Stabilizer

T.

TOD	Top Of Descent
TSN	Time Since New
TOW	Take-Off Weight

U

UTC	Universal Coordinated Time

V.

VFE	Maximum Velocity Flaps Extended
VMO	Maximum Operating Speed
VOR	VHF Ominidirectional Range
V/S	Vertical Speed
Vr	Rotation Speed

W.

W&B	Weight and Balance

X.

Y.

Y/D	Yaw Dumper

Z.

ZFW	Zero Fuel Weight

INTRODUCTION

The investigation of the accident occurred on September 14, 1999, involving the aircraft Mystère Falcon 900 B, registration SX-ECH, operated by Olympic Airways is the result of a common international team, involving more air accident investigation authorities.

The Romanian Civil Aviation Inspectorate conducted the investigation on behalf the State of occurrence, providing also the investigator-in-charge, who leaded the investigation team and a group of investigators.

The Governor of the Hellenic Civil Aviation Authority - HCAA - appointed an accredited representative of Greece, as the State of Registry, assisted by a group of advisers, specialists in different fields of aviation.

The French Bureau Enquètes-Accidents - BEA - appointed also an accredited representative of France, as the State of Design and Manufacture, assisted by a group of advisers, investigators and specialists in different fields of civil aviation.

An other participating State in the investigation was the United States of America. On request of the State of occurrence, since the autopilot was designed and manufactured in USA, the American National Transportation Safety Board - NTSB - appointed an accredited representative assisted by an adviser.

The investigation team was also assisted by the manufacturer of the aircraft, Dassault Aviation, and the manufacturer of the autopilot, Honeywell Inc., who provided technical expertise on all components and aspects requested by the investigation team. A team of engineers of the aircraft's operator, Olympic Airways provided technical support.

Expertise was carried out on site in Bucharest where the aircraft was located during the investigation or at their own facilities. The manufacturers' expertise performed at facilities located in France, were conducted only under the supervision of investigation team members from Romania, Greece and France. For the expertise conducted at facilities located in the United States the investigation team was represented by the NTSB, who appointed its investigators to supervise the expertise.

Initial Flight Data Recorder (FDR) readout was completed by the German Aviation Accident Investigation Board (BFU). A second FDR readout took place in the Air Accident Investigation Branch of United Kingdom (AAIB).

SYNOPSIS

Aircraft Accident Report:	Nr.711/01 .08.2000(File:1999091401)
Registered Owner:	Hellenic Air Defence
Operator:	Olympic Airways
Aircraft Type:	Mystère Falcon 900B
Nationality:	Hellenic
Registration:	SX-ECH
Place of Accident:	Romanian Airspace, FIR Bucharest Latitude: N44 04.8 Longitude: E025 15.2 FL 150
Date and Time:	14.09.1999 at 21.35 hr.(UTC)

The accident was notified to the ROMANIA Ministry of Transport - Civil Aviation Inspectorate by Romanian ATC. The investigation began immediately and was carried out in accordance with Romanian Ordinance nr. 51/1999 regarding Investigation of Air Accidents and Incidents.

The aircraft performed the flight OAL3838, from Athens to Bucharest as a government flight.

During climb after flap and slats were retracted, the flight crew noticed, on the warning panel, the "PITCH FEEL" light came on. The "PITCH FEEL" warning light, remained continuously ON, during cruise and descent until SLATS were extended.

During descent the Indicated Air Speed (IAS) increased from 240 Kts to 332 Kts.

Approaching FL 150, the F/O had a request for a further descent. Just before FL 150 the ATC re-cleared OAL3838 to continue descent to FL 50, while PIC briefed F/A about ETA. One second later, A/P disengaged and for the next 1 minute and 36 seconds the aircraft was manually flown by the PIC.

Between FL 150 and FL 140, for approximately 24 seconds, the aircraft experienced 10 oscillations in pitch axis which exceeded the limit manoeuvring load factor. Maximum recorded values of the vertical accelerations recorded by an accelerometer located in the landing gear bay were: +4.7 g and -3.26 g.

The impact of the unfasten passengers with cabin ceiling and aircraft furniture, due to accelerations occurring during the pitch oscillations caused fatal injuries to 7 passengers, serious injuries to 1 crew member and 1 passenger and minor injuries to 2 passengers.

