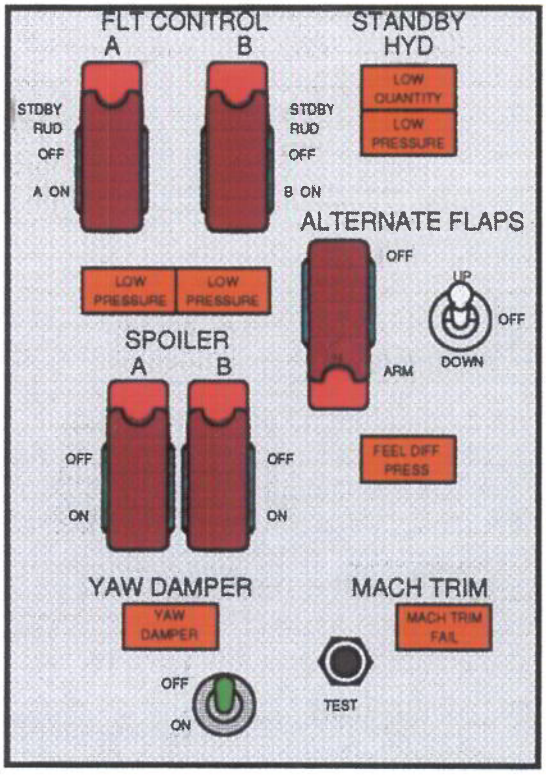


Figure 1 Flight Control Module. System selector panel in flight deck overhead

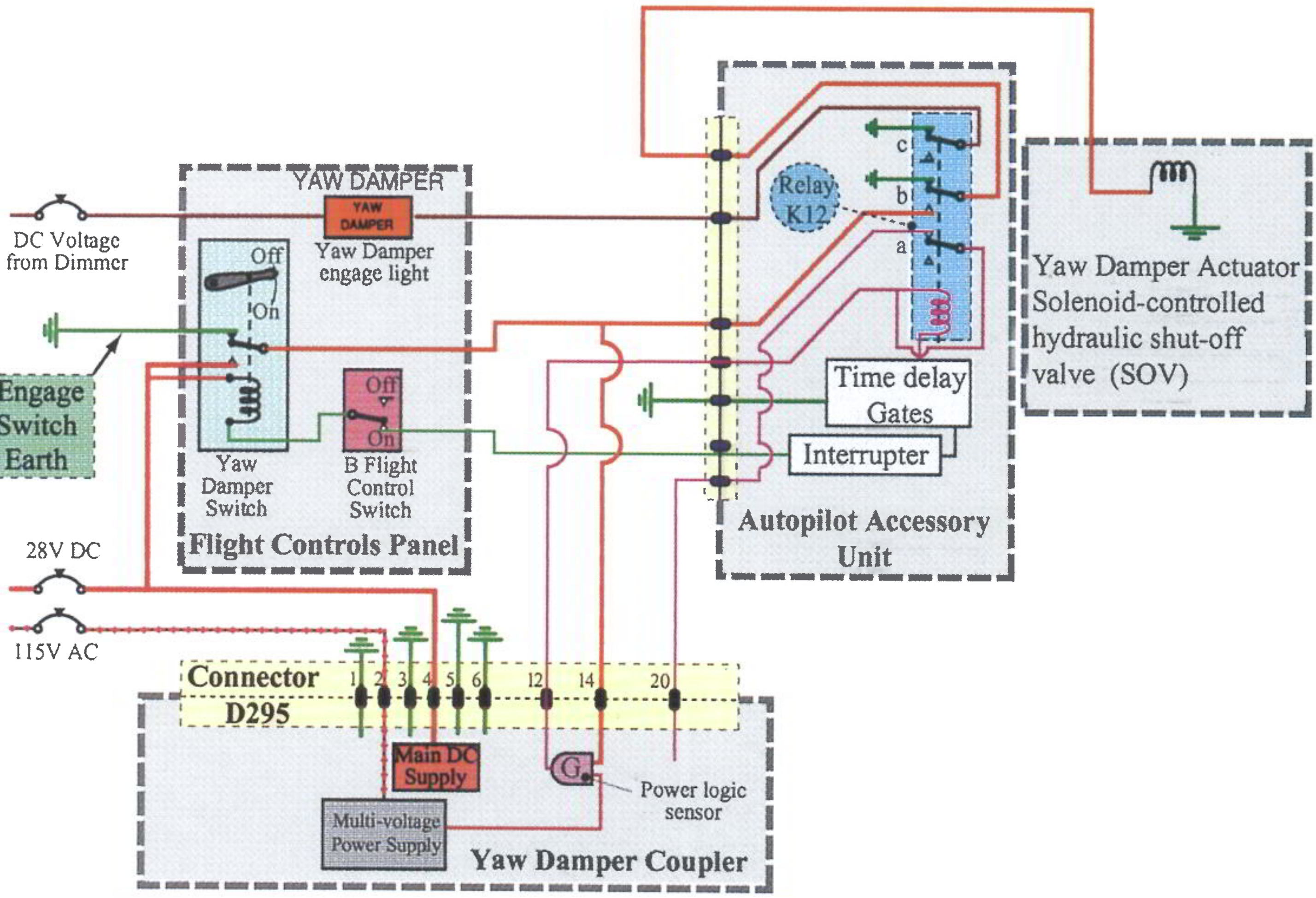
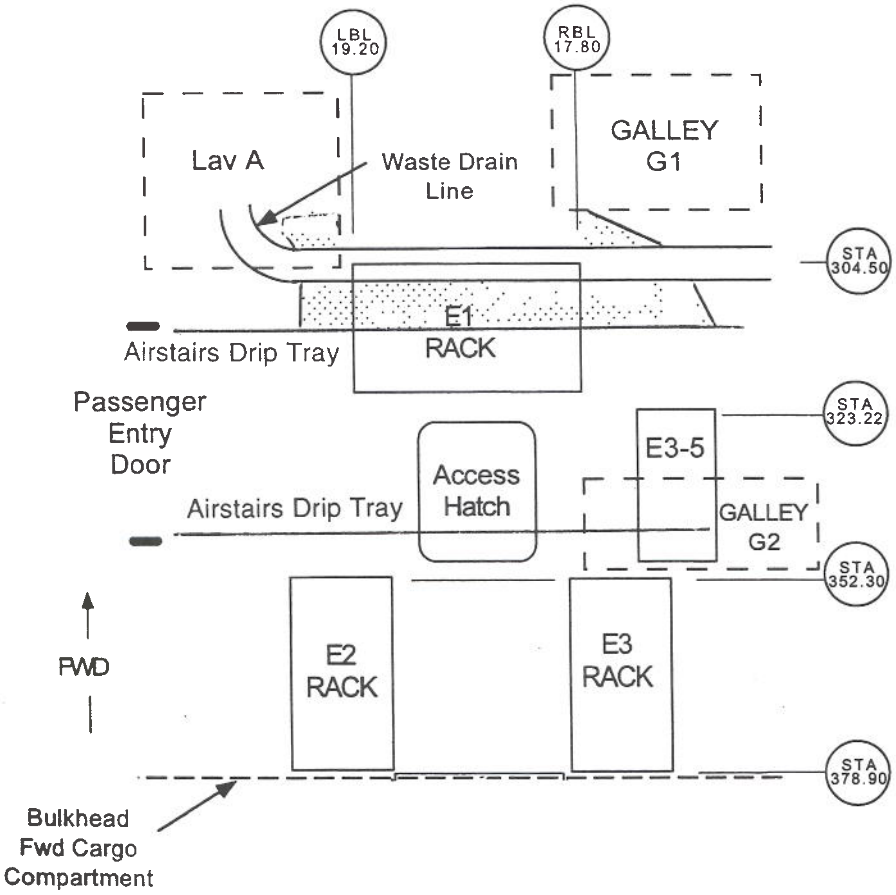
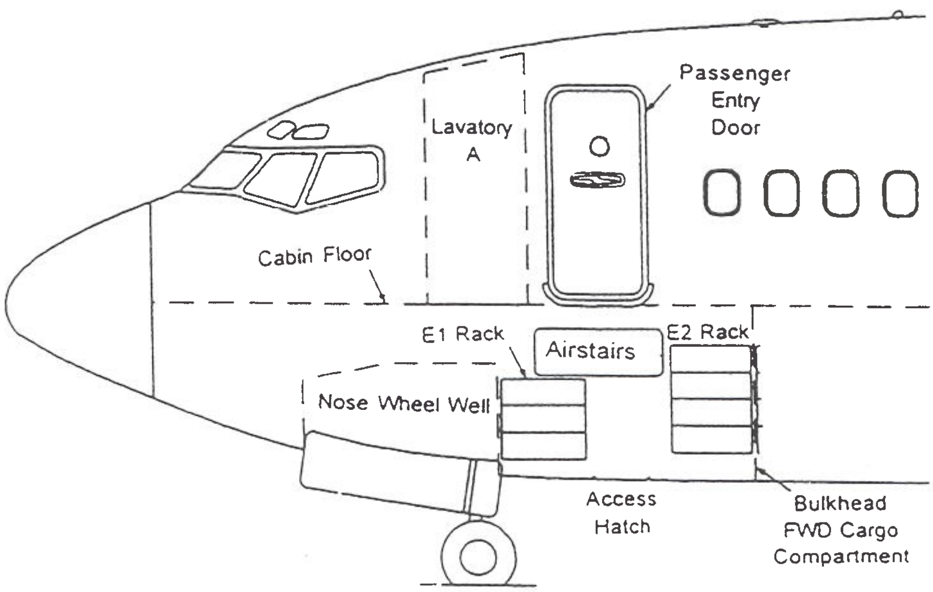


Figure 2 Schematic diagram of Yaw Damper system electrical power engagement interlocks

