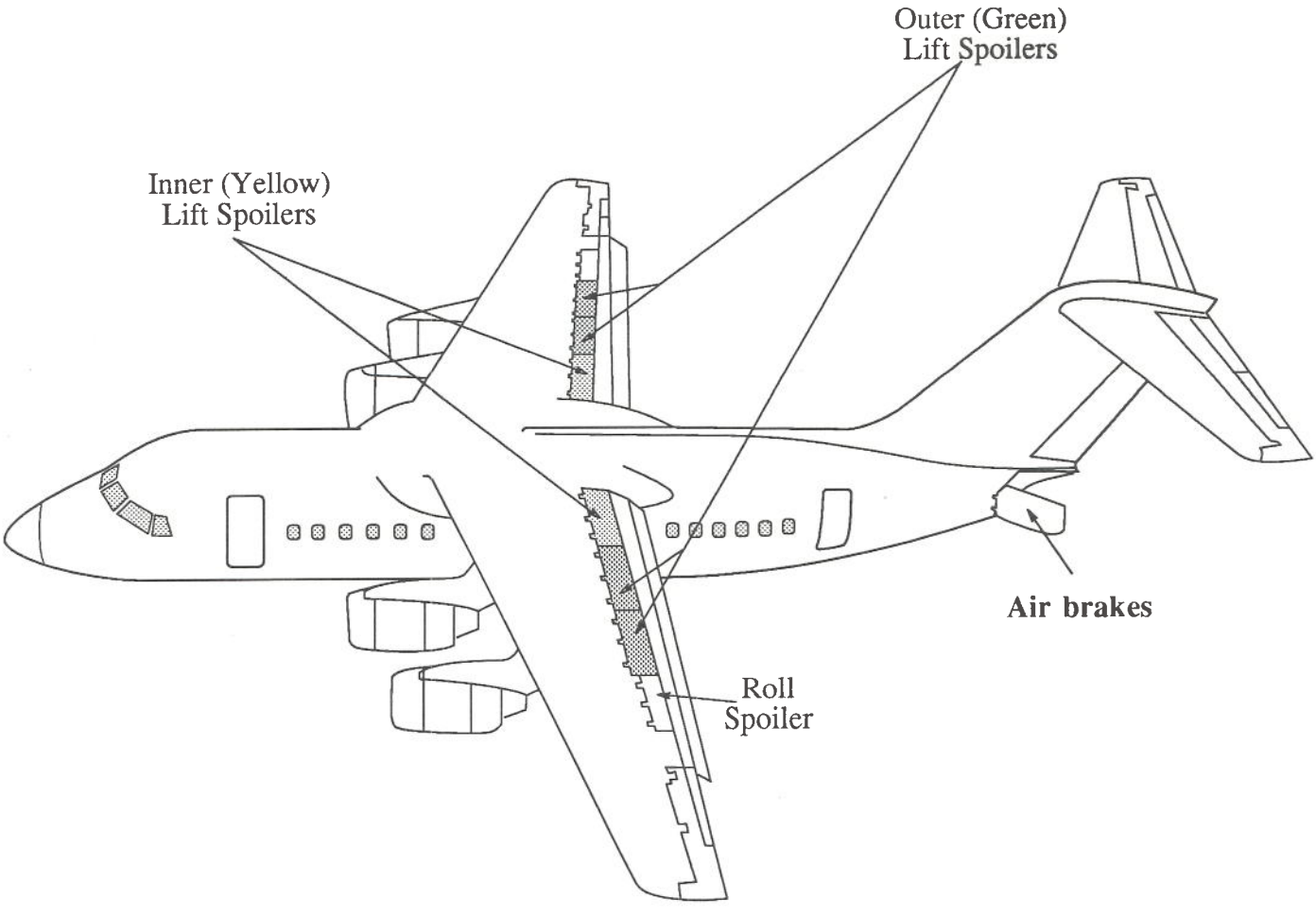


Figure 1 Location of Spoilers and Air brakes on BAe 146

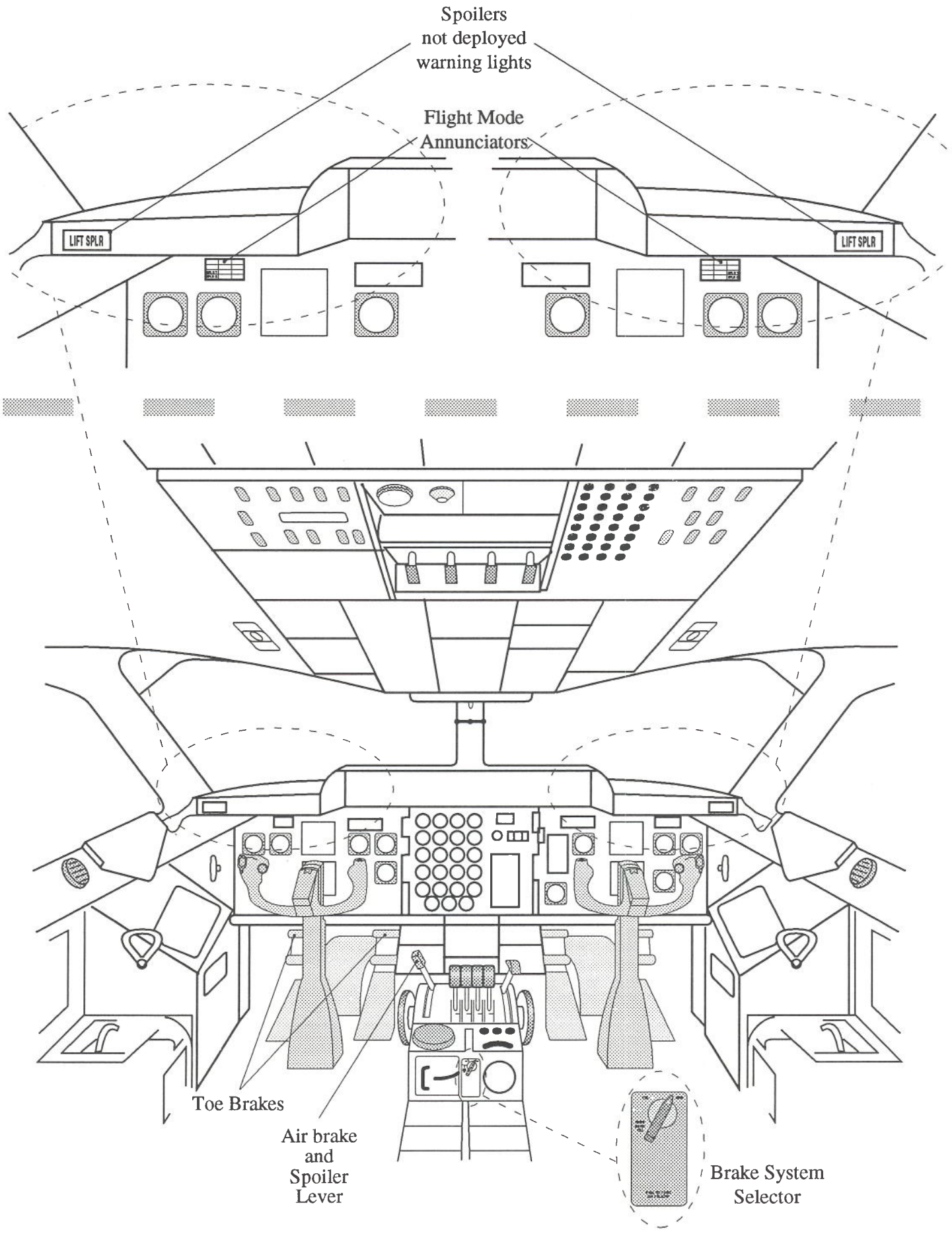


Figure 2 Location of Spoiler, Air brake and Wheelbrake controls and indications on BAe 146 flight deck