The investigation identified following causal factors:

1. Inadequate risk assessments of the PITCH FEEL malfunctions.

2. Overriding of the A/P on the pitch channel by the crew.

3. Inappropriate inputs on the control column at high speed and with Arthur unit failed in "low-speed" position leading to Pilot Induced Oscillations.

4. Seat-belts not fastened during descent flight phase.

Twelve Safety Recommendations have been made as a result of this investigation

1. FACTUAL INFORMATION

1.1. History of the flight

The flight OAL 3838, was planned on 14 September 1999, as a government flight from Athens (LGAT), ETD 18:00 (UTC) to Bucharest (LROP), ETA 19:18 (UTC).

OLYMPIC AIRWAYS performed the flight preparation.

At 16:30 UTC, the aircraft was refuelled with 5130 litres of fuel, type JET A1, by the AIR BP Athens.

The designated crew, were two Captains. Tasks were allocated as follows: Pilot in Command (PIC) was the Pilot Flying (Left Seat) and Co-Pilot as Pilot Non Flying (Right Seat) for the sector LGAT-LROP.

Crew pre-flight checks started at 16:50 UTC. The Co-Pilot (F/O) had completed the external check and after that, along with the Pilot in Command (PIC), completed the cockpit preparation items of the Aircraft Checklist.

The passengers started boarding on the aircraft at 17.45 UTC.

At 18.16 UTC, with 16 minutes delay, the aircraft took-off from the runway 33 of the Athens Hellenikon International Airport (LGAT) and after 1 minute and 30 seconds the autopilot (A/P) was engaged.

During climb ,after the flaps and slats were retracted, the flight crew noticed, on the warning panel, the "PITCH FEEL" light, was illuminated. The PIC disengaged the autopilot, checked the forces on the control column and re-engaged the autopilot. The "PITCH FEEL" warning light, remained continuously ON, during cruise and descent until SLATS were extended.

The final cruise level was FL 400, as requested by the crew and cleared by ATC, and was reached 27 minutes after take-off. Based upon crew declaration, during cruise flight, the crew noticed a roll mistrim warning, which disappeared after adequate compensation on ailerons trim, performed by the PIC.

After 47 minutes from take-off, a normal descent to FL 150 was initiated, with the A/P engaged in vertical speed (V/S) mode. During descent the Indicated Air Speed (IAS) increased from 240 Kts to 332 Kts.

At 12 minutes from Top of Descent (TOD), approaching FL 150, the F/O had a request for a further descent. Just before FL 150 the ATC recleared OAL3838 to continue descent to FL 50, while PIC briefed F/A about ETA. One second later A/P disengaged and thereafter the aircraft was manually flown by the PIC.

Between FL 150 and FL 140, for approximately 24 seconds, the aircraft experienced 10 oscillations in pitch axis which exceeded the limit manoeuvring load factor. Maximum recorded values were: +4.7 g and -3.26 g. During the event the thrust power was reduced.

At about FL 130, after aircraft recovery from the encountered oscillations, F/O declared an EMERGENCY, saying: "*We are in emergency sir, request vector to final approach. We have problems with the controls*".

The aircraft was manually controlled by the PIC for 1 minute and 36 seconds, thereafter A/P was re-engaged for approximately 4 minutes, from FL130 to 2500 feet, as recorded by the DFDR.

At the request of the flight crew, radar vectoring was provided by the ATC, and a VISUAL approach was performed on RWY 08R.

During approach, the crew requested medical assistance on the ground.

The aircraft had an uneventful landing on the Bucharest-Otopeni International Airport (LROP) at 19:33 UTC and was parked at the VIP terminal.

The required medical and emergency assistance was provided.

1.2. Injuries to persons

Injuries	**Crew**	**Passengers**	**Others**
Fatal	0	7*	0
Serious	1	1	0
Minor / None	2	2	0

NB (*) - 1 passenger died 3 days after the accident.

1.3. Damage to aircraft

	Destroyed	**Substantial**	**Minor**	**None**
Damage to the structure	-	-	yes	-
Damage to the flight deck	-	-	yes	-
Damage to the passenger cabin	yes	-	-	-
Damage to the luggage compartment	-	yes	-	-

1.3.1. Damage to the structure

The aircraft structure was not damaged, except for a crack located on the top of the fuselage skin, caused by the penetration of a metallic catering container which is usually placed in the luggage compartment arrangement furniture (see pictures 1 & 2 in Annex 1). The hole, size of 127 mm x 25 mm, was found between frames 20 - 21 and stringers 4-5 left.