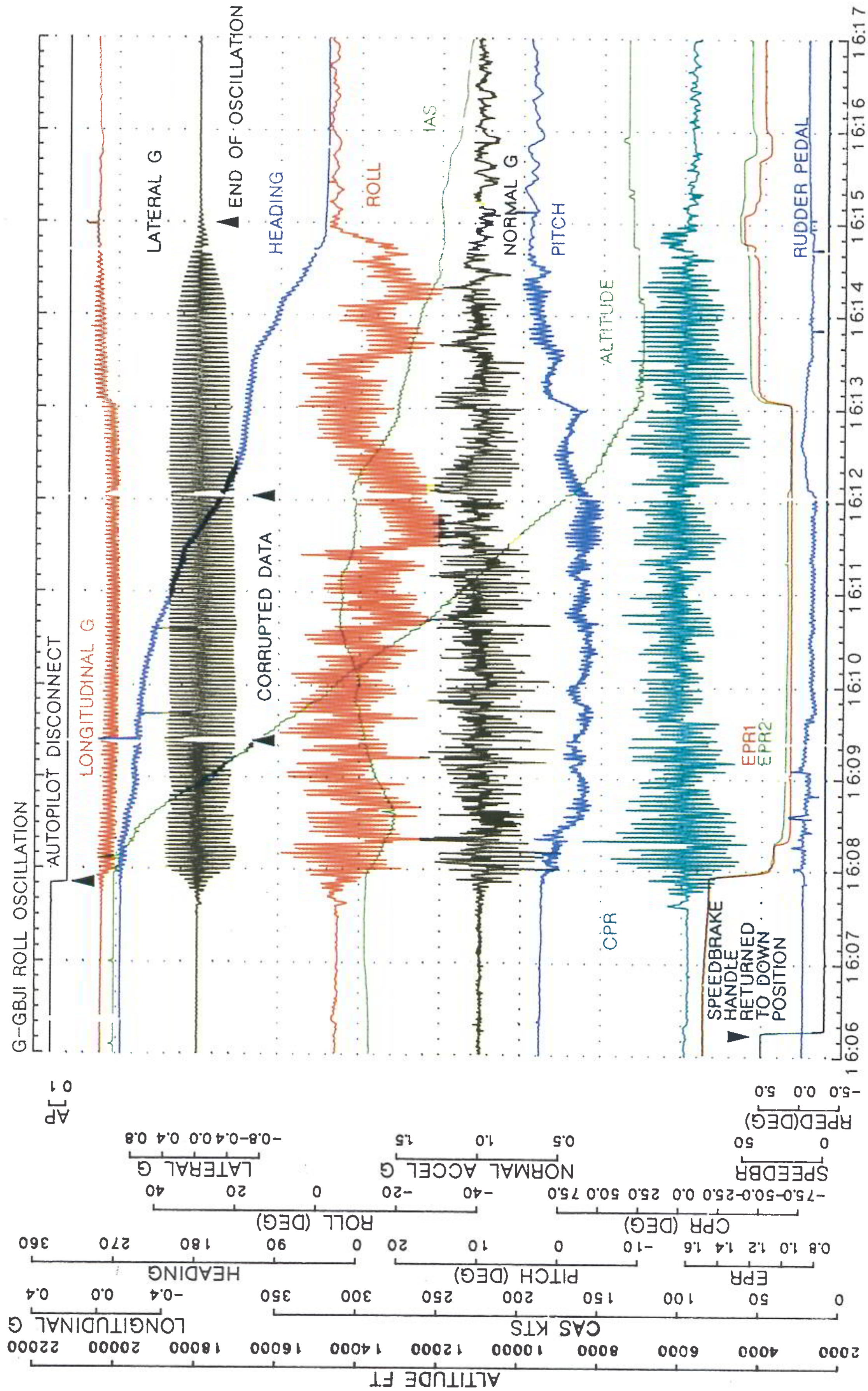


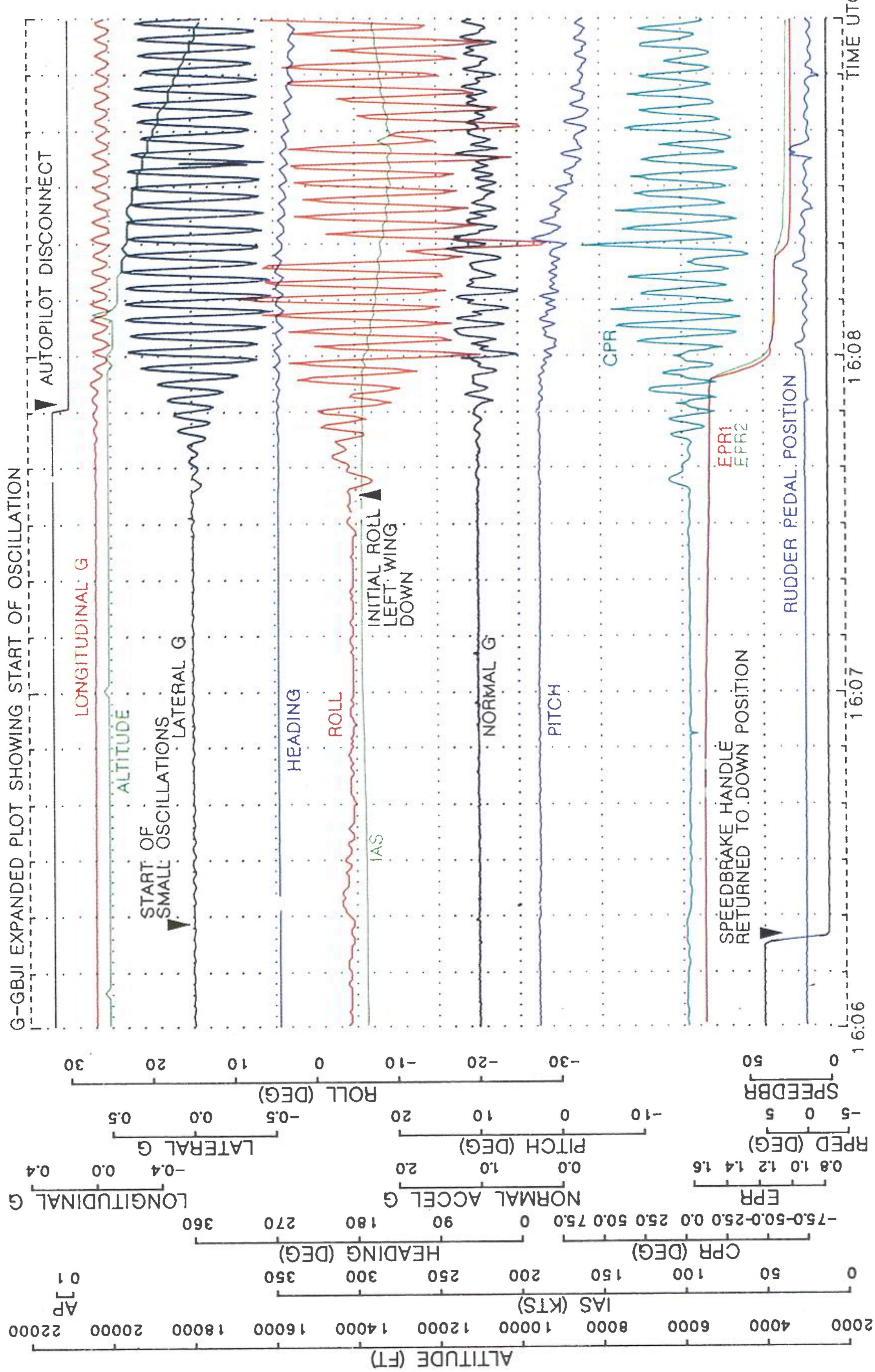
Plan - view of E&E Bay showing location of avionic racks and rubberised fabric shroud protecting E-1 rack (shaded)

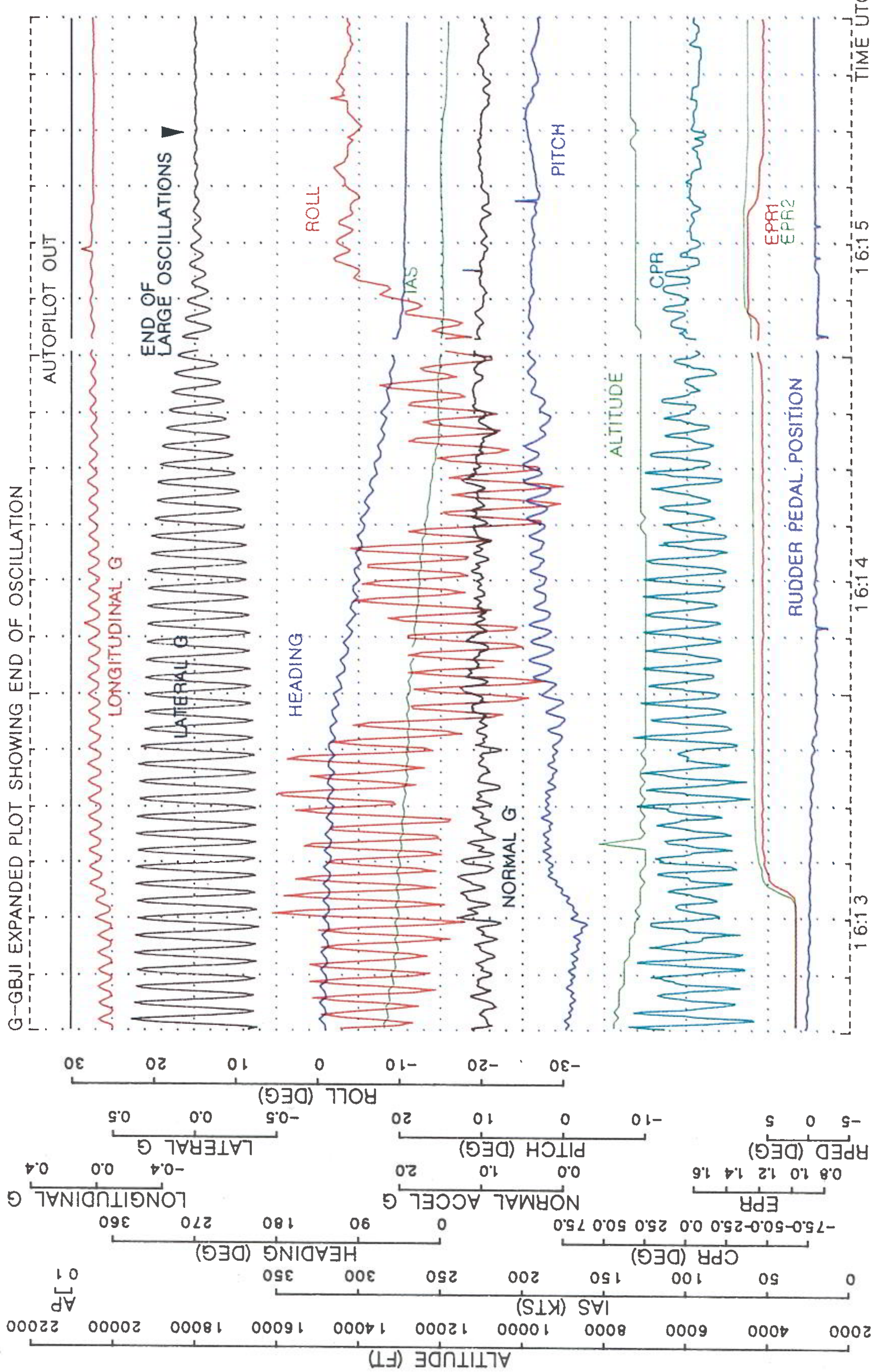


Side elevation of forward fuselage showing location of E&E Bay (shroud and waste drain line omitted for clarity)