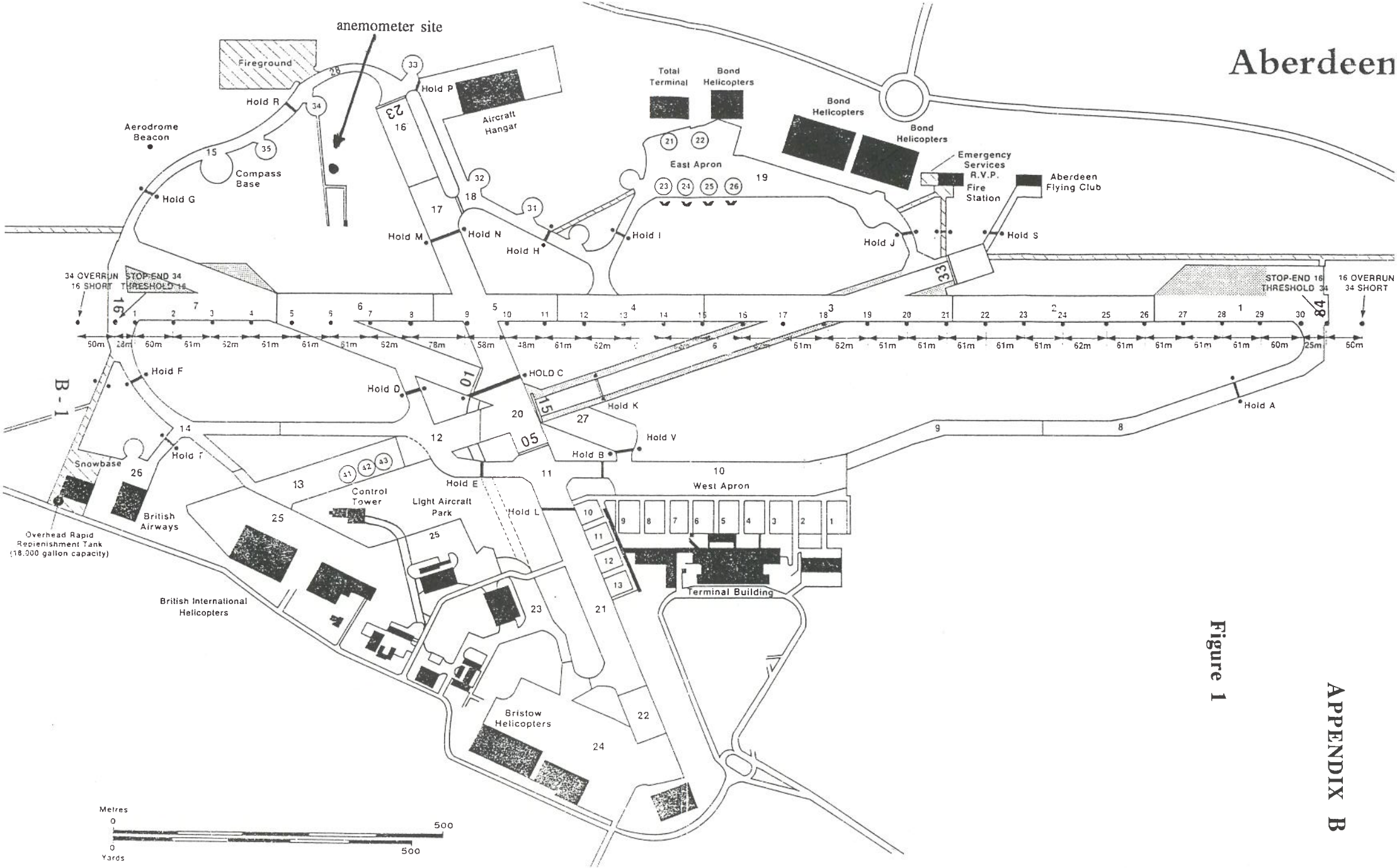
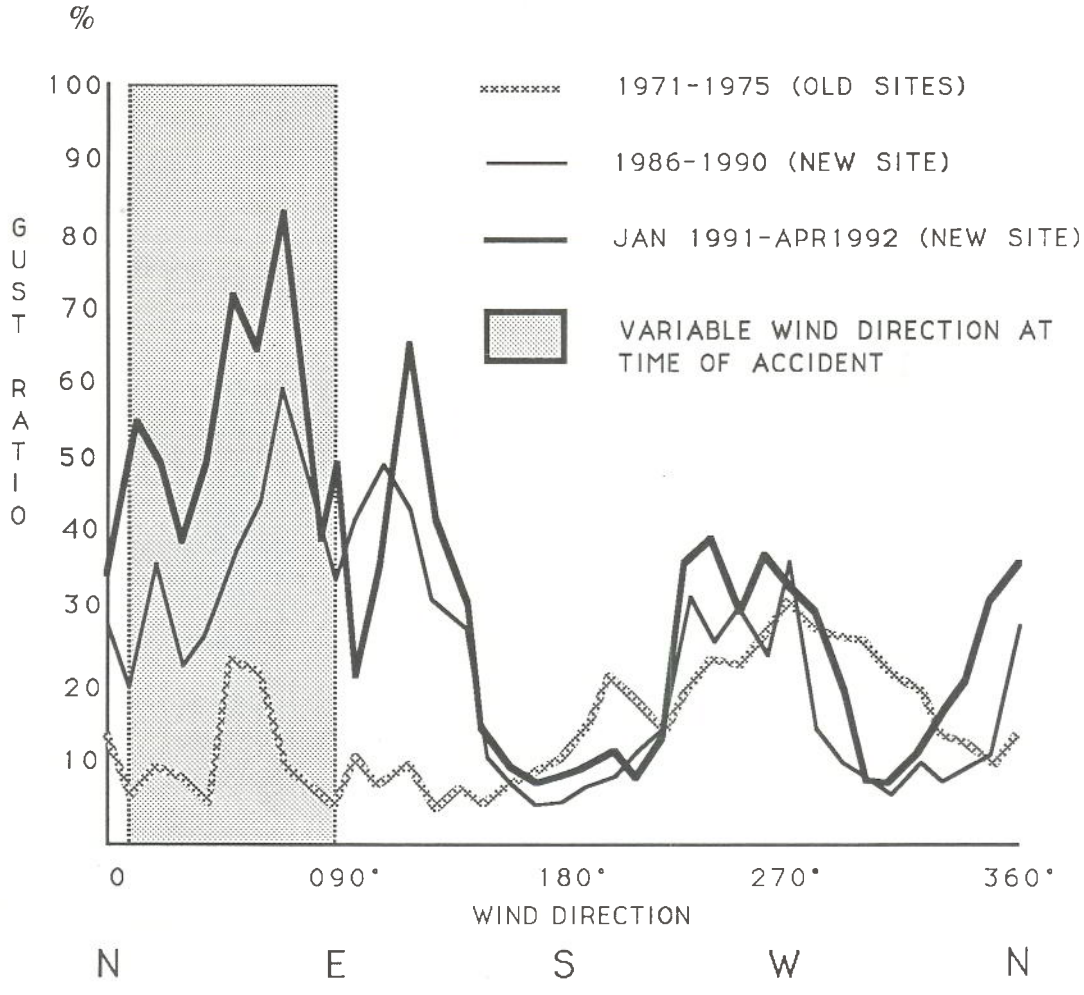


Figure 1

APPENDIX B

ABERDEEN DYCE ANEMOMETER RECORDINGS 1971 TO 1992, OF MEAN HOURLY WINDS OF 12 KTS OR MORE WITH GUST RATINGS GREATER THAN 1.8



The Aberdeen Dyce anemometer has been located at its present site since 1976. Prior to that time it was located at two other sites.