Due to the accelerations sustained by the aircraft a structural inspection usually required after severe turbulence was conducted. No damage to the structure was found.

1.3.2. Damage to the flight deck

The co-pilot's left armrest was found collapsed. Several circuit breakers were found broken. Pushbuttons on the upper panel were covered with traces of blood. The cup-holder located on the front of the central pylon was distorted. The front cabin door had no damage and was working properly.

1.3.3. Damage to the passenger cabin

Interior furnishings, tables and armchairs were severely damaged. Both of luggage compartment and aft lavatory were in a great disarray with glass particles, grease, toilet paper and waste found on the inner surface assembly.

The cabin was destroyed, covered light panels on the floor along with newspapers, dishes and cell phones.

In the right galley, the drawer under the sink was missing, the two guiding rails were twisted and in the open position. The two doors closing the cupboard were torn from their hinges and missing.

Most of the armrests were found torn off or broken. The side sofa was found broken. The Passenger Service Units, the passenger warning signs and oxygen mask boxes were out of their compartment.

Several floor panels between frames 4 and 25 were distorted. The most distorted were located between frames 19 and 25. Visual examination revealed no distortion or interference with the control cables of the flight controls. The lower panel of the door separating the cabin from the rear lavatory was destroyed.

1.3.4. Damage to the luggage compartment

The lower doors of the furniture storage were torn off and missing. The containers, which are normally located in this area during descent, were also missing. An attachment bolt from a baffle, which retains luggage, was pulled out. The dustbin was distorted and included some black rubber traces from the two spare wheels which were recovered in this compartment. Tools were recovered on the floor out of their tool-box.

An aircraft interior presentation, after the accident, is illustrated in the photo 3 of Annex1.

1.4. Other damage

There were NO other damages.

1.5. Personal Information

Flight Crew personal data:

Pilot in Command:	Male, aged 46 years
Licence:	Airline Transport Pilot Licence Issued by Hellenic-Civil Aviation Authority Valid until 09.01.2000
Aircraft Ratings:	Boeing 737-, Falcon 900
Instrument Ratings:	Valid until 04.01.2000
Medical Certificate:	Class I, Valid until 28.09.1999
Last Proficiency-Check:	17.06.99 on B 737 No Proficiency-Check on Falcon 900
Last Line-Check:	06.05.99 on B 737, valid also on Falcon 900 according HCAA rules
Recurrent training on Falcon:	16-18.08.1999 at FlightSafety International SARL – Dassault Falcon Service / LeBourget-France

Flying Experience:	Total all types:	8239 hours
	Total on B 737-400:	2213 hours
	Total on Falcon 900:	270 hours
	In last 90 days on B737 and Falcon 900:	166 hours
	In last 30 days on B737 and Falcon 900:	62 hours
	In last 30 days on Falcon 900:	5 hours 30'

Last Flight on Falcon 900	08.09.1999 / 3 hours 10 minutes
Last Flight on B737	11.09.1999/ 2 hours 05 minutes
Duty Time:	2 hours 45 minutes
Previous Rest-Time:	In excess of 24 hours

Co-Pilot:	Male, aged 44 years
Licence:	Airline Transport Pilot Licence Issued by Hellenic-Civil Aviation Authority Valid until 20.01.2000
Aircraft Ratings:	Boeing 737-200, B737-400, Falcon 900
Instrument Ratings:	Valid until 28.02.2000
Medical Certificate:	Class I, Valid until 17.11.1999
Last Proficiency-Check:	10.06.99 on B 737 No Proficiency-Check on Falcon 900
Last Line-Check:	23.06.99 on B 737, valid also on Falcon 900 according HCAA rules
Recurrent training on Falcon :	26-29.07.1999 at FlightSafety International SARL – Dassault Falcon Service / LeBourget-France

Flying Experience:	Total all types:	7465 hours
	Total on B 737-400:	1209 hours
	Total on Falcon 900:	231 hours
	In last 90 days on B737 and Falcon 900:	145 hours
	In last 30 days on B737 and Falcon 900:	56 hours
	In last 30 days on Falcon 900:	5 hours 30'

Last Flight on Falcon 900	08.09.1999 / 3 hours 10 minutes
Duty Time:	2 hours 45 minutes
Previous Rest-Time:	In excess of 24 hours