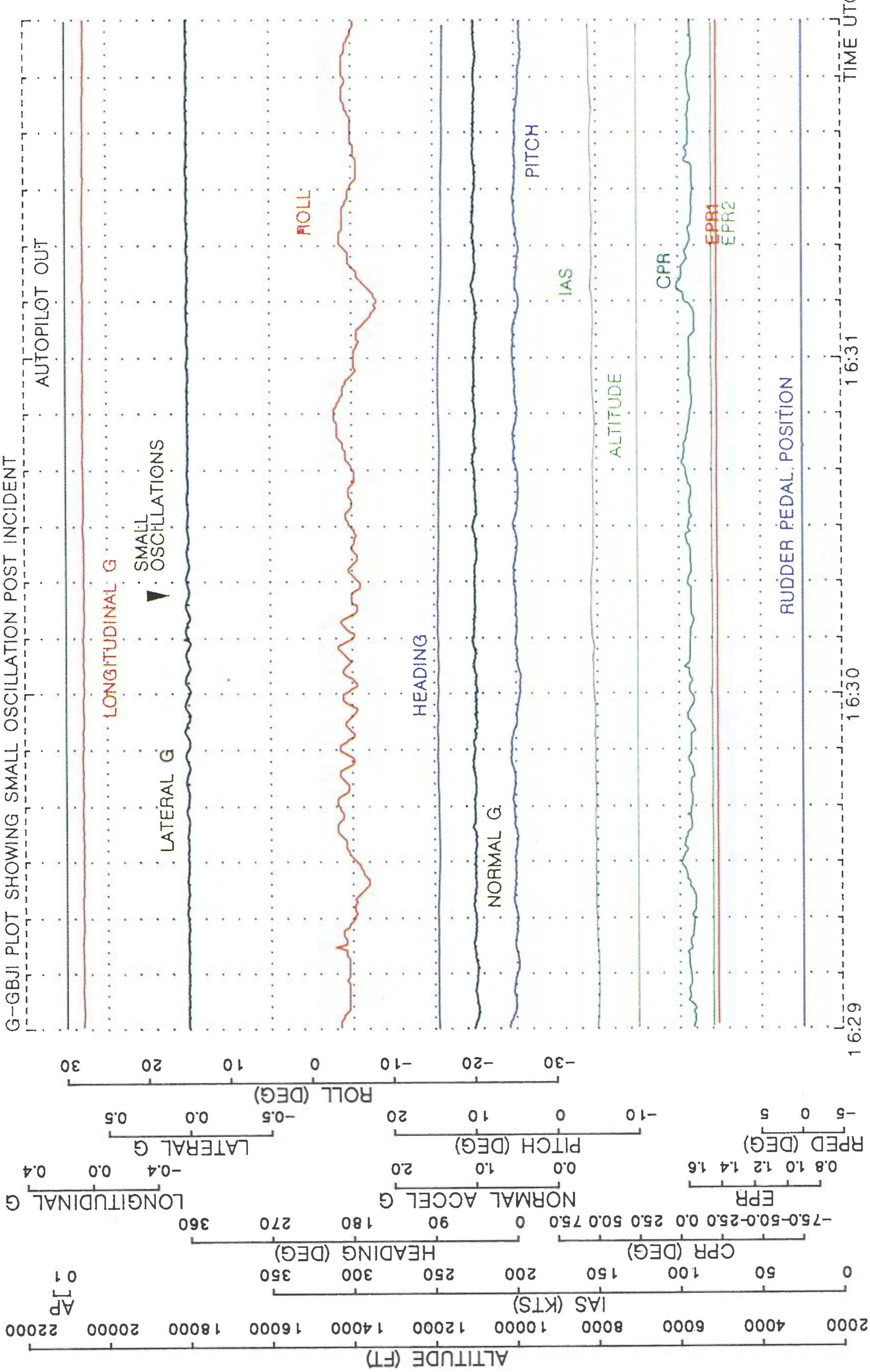
APPENDIX 3
FIGURE 1



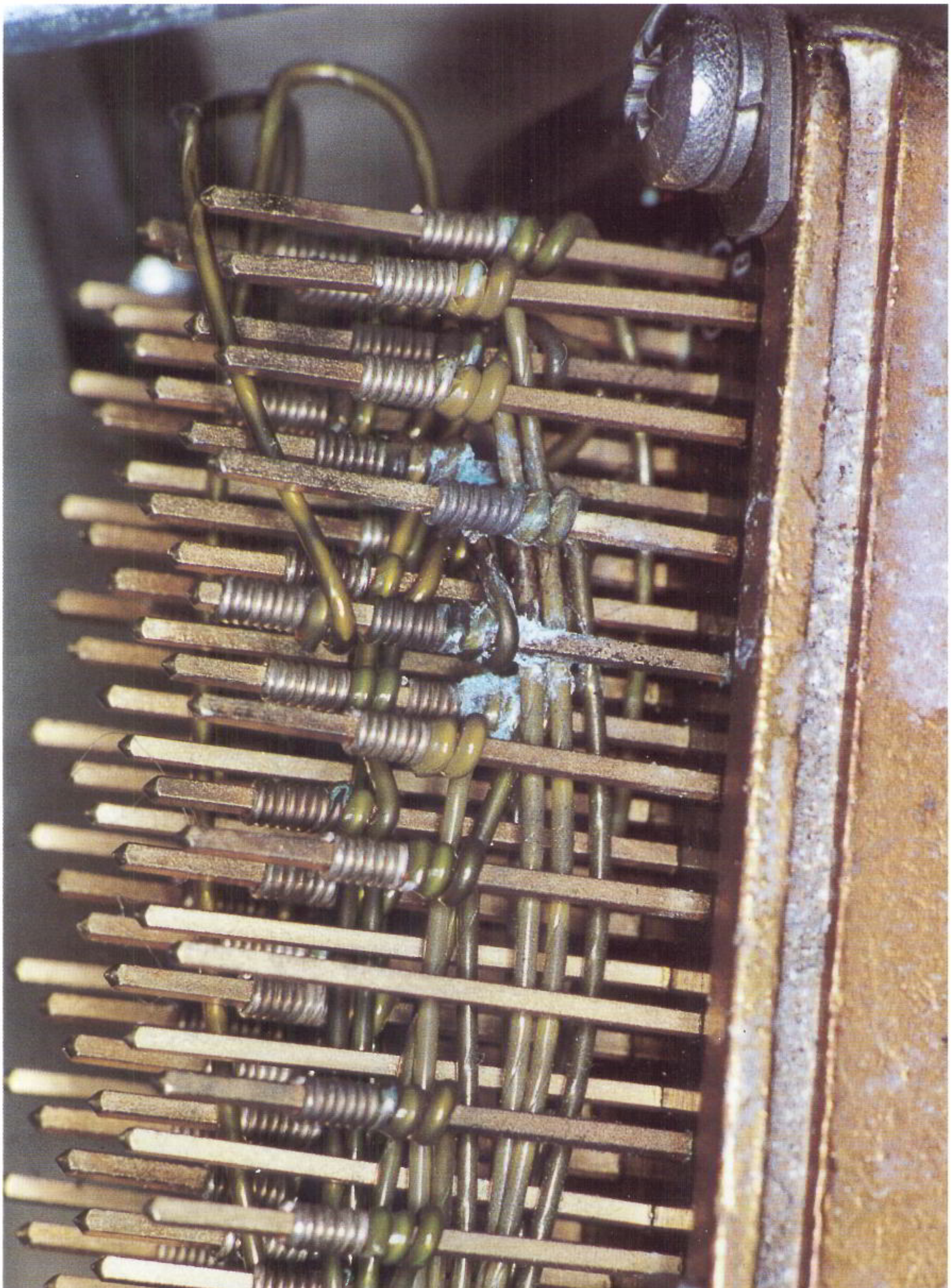

G-GBJI EXPANDED PLOT SHOWING START OF OSCILLATION
AUTOPILOT DISCONNECT
LONGITUDINAL G
ALTITUDE
START OF SMALL OSCILLATIONS
LATERAL G
HEADING
ROLL
IAS
INITIAL ROLL LEFT WING DOWN
NORMAL G
PITCH
CPR
EPR1
EPR2
SPEEDBRAKE HANDLE RETURNED TO DOWN POSITION
RUDDER PEDAL POSITION
TIME UTC
16:06
16:07
16:08
ROLL (DEG)
LATERAL G
PITCH (DEG)
SPEEDBR
RPED (DEG)
LONGITUDINAL G
NORMAL ACCEL G
EPR
HEADING (DEG)
CPR (DEG)
AP
IAS (KTS)
ALTITUDE (FT)


G-GBJI EXPANDED PLOT SHOWING END OF OSCILLATION
AUTOPILOT OUT
END OF LARGE OSCILLATIONS
LONGITUDINAL G
LATERAL G
HEADING
ROLL
IAS
NORMAL G
PITCH
ALTITUDE
CPR
EPR1
EPR2
RUDDER PEDAL POSITION
TIME UTC
16:13
16:14
16:15
ALTITUDE (FT)
IAS (KTS)
AP
HEADING (DEG)
CPR (DEG)
LONGITUDINAL G
NORMAL ACCEL G
EPR
LATERAL G
PITCH (DEG)
RPED (DEG)
ROLL (DEG)

APPENDIX 3
FIGURE 4



APPENDIX 4
FIGURE 1

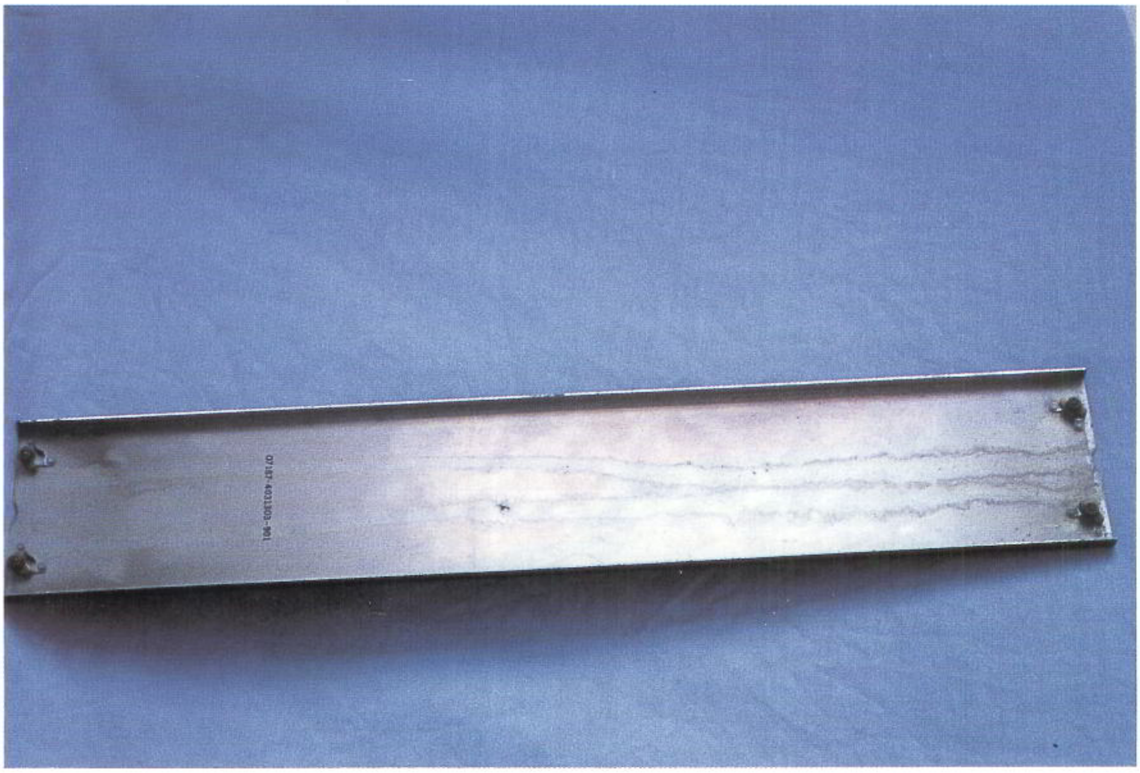


Close-up view of terminal posts at the back of Yaw Damper Coupler connector showing accumulation of electrolytic/corrosion deposits around wire-wrapped joints