The old sites (1971-1975) show very little gustiness with easterly winds.

Statistics for the new site show a marked increase in gustiness with easterlies as a result of a large surface feature to the east of the site.

For the period Jan 91 to Apr 92 data shows even higher values from 350° to 090° which could be due to recent construction to the east and close to the present anemometer location.

Figure 3 Close-up of old weathered runway surface at thresholds

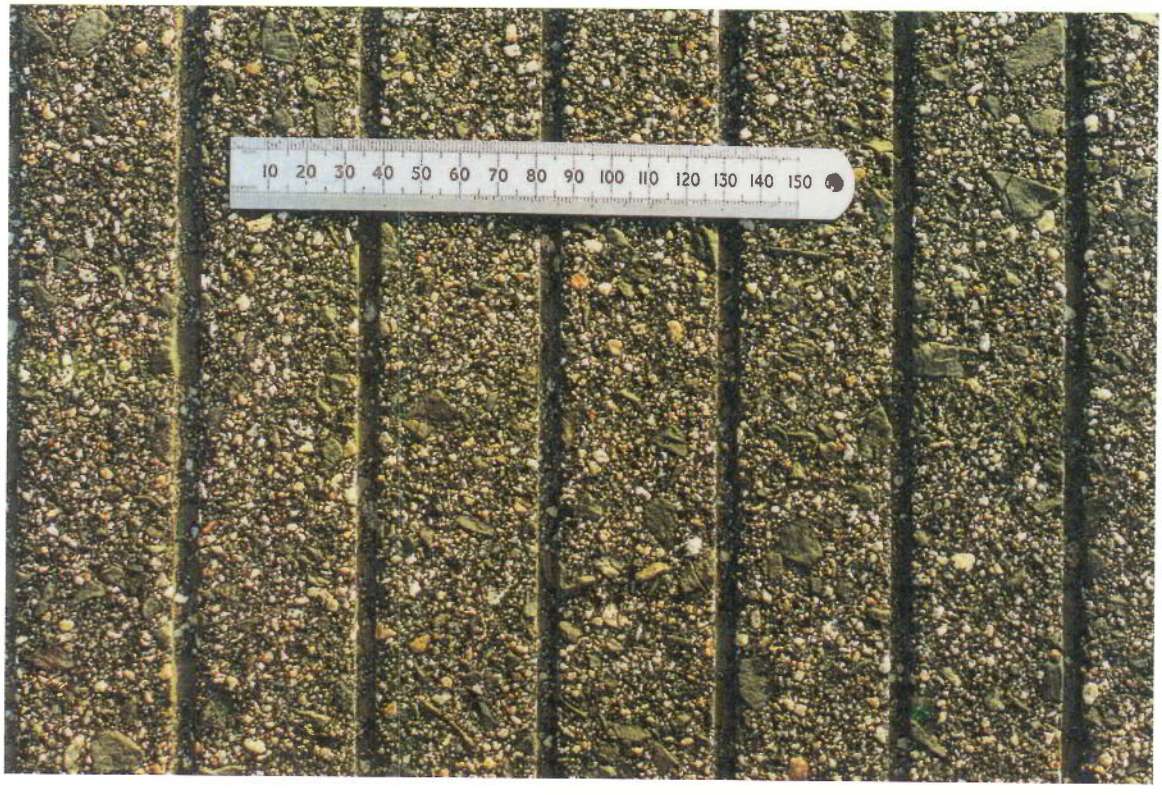


Figure 4 Close-up of runway surface laid in 1988

Figure 5 **Mu-Meter and tow vehicle**

Airport: ABERDEEN Rwy: 16/34

Date:	04:06:92	Time:	14.50hrs
Condition:	Good	Length:	1830m
Surface Description:	Grooved Asphalt	Width:	46m
Rubber Deposits:	Heavy		
Weather:	Fine, sunny		

Run no	Dirn	Speed km/h	Distance from c/l	Self-wet	μ16	μ Centre	μ34
1	34	64	1mE	Off	0.77	0.79	0.78
2	16	130	3mE	On	0.55*	0.68	0.69
3	34	130	4mE	On	0.66	0.67	0.60*
4	16	130	3mW	On	0.59*	0.70	0.71
5	34	130	4mW	On	0.73	0.67	0.59*
6	16	130	10mW	On	0.60*	0.68	0.69
7	34	32	2mW	On	-	-	0.73
8	16	64	4mW	On	-	0.74	-
9	34	97	5mW	On	-	0.71	-
10	16	64	6mE	On full	0.70*	0.74	0.74*
11	34	64	6mW	On full	0.76*	0.76	0.75*
12	16	64	1mE	Off	0.78	0.79	0.77
13	34	130	2mE	On	0.68	0.86	0.58