Flight Attendant:	Female, aged 37 years
Licence:	Flight Attendant Licence Issued by Hellenic-Civil Aviation Authority Valid until 20.01.2000
Aircraft Ratings:	A300-600, A340, B737-200, -300,-400, B747- Falcon 900 from 13.07.1999
Medical Certificate:	Class I, Valid until: 28.09.2000

Flying Experience:	Total all types:	8235 hours
	Total on Falcon 900:	5 hours
	In last 30 days all types:	34 hours 25’
	In last 30 days on Falcon 900:	- hours

Last Flight on Falcon 900	27 July
Last Flight	11.09.1999/ 2 hours
Duty Time:	2 hours 45 minutes
Previous Rest-Time:	In excess of 24 hours

1.6. *Aircraft information*

1.6.1. Airworthiness and Maintenance of the aircraft

1. Airplane manufacturer	Dassault Aviation
2. Aircraft type and model:	MYSTERE FALCON 900
3. Engines type:	TFE 731-5BR-1C
4. Certificate of Registration	SX - ECH Nr.20 issued 16 December 1992
5. Certificate of Airworthiness:	Nr.481 issued 16 December 1992 Valid until 06 November 1999
6. Registered owner:	HELLENIC AIR DEFENCE
7. Operator:	OLYMPIC AIRLINES

1.6.1.1. Airframe:

i) S/N: 026
ii) Date of manufacture: 1987
iii) TSN: 6427 FH (at 13.sept.1999)
iv) CSN: 3405 cycles (at 13.sept.1999)
v) Last maintenance check:

"A" check:	Date: 21.08.1999 A/C TSN: 6392:36 A/C CSN: 3391 Service Station: Olympic Airlines - Athens
"B" check:	Date: 08.05.1997 A/C TSN: 5250:39 A/C CSN: 2816 Service Station: Olympic Airlines - Athens
"C" check:	Date: 31.12.1993 A/C TSN: 3314:01 A/C CSN: 1869 Service Station: Olympic Airlines - Athens

1.6.1.2. Engines:

	S/N	TSN	CSN	Last major periodic inspection	Last core inspection
Eng. #1	P-97127	6427	3405	TSN: 2069 CSN: 990 Service station: Transairco (Geneva)	TSN: 3971 CSN: 2028
Eng. #2	P-97111	6427	3405	TSN: 2069 CSN: 990 Service station: Transairco (Geneva)	TSN: 3971 CSN: 2028
Eng. #3	P-97122	6427	3405	TSN: 2069 CSN: 990 Service station: Transairco (Geneva)	TSN: 3971 CSN: 2028

1.6.1.3. Auxiliary Power Unit (APU)

i) S/N: P-133
ii) TSN: 3572 (at 21.Aug.1999, OCIP no. 74)

1.6.1.4. Deficiencies and maintenance history

According to the aircraft flight log, all the previous defects were solved before the next flight. Aircraft flight log onboard the aircraft records no defects between 21.aug.1999 - 14.sept.1999.

Between 29.11.1995 and 15.03.1999 there were recorded 8 malfunctions in connection with the PITCH FEEL light, with various maintenance corrective actions:

- Air Data Computer reset;
- ADC replacement;
- pitch feel BAP reset;
- pitch feel BAP replacement.

The manufacturer was not involved, in order to decide the proper corrective action.

Last recorded PITCH FEEL malfunction was on 15.03.1999, according to the Aircraft logbook.

There were no reported malfunctions of the auto flight system since July 1998.

In 1995 was reported a malfunction of the HS sensor as follows: '*No.1 and No.2 A/P elevator potentiometers wrong indications. During flight stabilizer moves up-down with both A/P/s without reason*'. The malfunction was rectified by replacing the horizontal stabilizer sensor. The installed sensor, supplied by Dassault, was new. It is the same serial number that was found defected during the investigation of the 1999 accident. This new sensor was in operation for a period of approximately 4 years.

CVR and DFDR were installed in this aircraft on 1992 at delivery. There were no reported malfunctions of the recorders.

In accordance with aircraft maintenance programmed the CVR is an “on condition” item. The AFM requires an operational test to be performed by the crew during prestart checks.

In accordance with aircraft maintenance programme, a DFDR read-out has to be performed every 1500 FH or once a year, whichever comes first. Last DFDR read-out was performed in 1995.