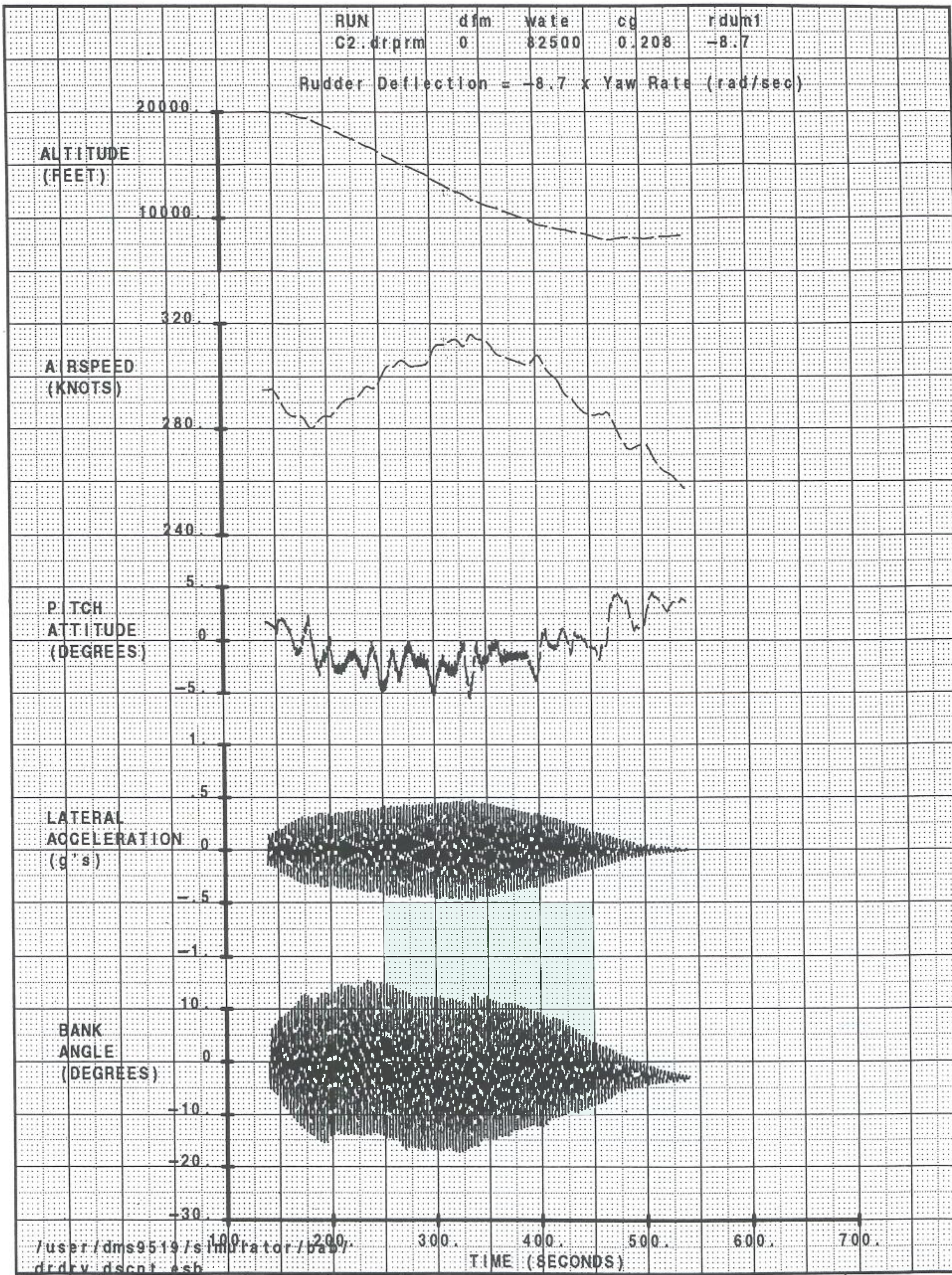
APPENDIX 4
FIGURE 2

View of YDC connector shell showing evidence of dry corrosion products on exterior surface

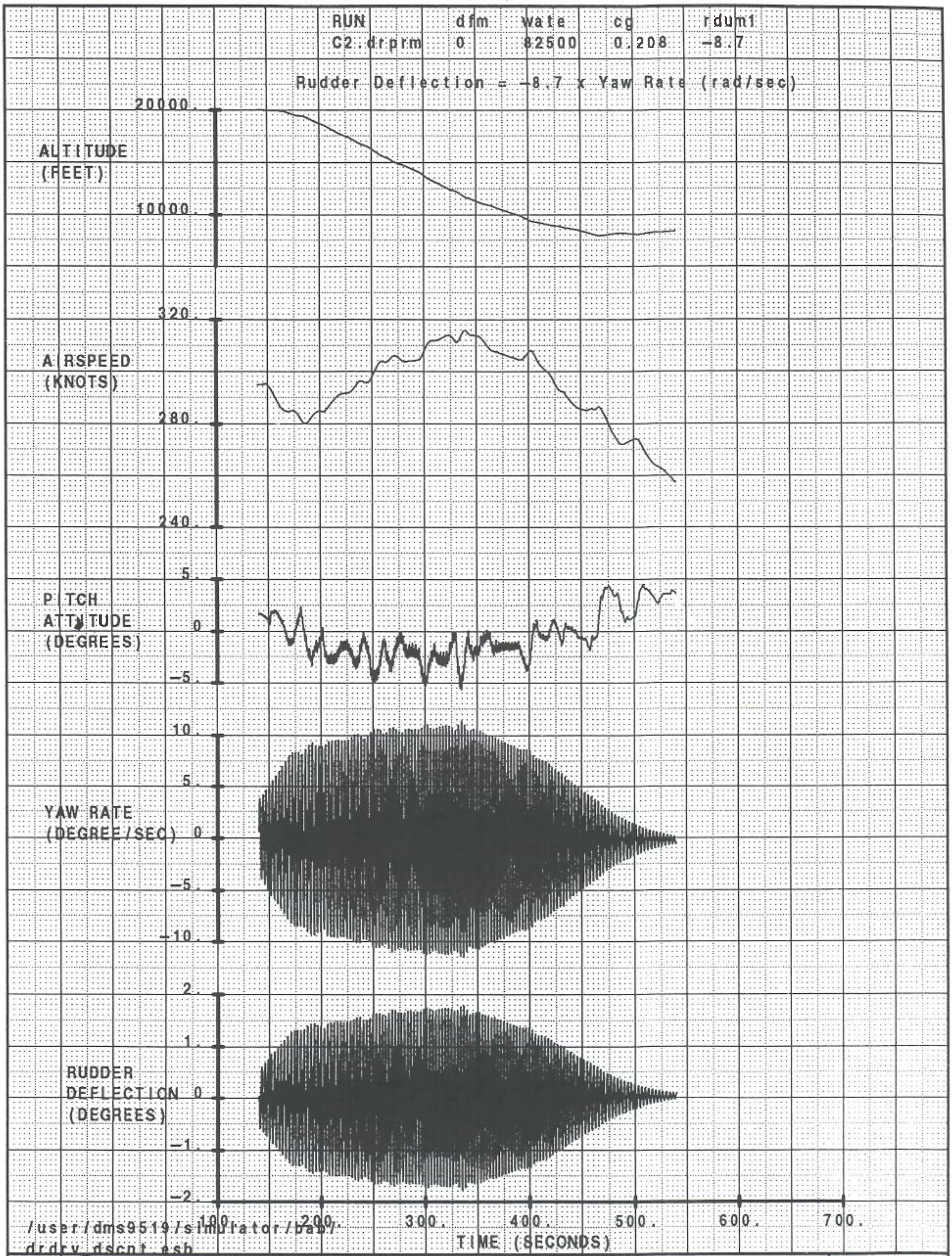
APPENDIX 4
FIGURE 3



View of YDC lower cover plate showing evidence of dried fluid runs on the inner face

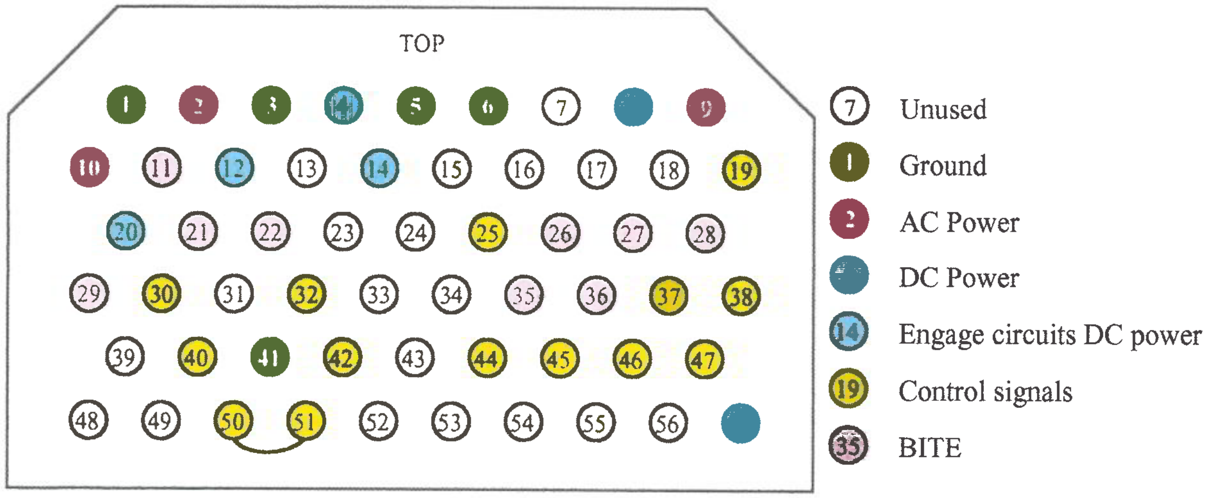


CALC		28OCT95	REVISED	DATE	SIMULATOR DATA BRITISH AIR DUTCH ROLL OSCILLATORY RUDDER INPUT GAIN = -8.7	737-200
CHECK						PK775
APR					THE BOEING COMPANY	PAGE
APR						



CALC		28OCT95	REVISED	DATE	SIMULATOR DATA BRITISH AIR DUTCH ROLL OSCILLATORY RUDDER INPUT GAIN = -8.7	737-200 PK775
CHECK						
APR						
APR					THE BOEING COMPANY	PAGE