Avge 64km/h dry reading (Runs 1 & 12) : 0.78

Avge UK self-wet reading (Runs 2 -5): 0.69

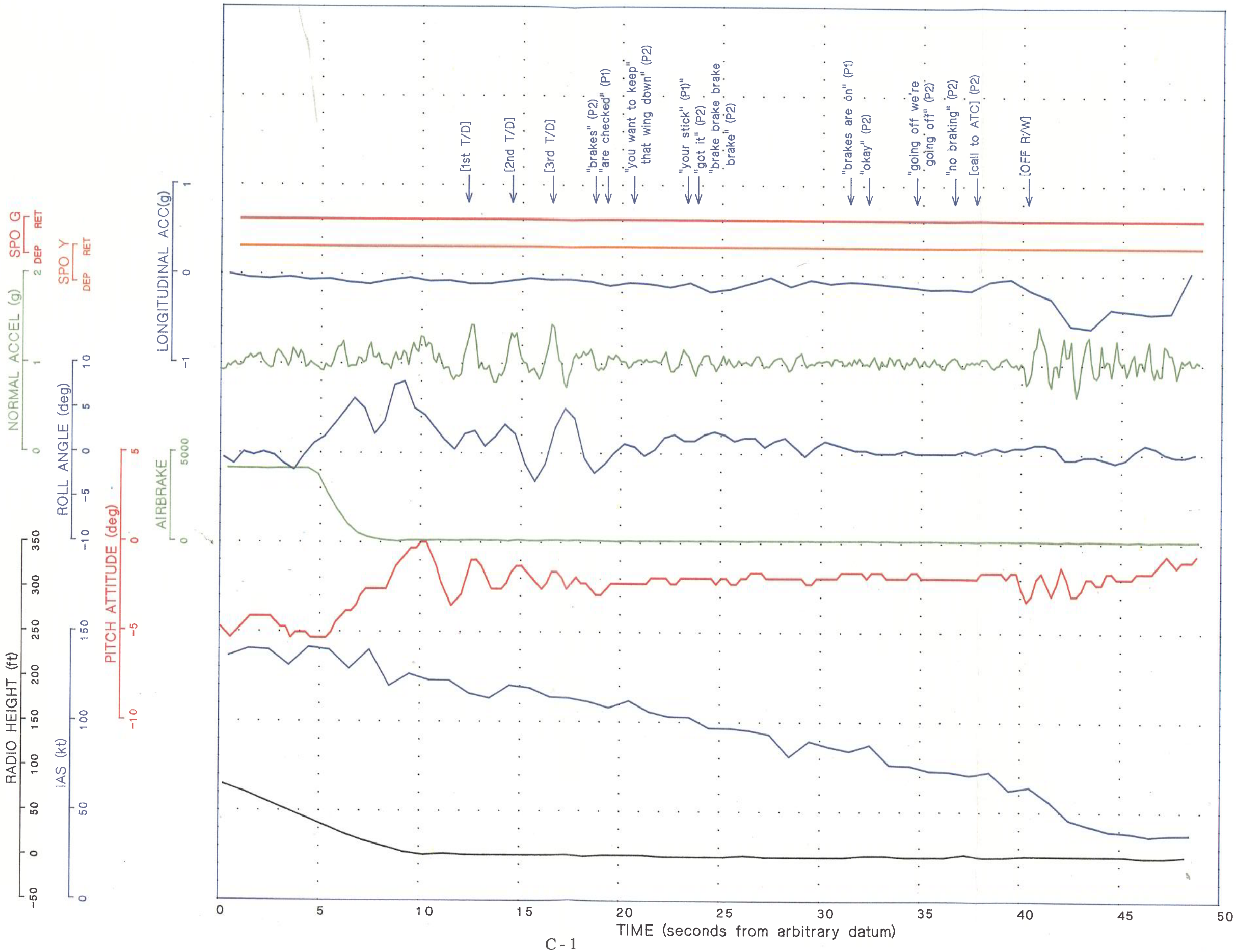
Table 1 Mu-Meter Test Results

Figure 6 Rubber deposits at runway 16 threshold

Figure 7 Rubber deposits at runway 34 threshold

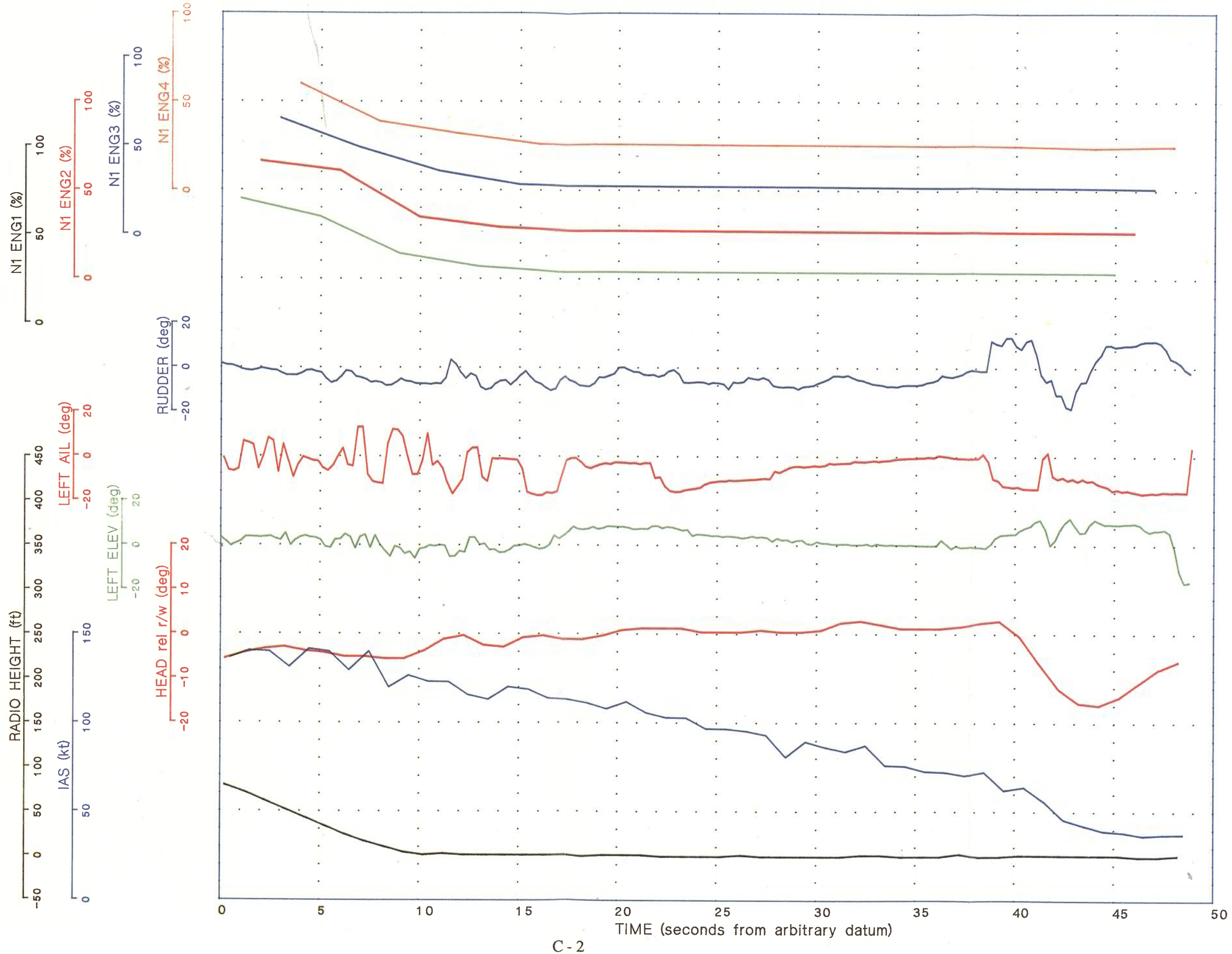
Plot 1

SELECTED DFDR PARAMETERS SYNCHRONISED WITH CVR INFORMATION

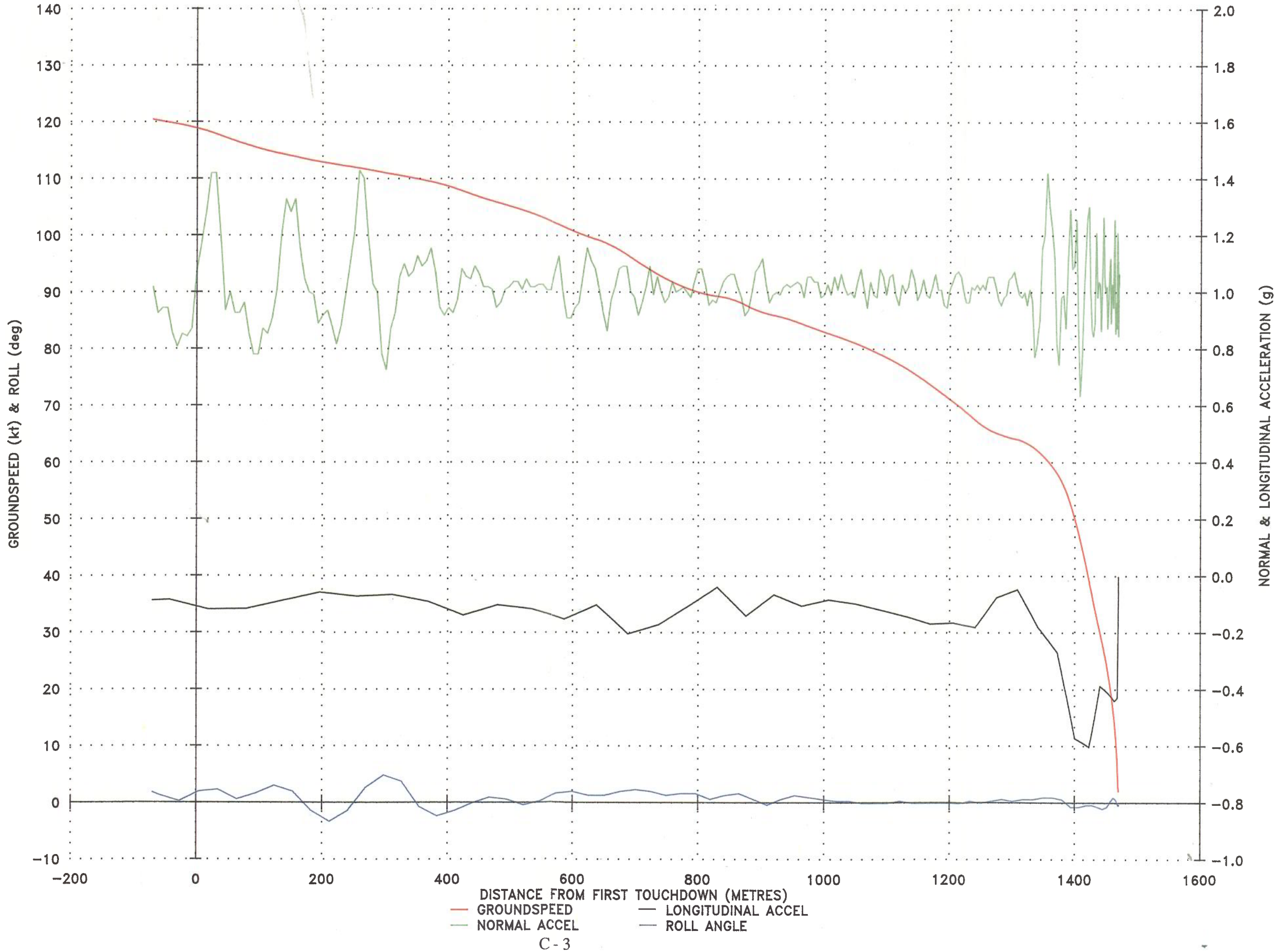


SELECTED DFDR PARAMETERS

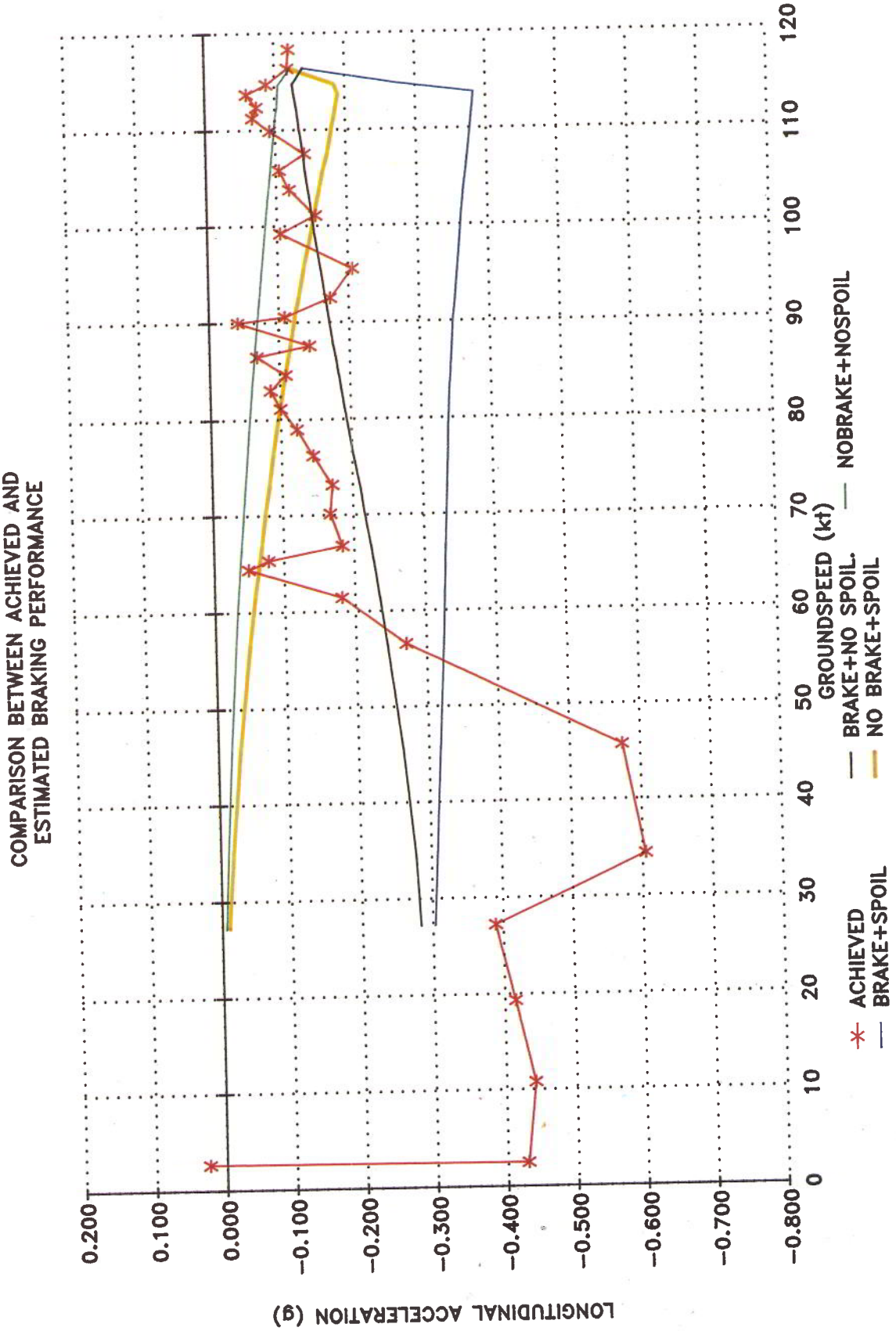