1.6.2. Systems description

1.6.2.1. Flight controls

The aircraft is controlled by means of conventional control surfaces:

- two ailerons for roll,
- two conjugated elevators and a mobile horizontal stabilizer for pitch,
- a rudder for yaw,
- four mobile leading edge slats and four flaps for high lift,
- six airbrakes for aerodynamic braking.

The primary flight control system is fully power-assisted non-reversible system. The control inputs originate from the cockpit where a system of rigid rods and bellcranks link the control wheels and rudder pedals to the servo-actuators of the rudder, the elevators and the ailerons. Twenty-three turquoise-coloured rods (22 for aircraft 88 onwards) in the fuselage are made of carbon. In case of a total hydraulic failure, control surfaces can be operated manually within restricted flight envelope. In this case the servo-actuators transmit control movements mechanically to the control surfaces.

The aileron, elevator and rudder controls incorporate the following:

- a system of springs forming an artificial feel unit (AFU),
- an automatic spring load adjusting system ("ARTHUR" Q unit), for increasing the force required to operate the aileron control (according to the speed) and the elevator control (according to the position of the horizontal stabiliser).

The correspondence between the Arthur Q actuator and the horizontal stabilizer position is continuously monitored by the Box Arthur Pitch(BAP). If the difference between the two position data passes a certain threshold, one lock will operate, causing the PITCH FEEL light to illuminate on the warning panel, and the Arthur will return to “low speed” position provided that the Arthur is not jammed.

The PITCH FEEL light on the warning panel comes on in the following cases:

1. there is a discrepancy between the position of the elevator Arthur actuator and the position of the horizontal stabilizer;
2. an elevator Arthur box malfunction;
3. electrical or hydraulic power supply fault.

The Pitch Feel light will go out as soon as the slats are extended and air speed is less than or equal to 210 knots, provided that the Arthur is in “low speed” position. Otherwise, Pitch Feel keeps on illuminating.
When the landing gear is compressed the light comes again indicating that repair is necessary. Upon energization, the system is automatically activated. When the actuator reaches its slaved position, the PITCH FEEL light goes out.

1.6.2.2. Auto Flight System (AFS)

The DFZ 800 AP/FD system provides the following functions:

- FD-flight director, produces flight orders and transmits them to the electronic flight instrument system (EFIS), which display them to the pilot and Co-Pilot. The FD has pitch and roll attitude command and hold modes and roll hold mode;
- the autopilot, produces flying orders and transmits them to the control surfaces by means of servo-actuators which are acting on mechanical linkage in parallel. This function operates on three axes: pitch, roll and yaw. The autopilot also has an automatic pitch trim function;
- yaw damper generates an order positioning a linear actuator mounted in series with the rudder linkage. This yaw damper can be either activated separately from the autopilot (when the latter is not in operation), or else automatically (as soon as the autopilot is engaged).

Flight director (FD): The aircraft is flown manually by the pilot as described by the information displayed on the EFIS. The flight director function enables the pilot, on the lateral plane:

- to hold a present heading or course,
- to intercept and hold a navigation route (VOR or FMS),
- to command and hold a roll attitude,
- to intercept and lock onto a LOC (ILS) or Back LOC beam,
- to make a Category II approach,
  on the vertical plane:
- to make a flight level change (in ISO Mach or ISO IAS),
- to hold a vertical speed,
- to hold a present altitude,
- to reach and hold a preselected altitude,
- to hold a navigation route in the vertical plane (FMS),
- to intercept and lock onto a GLIDE beam (ILS),
- to make a Category II approach.

Autopilot (A/P): When coupled to the flight director, the autopilot provides:

- automatic control of the aircraft on the pitch and roll axes by means of two servomotors, mounted in parallel on the elevator and aileron control linkages,
- roll/yaw coordination turning coordination by means of the rudder linear actuator which also receives the yaw damper orders,
- automatic pitch trim by means of a trim actuator connected to the horizontal stabilizer.

The autopilot can be engaged for its basic modes (pitch and roll attitude hold), as long as no flight director mode has been selected. However, if a flight director mode has been selected, the autopilot slaves the aircraft to the orders produced by the flight director.

Yaw damper: The yaw damper is independent of the autopilot. In manual flight (when activated manually) or in auto flight (automatic operation), it can be used to stabilize the aircraft around the yaw axis.