Figure 1a Geometric layout of pins in connector D295



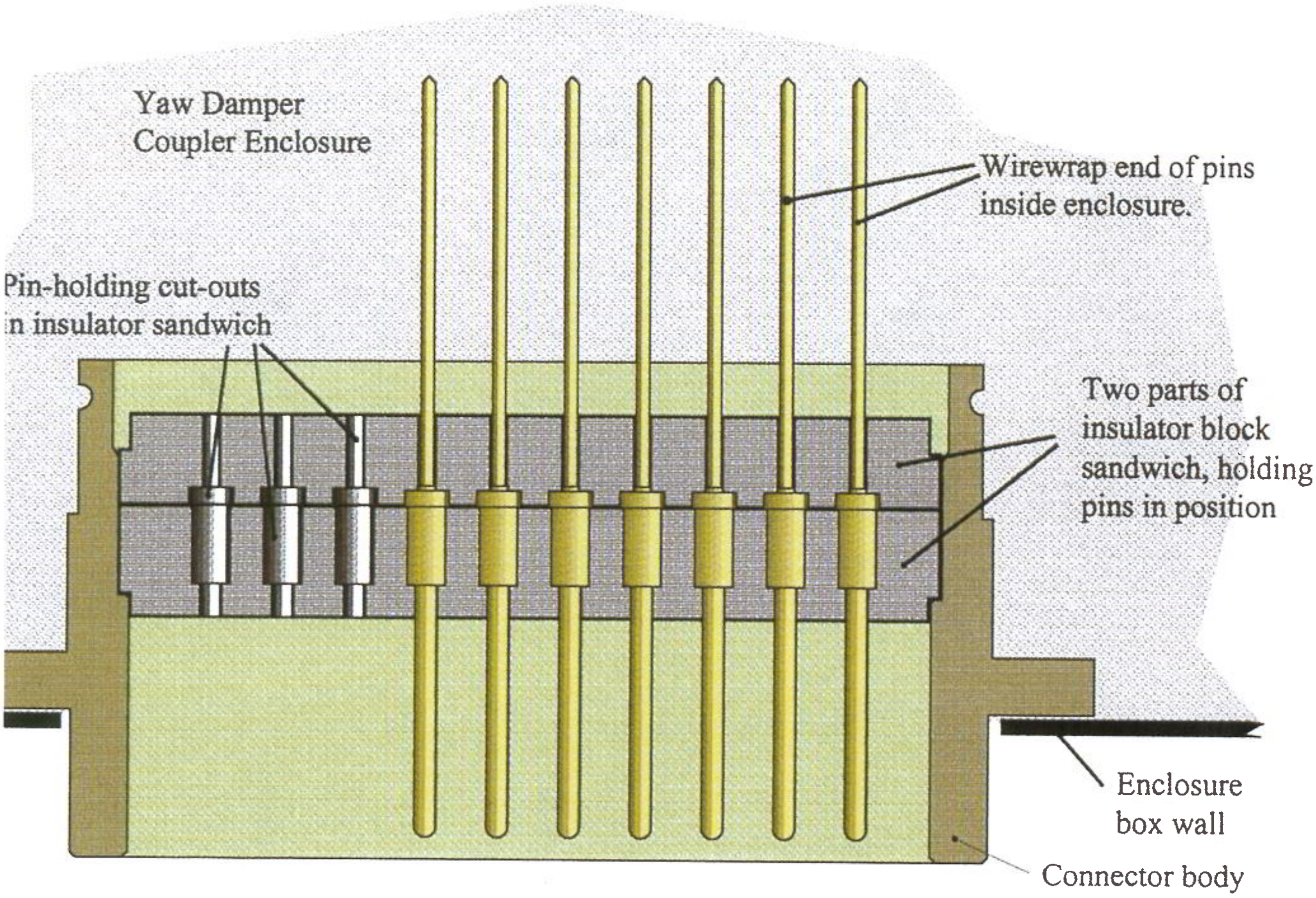
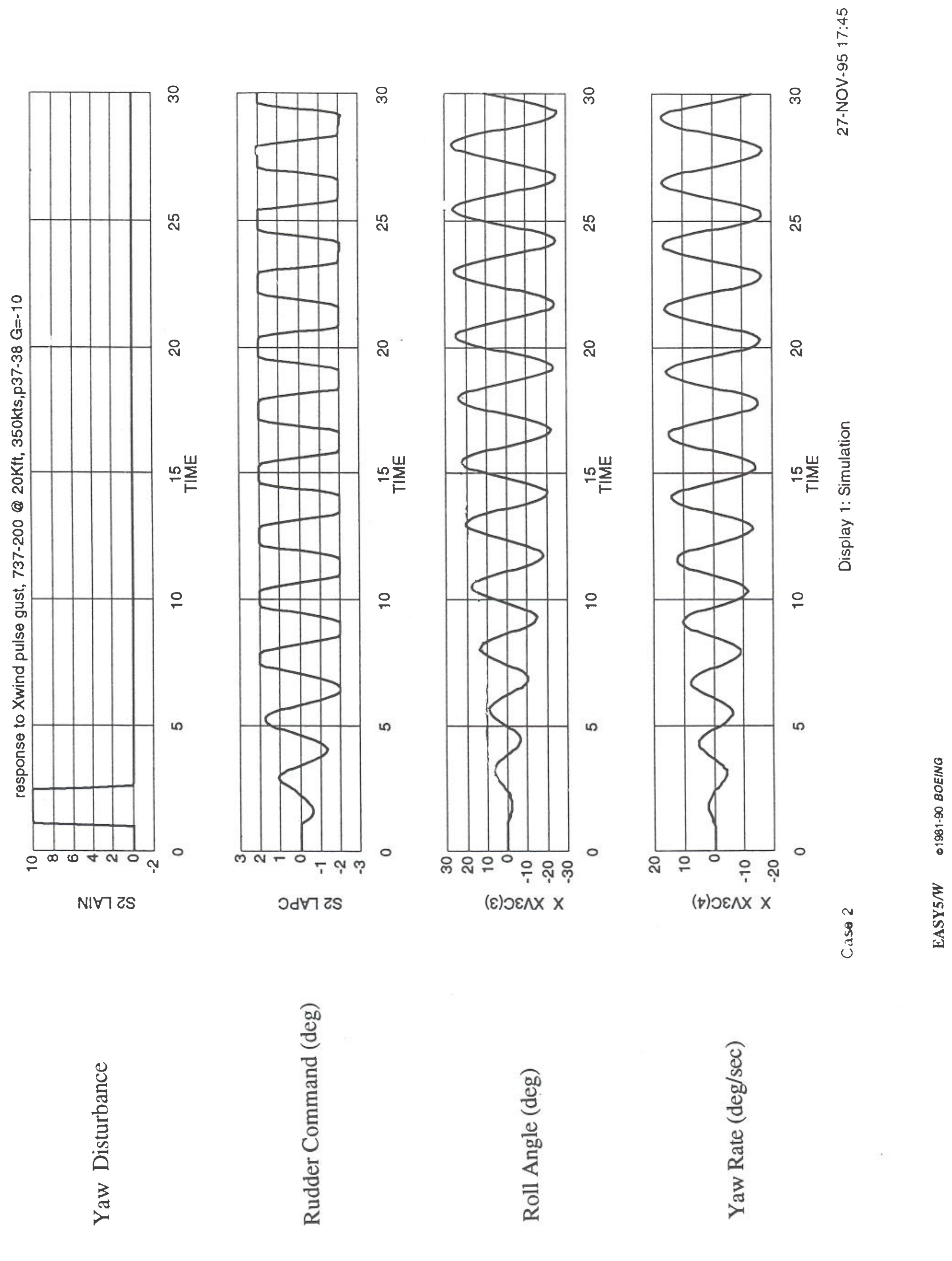
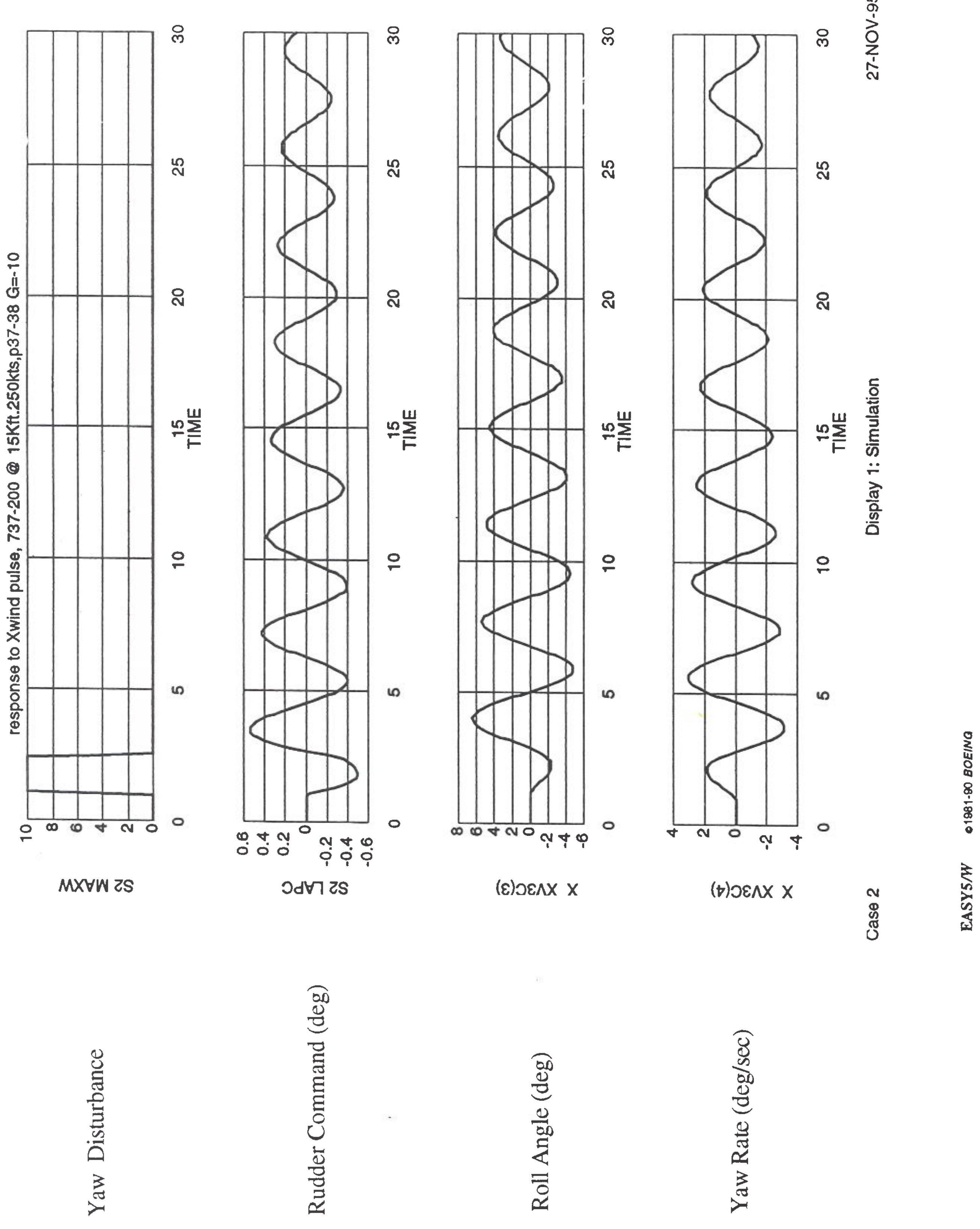


Figure 1b Cross section through a line of pin holes of connector D295 showing assembly.


response to Xwind pulse gust, 737-200 @ 20Kft, 350kts,p37-38 G=-10
Yaw Disturbance
S2 LAIN
Rudder Command (deg)
S2 LAPC
Roll Angle (deg)
X XV3C(3)
Yaw Rate (deg/sec)
X XV3C(4)
TIME
Display 1: Simulation
27-NOV-95 17:45
Case 2
EASY5/W
©1981-90 BOEING


response to Xwind pulse, 737-200 @ 15Kft.250kts,p37-38 G=-10
Yaw Disturbance
S2 MAXW
Rudder Command (deg)
S2 LAPC
Roll Angle (deg)
X XV3C(3)
Yaw Rate (deg/sec)
X XV3C(4)
TIME
0 5 10 15 20 25 30
Case 2
Display 1: Simulation
27-NOV-95 17:49
EASY5/W
©1981-90 BOEING

PIN TO PIN SHUNT ANALYSIS

Extract from: Yaw Damper Coupler Connector - Fluid Contamination Analysis (Boeing Reference Enclosure 1 to B-B600-15718-ASI) Figure 4 Pin-to-Pin Shunt Analysis

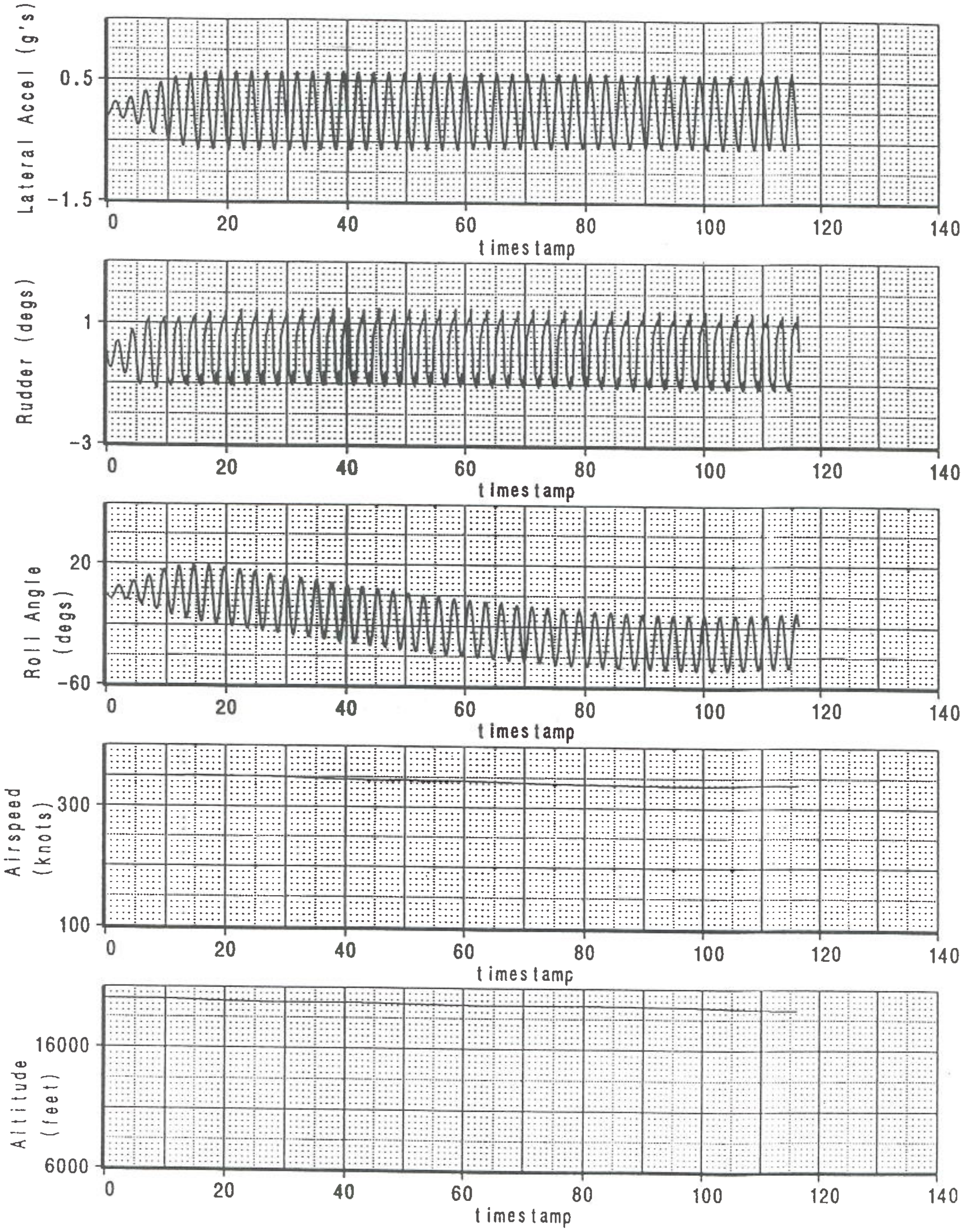
NB Bold Typeface denotes combinations which were simulated in both the computer EASY 5 model, and the M-Cab testing.