Plot 2



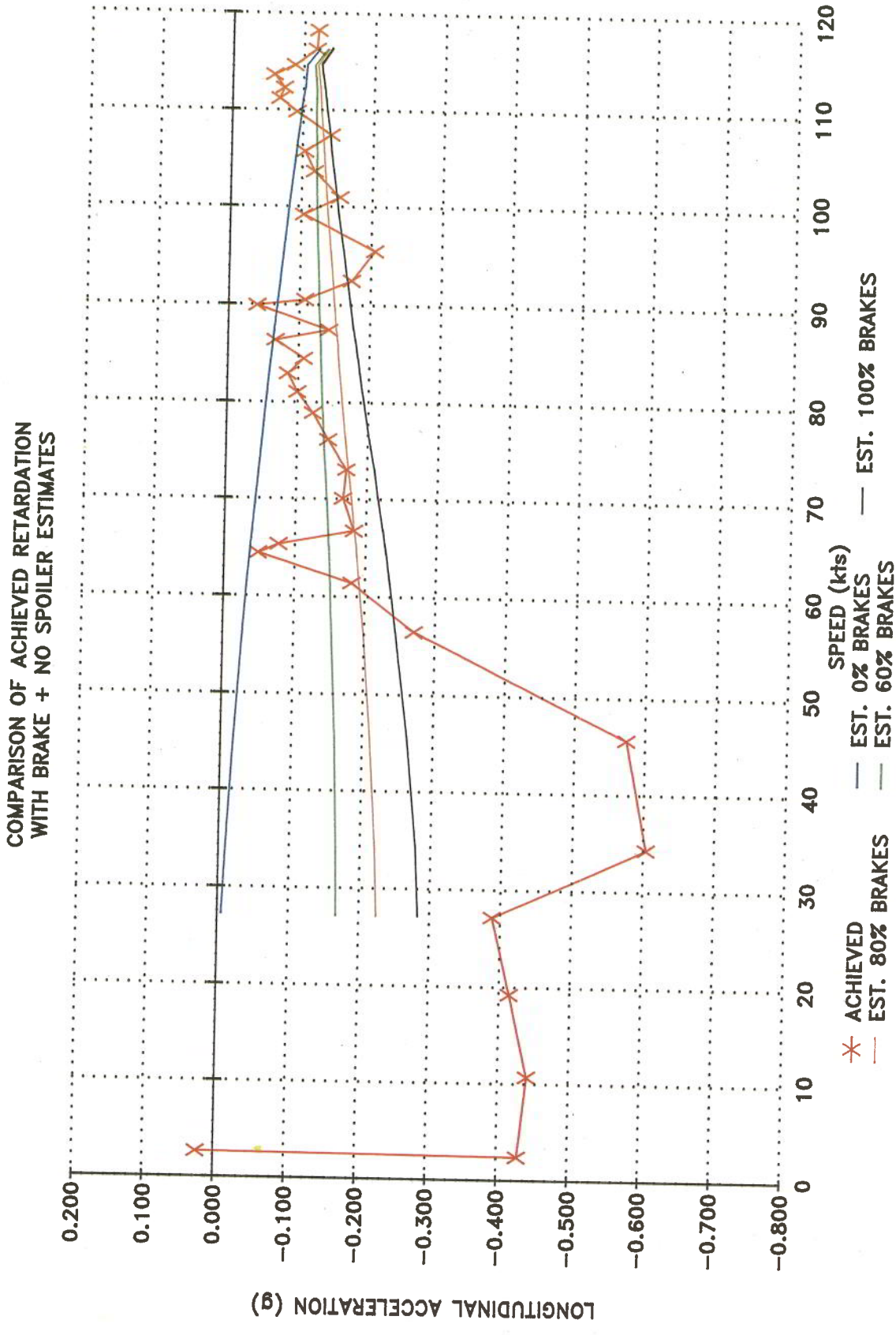
SELECTED PARAMETERS PLOTTED AGAINST
DERIVED RUNWAY POSITION

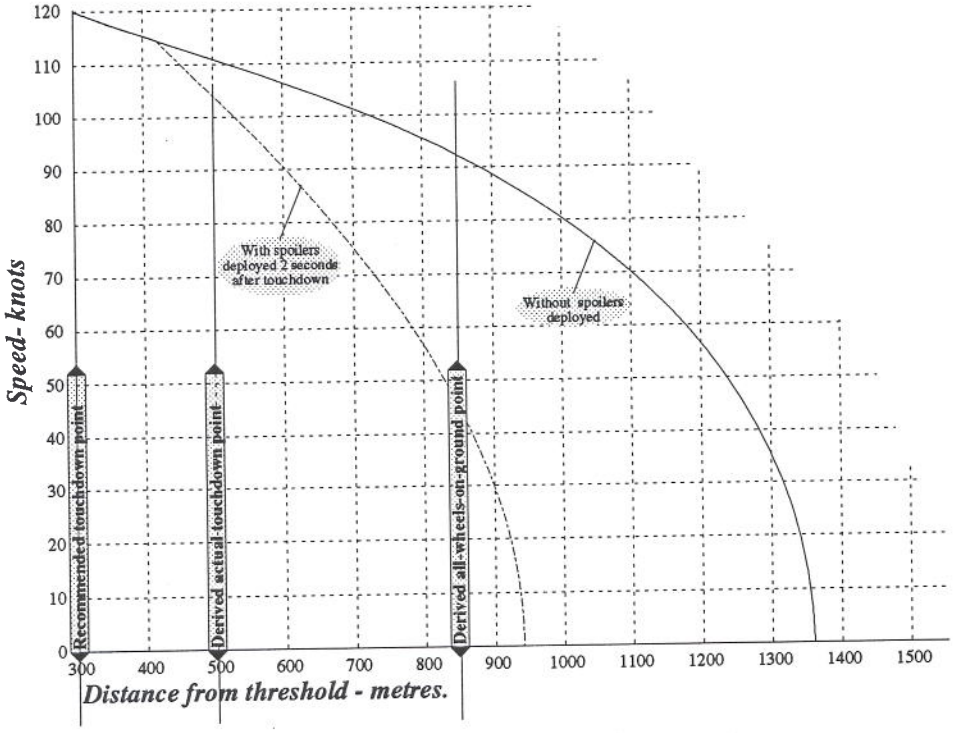


Plot 4

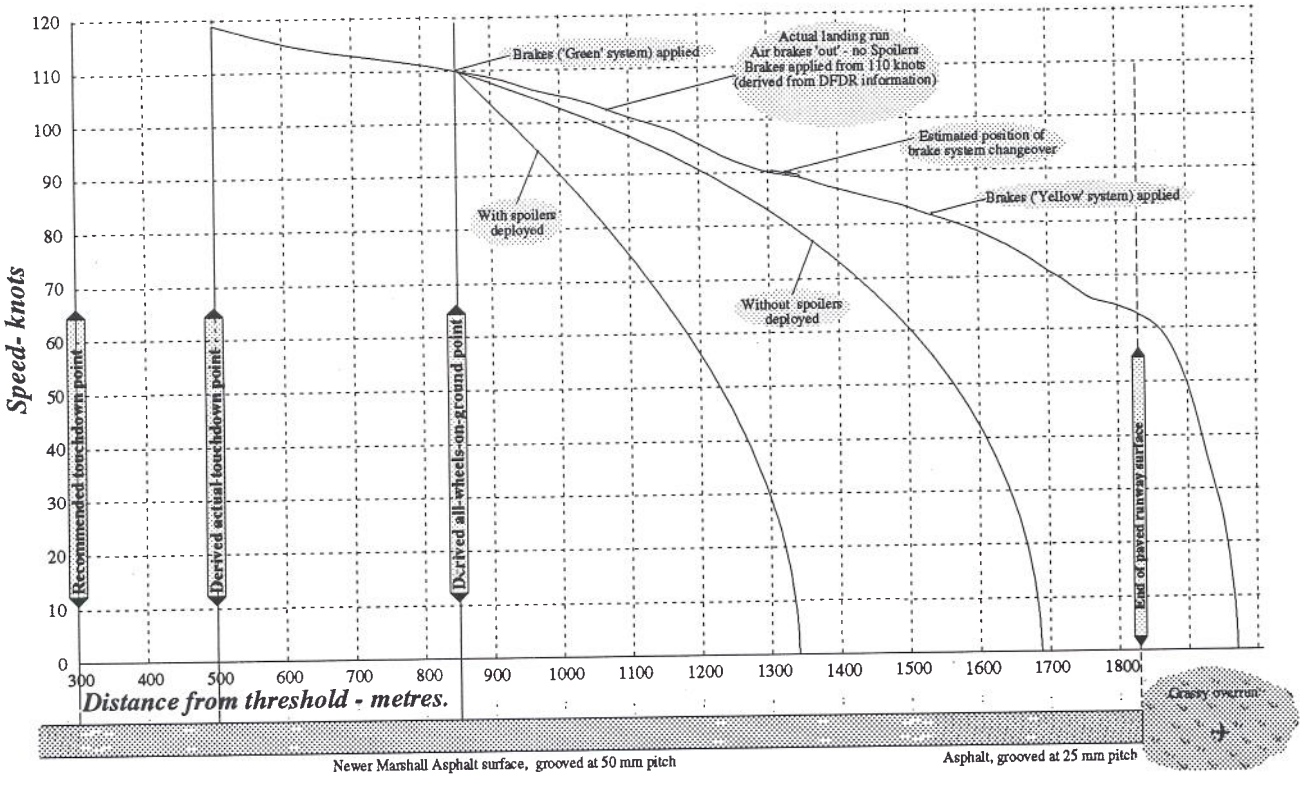

COMPARISON BETWEEN ACHIEVED AND
ESTIMATED BRAKING PERFORMANCE
LONGITUDINAL ACCELERATION (g)
0.200
0.100
0.000
-0.100
-0.200
-0.300
-0.400
-0.500
-0.600
-0.700
-0.800
0
10
20
30
40
50
60
70
80
90
100
110
120
GROUNDSPEED (kt)
ACHIEVED
BRAKE+SPOIL
BRAKE+NO SPOIL
NO BRAKE+SPOIL