Each servomotor and the linear actuator is a single channel unit and is connected to both flight guidance computers. Only one computer will be actively controlling the servomotors and the linear actuator. Normally, the pilot's side will be automatically in control. The Co-Pilot’s side can be manually selected, if desired, or will automatically take control if there is a disengage type failure in the pilot's computer.

Elevators linkage: Pitch control is provided by a LH and a RH elevator, which constitutes the trailing edge of the horizontal stabilizer. Elevator deflection is commanded by a hydraulic dual-barrel servo-actuator.
Each barrel is linked to one elevator and has a control arm. The two coordinated control arms are connected to the manual control linkage in parallel with the autopilot control linkage (a servomotor connected to the manual linkage by a cable/quadrant assembly).
The A/P and manual controls are therefore mechanically linked; transmission to the servo-actuator inlet slide valve is identical.
An A/P order from the FGC in active mode causes movement of the whole of the linkage - control column to control surface.
The angular position of the servomotor outlet shaft (and therefore of the control surfaces) depends on the signals transmitted by the autopilot. These digital signals, produced by the FGC in active mode, are limited, adapted and transmitted to the servomotor by means of a digital-to-analog converter.
The position slaving is obtained from an angular speed detection signal sent by a tachometer generator coupled with the servomotor. This signal is processed by the FGC in active mode to define the relative angular motion of the outlet shaft and therefore of the elevators (differences between actual and commanded elevator positions, respectively horizontal stabilizer).

Elevator servo-motor operation: The output of the servo amplifier is sent to the SM-300 elevator servo drive motor, the "A" processor current monitor to check for servo runaway current, and to the pitch trim threshold sensor.