Pin-to-pin Shunt	Additional Facts/Assumptions	System Effects
1-2, 1-10, 2-3	Photos show that the fluid had little if any contact with these pins. If the fluid had contacted these pins, it is believed that a circuit breaker would have tripped or the fluid would have evaporated almost instantaneously.	No effect
2-12	AC signal will not affect the DC engage function	No effect
3-12	Photos show that a fluid path may not have been established	Will pull down voltage on 12. If pull down is large, system will disengage
3-4	Pin 4 has two wires connected to it. The bottom wire which was closest to the fluid provides a direct path to pin 12. The top wire provides a direct path to pin 3. It is assumed that all fluid was conducted along the bottom wire to pin 12 and away from the top wire and pin 3. If the fluid had made a path between 3 and 4 it is likely that a circuit breaker would have tripped or the fluid would have evaporated almost instantaneously.	No effect
4-5	The photos show that it is unlikely that a fluid path was established between these pins.	No effect
4-14	A shunt here would have allowed 28V DC to be connected directly to the output of the yaw damper disengage switch.	No effect if the system was engaged. Circuit Breaker C286 would trip or the fluid path would evaporate almost instantaneously if the system was disengaged.
4-12	These pins are not adjacent, however the wire wrapped to pin 4 take a path that directly contacts with pin 12. Because it is believed that this area was saturated with fluid. It is also believed that a low impedance path existed between these pins.	This could keep the output of the coupler engage signal in an engaged state (assuming the engage signal is allowed to 'float', not forced to ground when pin 14 is grounded). This would cause the relay in the Autopilot Accessory Unit to remain in the engaged state

Pin-to-pin Shunt	Additional Facts/Assumptions	System Effects
5-6, 8-9	The photos show that it is unlikely that a fluid path was established between these pins.	No effect
9-19	Pin 9 carries the 400 Hz 26v ac excitation for the LVDT. Rate gyro signal is also 400 Hz	Full yaw damper command
10-20	Pin 10 is the 400 Hz, pin 20 the DC engage signal	No effect
20-30	Pin 30 is the servo valve ground pin. The photos show it is unlikely that a fluid path was established between these pins.	A low impedance shunt would disengage the system.
30-40, 40-41, 41-42		**A shunt here would produce an attenuation of the Q-pot gyro signal thereby reducing further the ability of the couple to provide control. It would not be sufficient in itself to cause this incident.**
40-50, 42-51		Changes the gain characteristics of the rate gyro path but does not produce a gyro signal sign change which is believed to be necessary to reproduce the incident.
50-51	These pins are electrically equivalent.	No effect
41-50, 41-51		A shunt here would attenuate the signal to the washout filter thereby reducing the ability of the coupler to provide control. It would not be sufficient in itself to cause this incident.
32-41		A shunt here would attenuate the signal to the PCU T-valve thereby reducing further the ability of the coupler to provide control. It would not be sufficient in itself to cause this incident.
32-42		A shunt here changes the gain of the gyro signal to the coupler valve amplifier but does not produce a gyro signal sign change which is believed to be necessary to reproduce the incident.
44-45		No effect
45-46		A shunt here appears to add a low gain positive feedback path to the LVDT feedback signal. It is possible that it could raise the overall gain of the feedback signal which should not be a problem. Detailed circuit analysis would be required to make a more definitive evaluation or a lab test simulating the shunt.
37-46, 37-47	Pins 46 and 47 are 400 Hz signals being summed into the servo loop	No effect

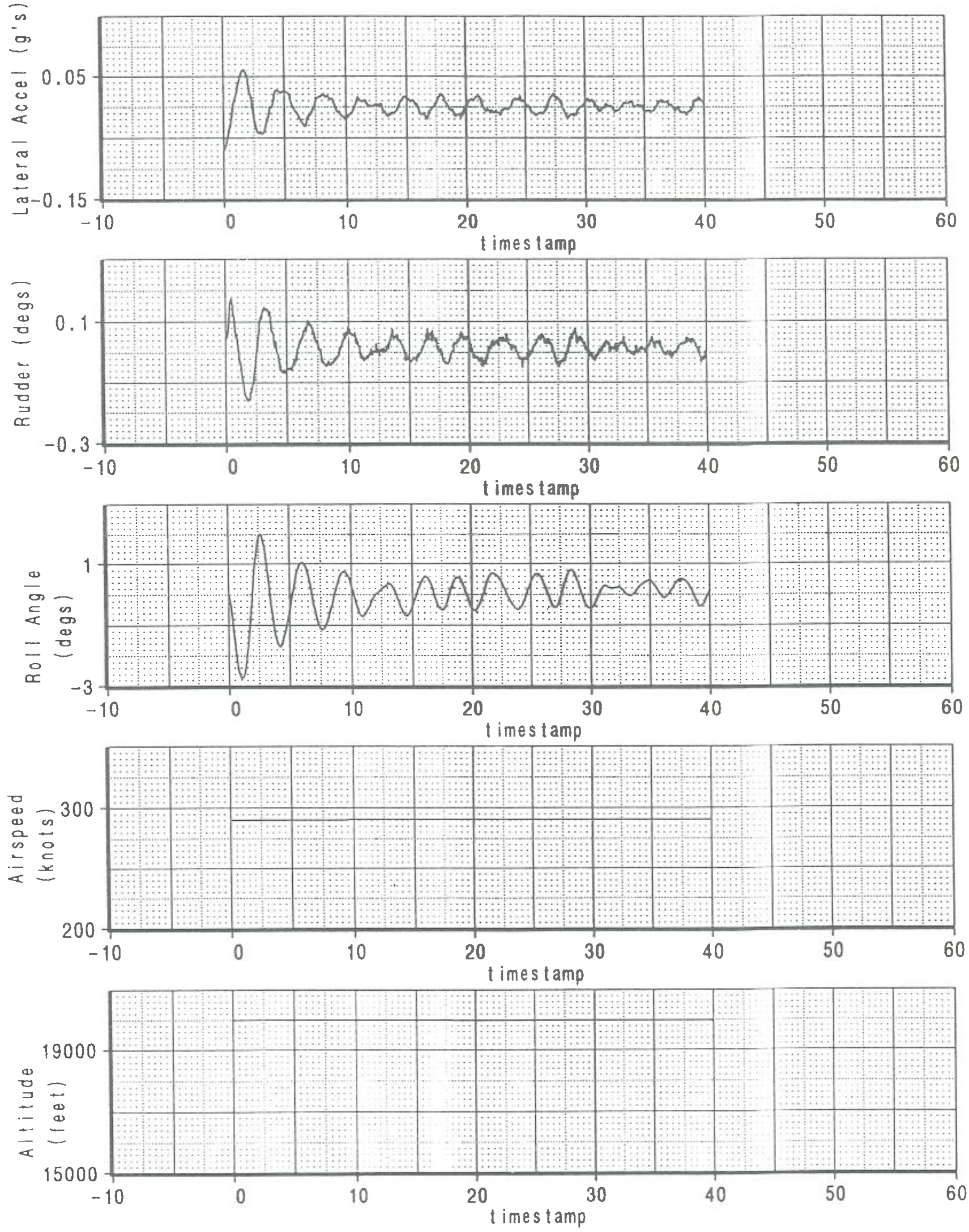
37-38	**This establishes a path from the output of the rate gyro demodulator directly into the servo loop summing junction. The normal rate gyro signal path applies a sign change (180° phase shift) to the gyro signal prior to the summing junction so that the rudder motion is applied in a direction which would counter the yaw rate. This shunt however bypasses the sign change, feeding a gyro signal into the summing junction which is in phase with the yaw rate.**	**A high impedance shunt would most likely produce an instability given the magnitude of the feedback resistance at the summing junction. Further evaluation should be possible using an EASY 5 computer simulation.**
38-47	Pin 47 is a 400 Hz signal	No effect should be seen if the Pin 47 signal is injected at pin 38 as it is introduced downstream of the rate gyro modulator. Conversely, however of the pin 38 signal is injected into the LVDT demodulator, then it may serve to oppose or even cancel (depending on the magnitude of the shunt) the LVDT signal producing an effect similar to the open feedback. This could be confirmed with a lab test.
46-47		**A shunt here serves to attenuate the feedback signal. This would ultimately leads to the open feedback condition where the system oscillates at a frequency of 0.8 Hz.**
46-57	Pin 46 is a 400 Hz signal and pin 57 is a DC engage signal.	No effect

APPENDIX 8
FIGURE 1



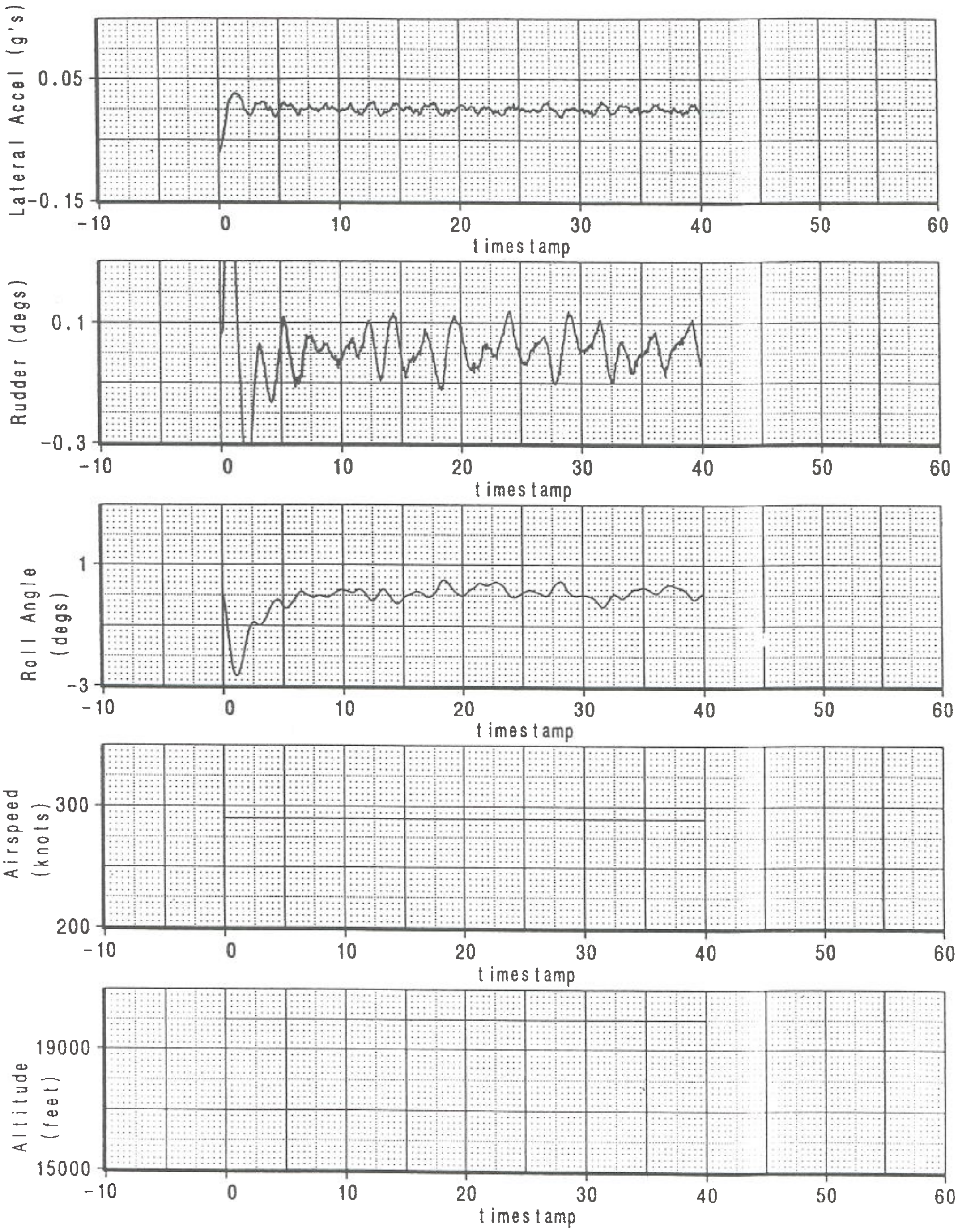
[A]: /acct/smw0585/pk775_m_cab/ydbab_121295.esb C17.sweP