NOBRAKE+NOSPOIL

Plot 5


COMPARISON OF ACHIEVED RETARDATION
WITH BRAKE + NO SPOILER ESTIMATES
LONGITUDINAL ACCELERATION (g)
0.200
0.100
0.000
-0.100
-0.200
-0.300
-0.400
-0.500
-0.600
-0.700
-0.800
0
10
20
30
40
50
60
70
80
90
100
110
120
SPEED (kts)
ACHIEVED
EST. 80% BRAKES
EST. 0% BRAKES
EST. 60% BRAKES
EST. 100% BRAKES

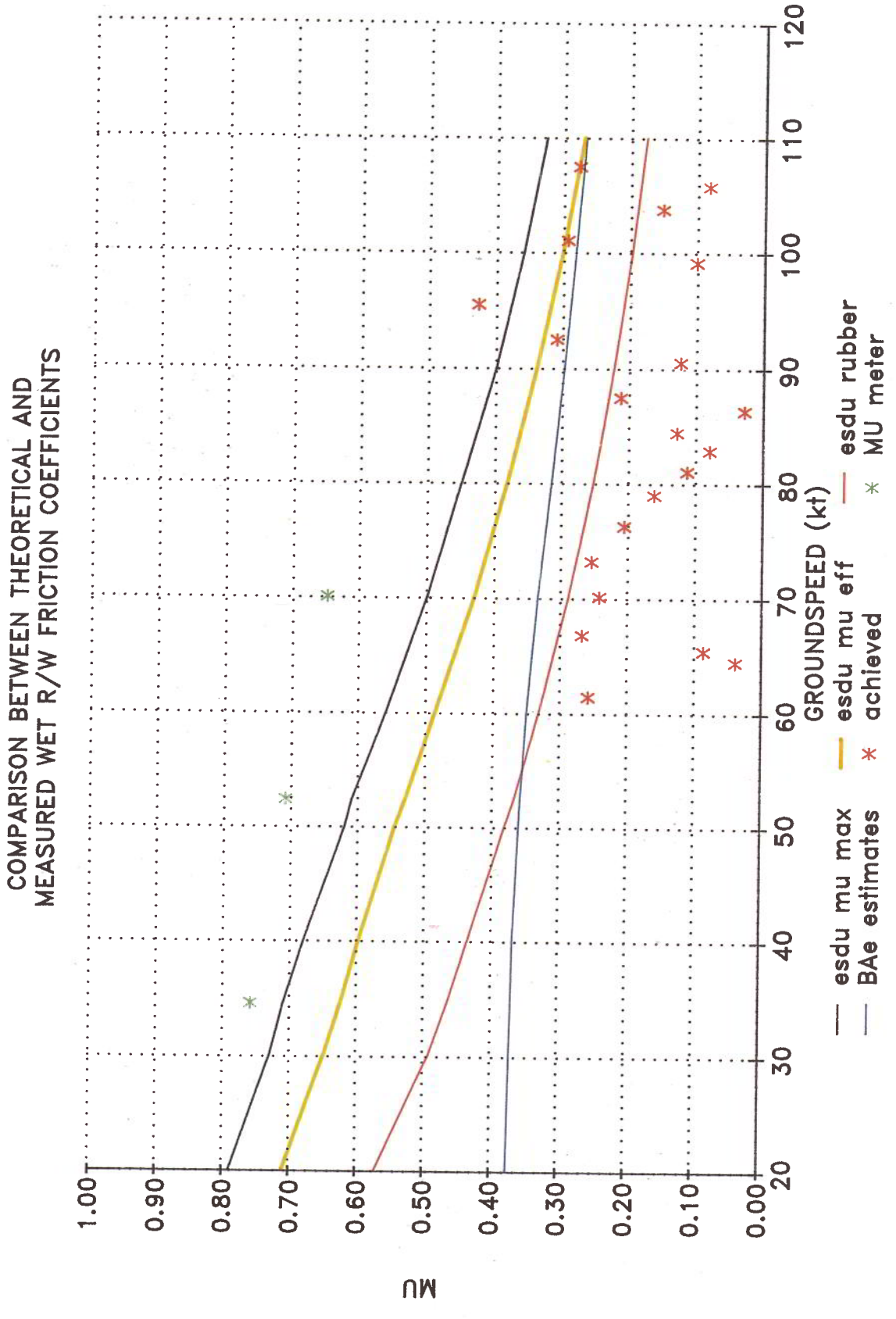


Plot 6 - Calculated landing ground roll following touchdown at 120 knots.
Air brakes fully out, wheelbrakes applied 1 second after touchdown.



Plot 7 - G-UKHP landing ground roll derived from DFDR information.
Calculated ground rolls with maximum braking applied from 110 kts,
with and without spoilers deployed, shown for comparison

Plot 8


COMPARISON BETWEEN THEORETICAL AND
MEASURED WET R/W FRICTION COEFFICIENTS
MU
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
20
30
40
50
60
70
80
90
100
110
120
GROUNDSPEED (kt)
esdu mu max
BAe estimates
esdu mu eff
achieved
esdu rubber
MU meter