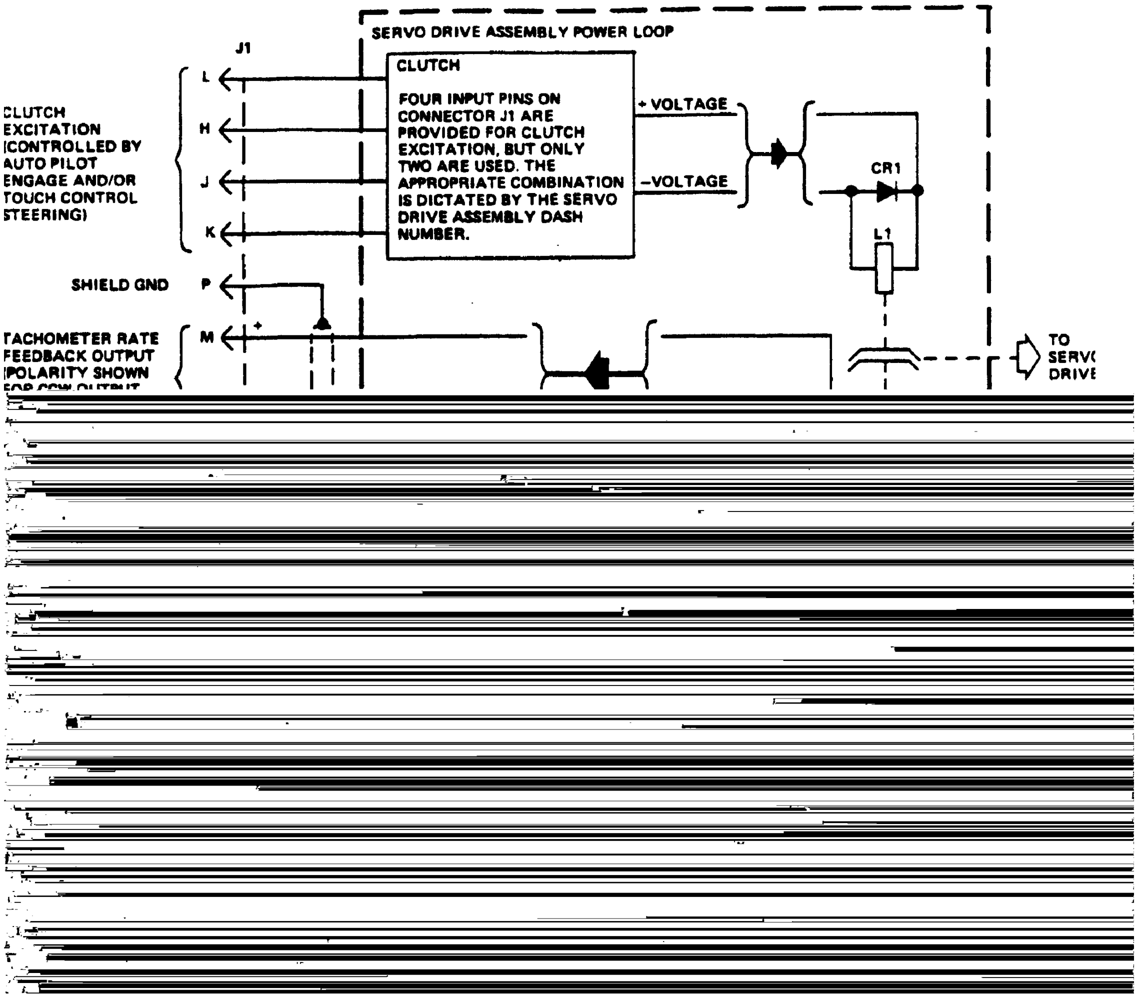

Figure: Elevator servo-motor operation

The SM-300 is a permanent magnet dc motor that utilizes a dc tachometer for rate feedback. It does not have a position feedback transducer. As the servo motor drives to position the elevator, it also drives the dc taco generator through mechanical coupling (represented by a dotted line). The tach generator provides a rate feedback signal that serves two functions. First, it acts as a damping term when summed with the vertical command input to the pulse-width command limiter. This helps to stabilize elevator position and minimize excessive elevator travel. Second, the rate feedback signal is integrated to obtain position feedback, gain adjusted and summed with the steering command. When these signals are equal, the elevator is in the proper position to satisfy the vertical command. As the aircraft responds, the flight director command diminishes and the position feedback signal drives the elevator servo back to its original position. Should there be a mismatch between vertical command and elevator servo position, a flight path standoff could occur.

FLIGHT CONTROLS – INOPERATIVE ELEVATOR LANDING

- Make approach with slats + flaps 40° at .... VREF + 10 kt
- Use very short inputs to set stabilizer to desired position.
- Perform a shallow final approach.
- Increase the landing distance by 1,800 ft / 549 m
  (3,000 ft / 916 m added to the landing field length).

FLIGHT CONTROLS – ARTHUR UNIT INOPERATIVE

WARNING – PITCH FEEL or AIL FEEL light on.

- Reduce airspeed down to 260 KIAS or MI 0.76 max.

CAUTION

The pitch and roll control forces may be higher or lower than normal depending on whether the Arthur unit has failed in "high" or "low" speed position.

- **Light forces: avoid large displacements and rapid movements of the control surfaces.**
- **High forces, use normal or emergency trim systems and execute an approach:**
  - PITCH FEEL **light on: at VREF + 10 kt and increase the landing distance by 800 ft / 244 m (1,335 ft / 407 m added to the landing field length).**
  - AIL FEEL **light on: at VREF.**

Section	3	Applicability:	DTM20103
Sub-section	15	Canadian A/C	DGAC APPROVED
Page	2 A		REVISION 21

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DASSAULT AVIATION

MYSTERE-FALCON 900

MASTER MINIMUM EQUIPMENT LIST

27 – FLIGHT CONTROLS (2 / 3)			
1 - System/Item	2 – Number installed	3 – Number required for dispatch	4 – Remarks or exceptions
PITCH			
7 - Horizontal stabilizer position indicator	1	0	(*) (O) May be inoperative provided : – the stabilizer is operative, – the stabilizer is checked and found to be between the two take–off reference marks, – the T/O CONFIG light and NO TAKE OFF voice warning are operating, – touch and go training maneuvers are prohibited.
8 - Arthur unit control system and PITCH FEEL indication	2	0	(O) May be inoperative in the low speed position provided that maximum airspeed is limited to 260 KIAS.
9 – Stabilizer trim audio warning	1	0	May be inoperative provided : – the stabilizer is operative, – the T/O CONFIG warning system is operative, – the position indicator is operating.
SLATS			
10 - Emergency control system (EMERG SLATS)	1	0	(O) May be inoperative provided the normal control system is operating.
11 - Configuration panel			
11–1 - Green light	1	0	(*) (O) May be inoperative provided : – the slat position is checked visually, – the T/O CONFIG light is operating.
11–2 - Red light	1	0	(*) (O) May be inoperative if the airspeed is limited to 200 KIAS maximum.

DTM9825
DGAC APPROVED
REVISION 1

MF900 – DGAC MMEL page 27-2