CALC	S.White	15Dec95	REVISED	DATE	PK775 - M Cab studies Test Case 17 from Tues 12/12/95 30kohm across Pins 37/38	
CHECK						
APPD.						
APPD.					BOEING	PAGE



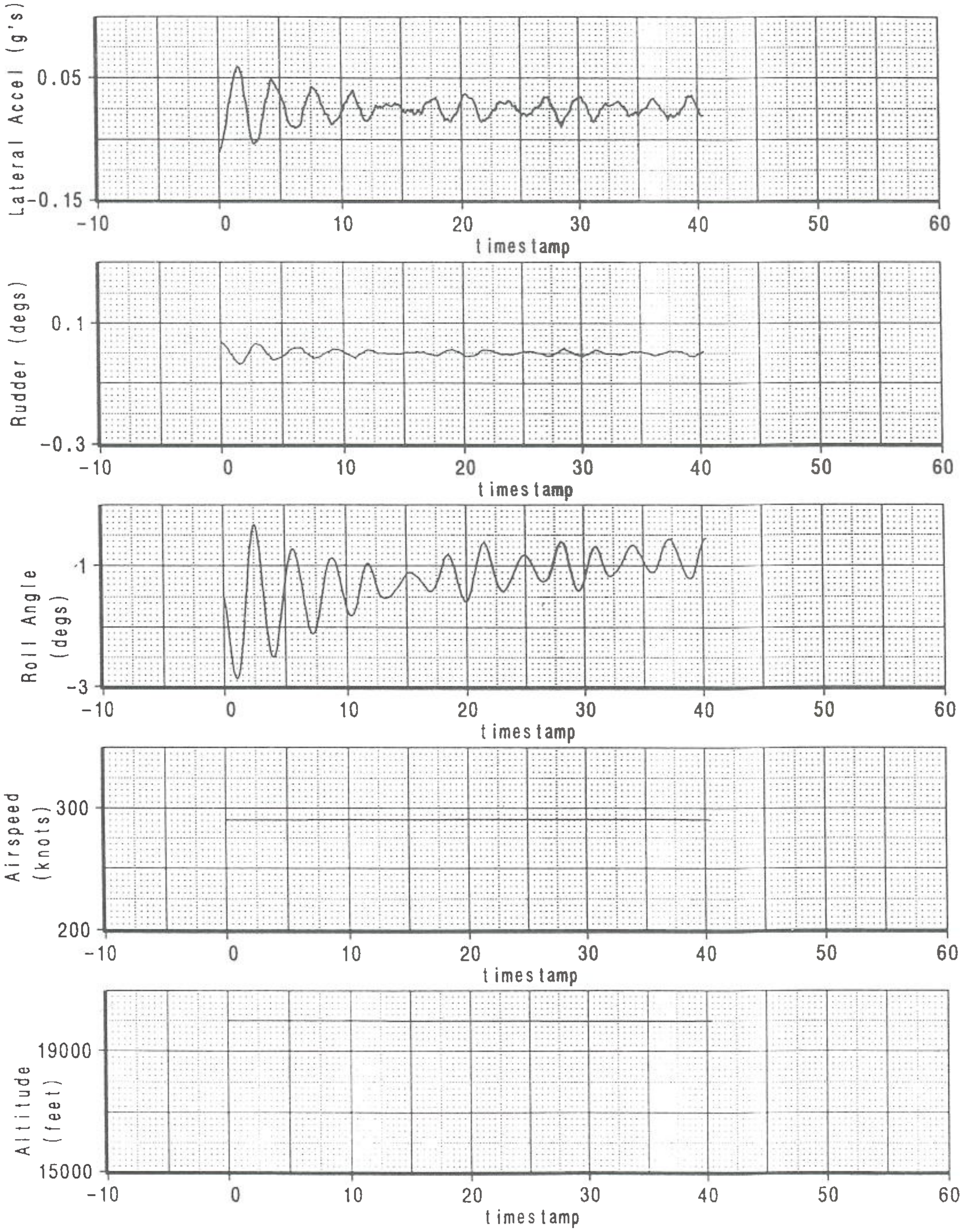
[A]: /acct/smw0585/pk775_m_cab/ydbab_011196.esb C10.sweP

CALC	S.White	19Jan96	REVISED	DATE	PK775 - M Cab studies	
CHECK					Test Case 10 from Thur 01/11/96	
APPD.					230kohm across 40/51, med turb	
APPD.					BOEING	PAGE



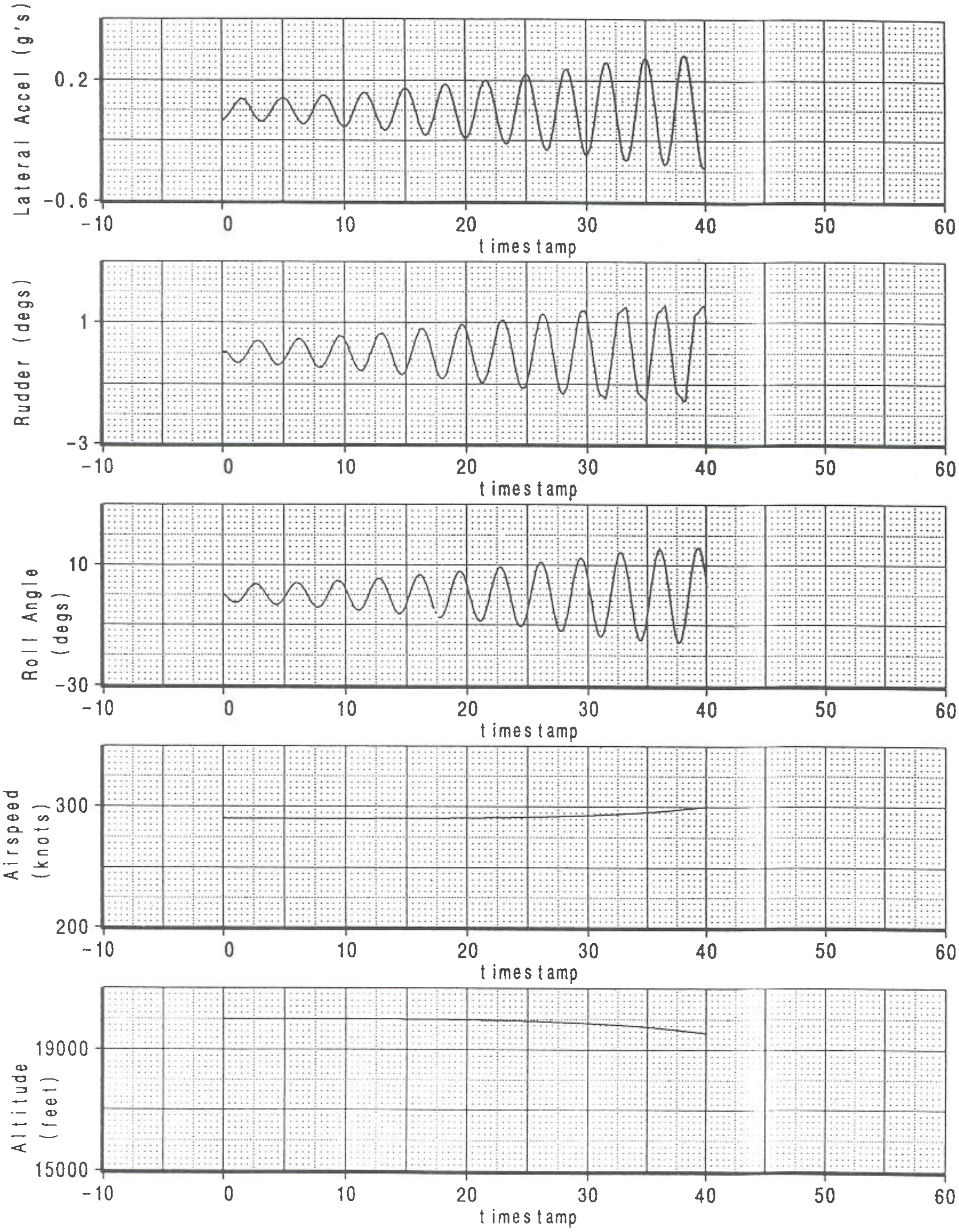
[A]: /acct/smw0585/pk775_m_cab/ydbab_011196.esb C16.sweP

CALC	S.White	19Jan96	REVISED	DATE	PK775 - M Cab studies Test Case 16 from Thur 01/11/96 Fully functional Yaw Damper, med turb	
CHECK						
APPD.						
APPD.					BOEING	PAGE



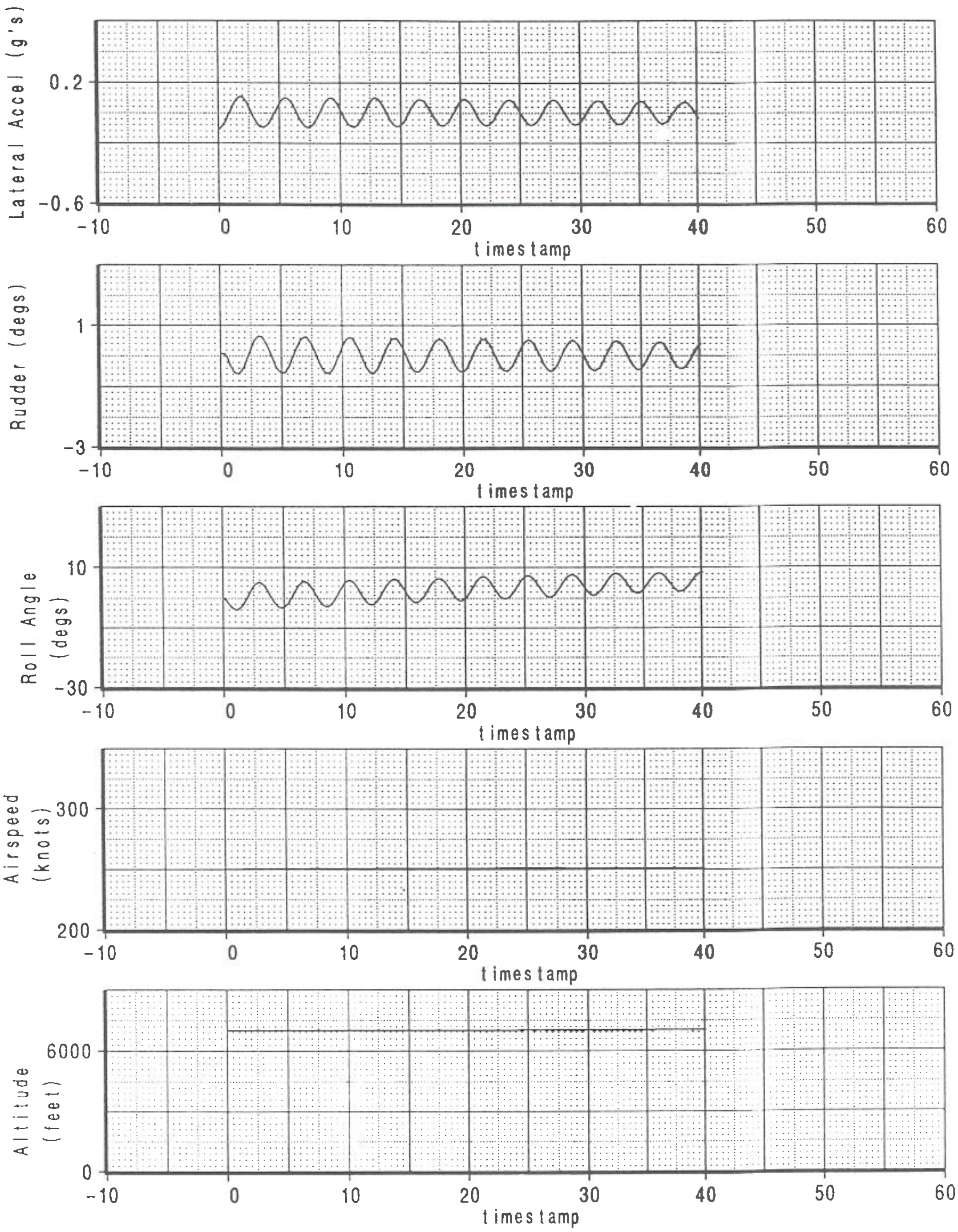
[A]: /acct/smw0585/pk775_m_cab/ydbab_011196.esb C2.swePa

CALC	S.White	19Jan96	REVISED	DATE	PK775 - M Cab studies Test Case 2 from Thur 01/11/96 Yaw Damper OFF, med turb	
CHECK						
APPD.						
APPD.					BOEING	PAGE



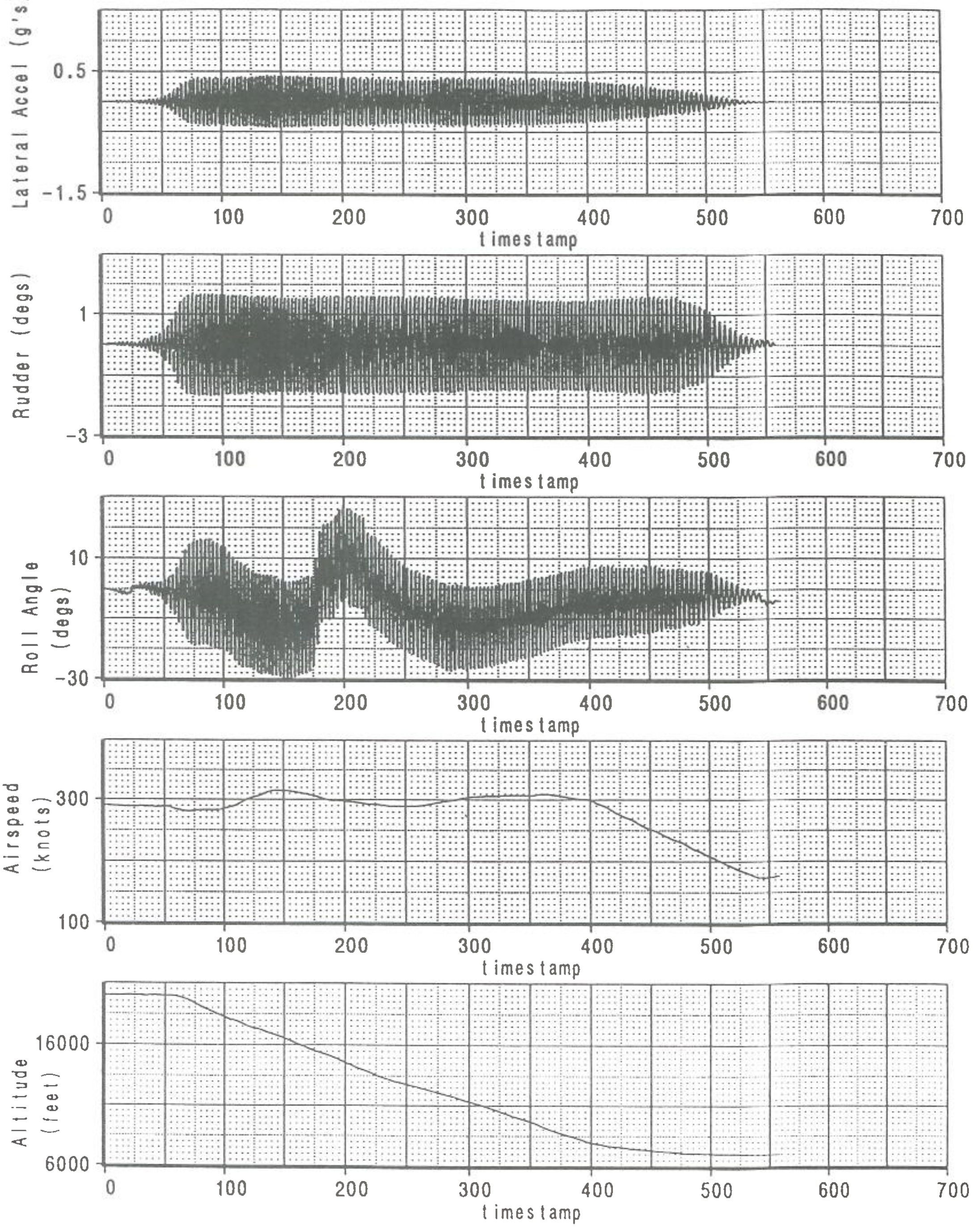
[A]: /acct/smw0585/pk775_m_cab/ydbab_011196.esb C27.sweP

CALC	S.White	19Jan96	REVISED	DATE	PK775 - M Cab studies Test Case 27 from Thur 01/11/96 230kohm across 40/51 & 37/38, light turb	
CHECK						
APPD.						
APPD.					BOEING	PAGE



[A]: /acct/smw0585/pk775_m_cab/ydbab_011196.esb C33.sweP

CALC	S.White	19Jan96	REVISED	DATE	PK775 - M Cab studies	
CHECK					Test Case 33 from Thur 01/11/96	
APPD.					230kohm across 40/51 & 37/38, light turb	
APPD.					BOEING	PAGE



[A]: /acct/smw0585/pk775_m_cab/ydbab_121395_2.esb C70.sweP

CALC	S.White	18Dec95	REVISED	DATE	PK775 - M Cab studies Test Case 70 from Wed 12/13/95 Pins 40/51 & 37/38, 200k & 200k, low turb	
CHECK						
APPD.						
APPD.					BOEING	PAGE

THE BOEING COMPANY, SEATTLE, WASHINGTON 98124

NUMBER: GUI(C/K/L)-15

DATE : August 4, 1995

SUBJECT: UNCOMMANDED YAW OR ROLL PROCEDURE

REASON : To inform flight crews of the revised UNCOMMANDED YAW Procedure, to change the title and to provide additional guidance when accomplishing the procedure.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model aircraft.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

BACKGROUND INFORMATION

As a result of numerous customer inquiries regarding the appropriate pilot response to uncommanded yaw or roll, the following procedure enhancement and background information are provided.

Apparent uncommanded yaw or roll can be caused by a variety of events, normal and non-normal. Normal events may include autopilot attempts to maintain course guidance and aircraft attitude during FMC position updates and autopilot approach course intercept. Non-normal events might include wake turbulence, adverse weather, flight control malfunctions, split throttles, engine power loss, yaw damper and autopilot malfunctions.

All aircraft, especially swept wing aircraft, exhibit an aerodynamic characteristic called Dutch Roll. Dutch Roll is a combination of yaw and roll. Active yaw damper systems prevent minor yaw disturbances from developing into Dutch Roll.

The 737 will dampen out any Dutch Roll motion naturally without an active yaw damper. The Yaw Damper on the 737 is designed to improve ride quality and is not required for dispatch. The Yaw Damper is limited to 3 degrees rudder deflection for the 737-300/-400/-500 and 2, 3 or 4 degrees (as installed) for the 737-100/-200. These are the physical limits of the yaw damper actuator. Yaw Damper commands are not fed back to the rudder pedals.

The 737 yaw damper system has three failure modes. First, the system can fail and not provide commands to deflect the rudder. Because there is no resulting movement in any aircraft axis, there are no special techniques for this condition. If the YAW DAMPER Light on the overhead panel is illuminated, accomplish the YAW DAMPER procedure.

In a second failure mode the yaw damper system gives commands that appear as an oscillation or erratic motion in the yaw axis. The Yaw Damper should be turned OFF in accordance with the UNCOMMANDED YAW OR ROLL procedure.

BACKGROUND INFORMATION (Continued)

The third failure mode occurs when the system commands a full yaw damper input. The aircraft responds with an initial yawing motion that may not be noticed by the crew, followed by a readily apparent rolling motion in the same direction as rudder deflection. The roll rate and roll acceleration are quicker than a normal autopilot input. Flight data shows that bank angles rarely exceed 10 degrees in the direction of rudder deflection. If engaged, the autopilot will respond with opposite aileron to counter the roll. At 0.74 Mach and at normal cruise altitudes, the autopilot may not be able to roll the aircraft back to wings level but will reduce the roll rate to 1-2 degrees per second, allowing the pilot ample time to recover. In the event of yaw damper system failure, turning the yaw damper system off will remove yaw damper commands to the rudder. Cross checking the YAW DAMPER Indicator will help identify a yaw damper malfunction. Accomplish the UNCOMMANDED YAW OR ROLL procedure.

Uncommanded roll can also be caused by a malfunction of the lateral axis of the autopilot. This malfunction is characterised by a control wheel deflection in the direction of the uncommanded roll with the autopilot engaged. In this case, the pilot should simultaneously disengage the autopilot and counter the roll input, bringing the aircraft to wings level and complete the UNCOMMANDED YAW OR ROLL procedure.

For uncommanded rolls not associated with an autopilot malfunction, the control wheel position will be opposite the direction of the uncommanded roll. In this case, the autopilot is attempting to oppose the uncommanded roll force. Allowing the control wheel to go to neutral after disengagement may allow the aircraft to roll even more in the uncommanded direction. The pilot should establish control of the aircraft by grasping and holding the control wheel firmly prior to disengaging the autopilot, make appropriate control wheel corrections to return to wings level and complete the UNCOMMANDED YAW OR ROLL procedure.

UNCOMMANDED YAW OR ROLL

Accomplish this procedure if uncommanded yaw or roll occurs in flight.

AUTOPILOT (if engaged) .... DISENGAGE

The pilot should be prepared to make control wheel corrections to return to wings level upon disengagement. The autopilot may be putting in an appropriate correction for an uncommanded yaw or roll. Allowing the control wheel to go to neutral after disengagement may allow the aircraft to roll even more.

If yaw and/or roll forces continue:

YAW DAMPER SWITCH .... OFF

The YAW DAMPER Light illuminates when the yaw damper is disengaged.

If it is confirmed that the autopilot is not the cause of the uncommanded yaw or roll, the autopilot may be re-engaged at the pilot's discretion.

Printed in the United Kingdom on behalf of
The Stationery Office Limited
JOO37212 C5 2/98 61743