Plot 9

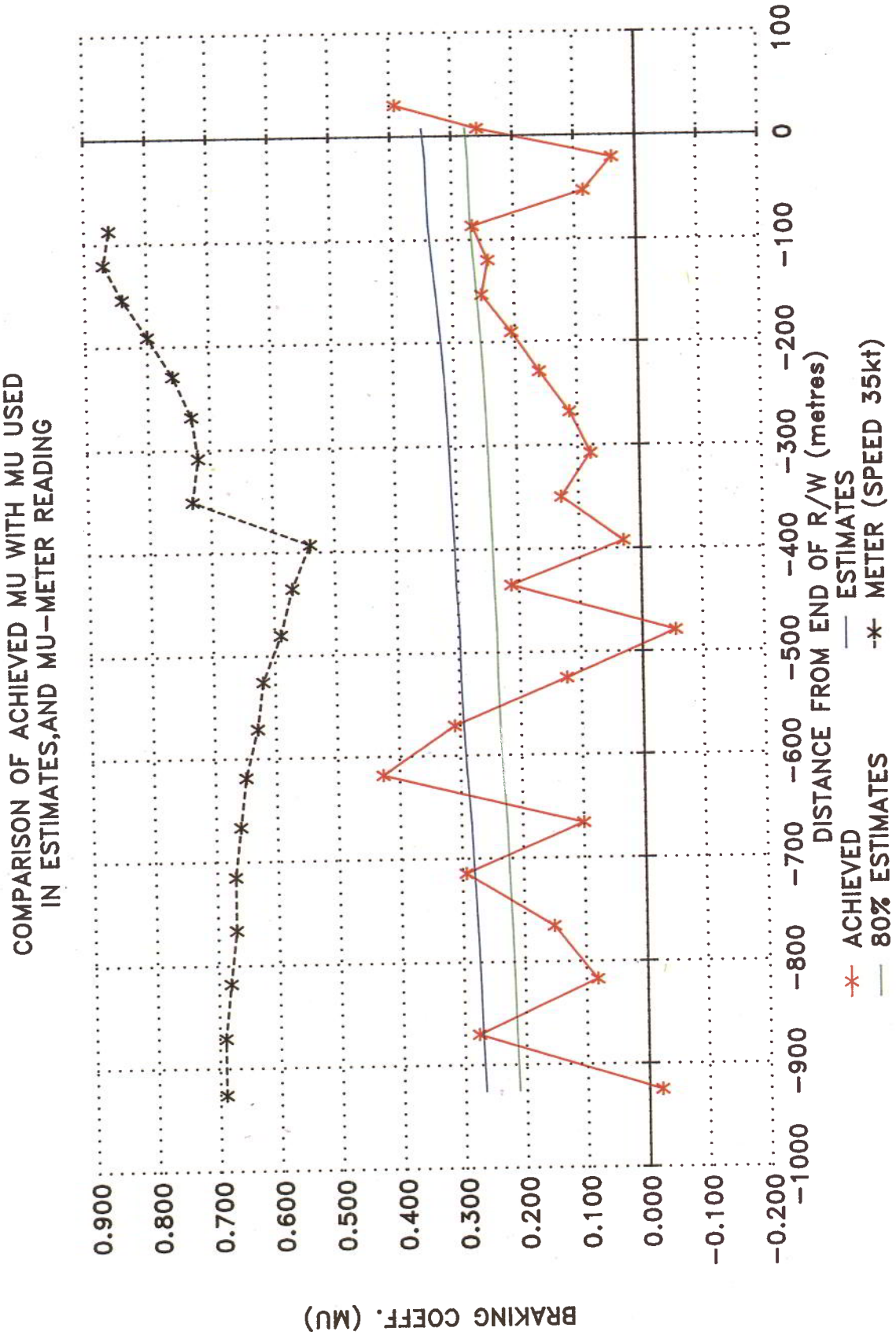

COMPARISON OF ACHIEVED MU WITH MU USED
IN ESTIMATES,AND MU-METER READING
BRAKING COEFF. (MU)
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
-0.100
-0.200
100
0
-100
-200
-300
-400
-500
-600
-700
-800
-900
-1000
DISTANCE FROM END OF R/W (metres)
ACHIEVED
80% ESTIMATES
ESTIMATES
METER (SPEED 35kt)

Table 1

Problem addressed	Bulletin	Issue date	Action or change
Lever microswitch operation	27-A-24 (M)	Aug 84	Inspection to ensure minimum overtravel of selector lever
	27-24-00321A and D	Sept 84	Modification required to satisfy conditions of SB 27-A-24
	27-30-00321E (O)	Dec 84	Required only if 24-00321A and D not sufficient
Squat logic	27-29-00485 A and B	Dec 84	Electrical change
Combined Airbrake /Spoiler Lever feel	27-31-00402A	Jan 85	Prevents loss of lever friction with wear
	27-39-00402B	Sept 85	Cure for clearance problem resulting from embodiment of last SB
	27-69-00905A	Aug 87	Increased force required to move lever through detent into 'spoiler'
	27-73-00889 A and B	Mar 88	Revised linkage, so distinct force now required to de-select spoilers
Throttle box microswitch operation	27-46-00568B	Jan 86	Fitting of means of adjustment of throttle box microswitch position
	27-63	Dec 86	Periodic inspection to ensure that no dormant microswitch failures exist
	27-61-0787A	Jan 87	Re-profiled cams fitted to prevent bending of microswitch operating arms
	27-117-01195B 27-139-01195D	Nov 90 Jan 93	Both modifications to improve microswitch operation reliability
Warning system	27-70-00913A and B	Nov 88	Introduction of glareshield warning to show when spoilers not deployed
		Nov 89	Warning bulb test and dim
	27-99-00913D 27-100-01109A	Nov 90	Change of electronics to ensure correct delays before warning

OFFICE OF
AIR ACCIDENTS
INVESTIGATION

AIRCRAFT INCIDENT

Enclosure 1

AIRCRAFT

Type	Registration
BRITISH AEROSPACE 146-200	ZK-NZB

OPERATION

Class	Purpose of flight
AIRLINE	SCHEDULED PASSENGER TRANSPORT

LOCALITY

Place	Province
QUEENSTOWN AERODROME	OTAGO

TIME: 0940

DATE: 28 APR 90

DAMAGE: MINOR

PILOT IN COMMAND

Licence	Age	Total Hours		Hours last 3 months	
		All types	On type	All Types	On Type
ATPL	41	8923	655	205	205

INJURIES

——	F	S	M	Nil
Crew				5
Passengers			1	43
Other				

CIRCUMSTANCES

The aircraft was being operated on the sector from Christchurch to Queenstown. During cruise the First Officer obtained the current weather conditions by RTF from Queenstown Flight Service. This included advice of continuous light to moderate rain, 5 octas of cloud at 5000 feet and 7 octas at 10000 feet. As a result an instrument approach to Alexandra was carried out and the aircraft then flown VFR through the Kawarau Gorge to Queenstown.

At Queenstown, Runway 05 was in use with a variable north to north-west wind reported as 320°, 10 to 14 knots. The aircraft was flown on a right hand circuit onto final at 3 nm, where the Captain took over control for landing as was standard Company procedure for that aerodrome.

The crew reported that the approach was initially high on the precision approach path indicator (PAPI) but was corrected by 500 feet. Sink was then encountered on short final, but was corrected with an application of power. A speed increase followed, but had been corrected as the aircraft crossed the runway threshold at normal height. Power reduction and normal flare led to a normal touchdown, apparently just past the "300 m" runway markers. Power was reduced to ground idle, the nosewheel was lowered and the air-brake/lift spoiler lever moved towards the lift spoiler position.

Wheel braking was commenced promptly, but it became evident to the crew that insufficient deceleration was being achieved. The First Officer assisted the Captain with brake pedal pressure, without evident further effect. 2000 psi brake system pressure applied was noted.

When it became obvious that the aircraft would not stop before the end of the runway, the Captain steered it left some 25 m to avoid a collision with the substantial concrete gateposts and strainers located 75 m along the extended centre line.

... (Cont)

InformationSource: OAAI Field Investigation

The aircraft rolled across firm grass, through the aerodrome boundary fence, across a 750 mm deep ditch, to come to rest in soft pasture 96.7 m from the runway end. Only minor damage was incurred.

The Captain ordered a cabin evacuation, with 1 L escape slide being deployed, However, as the situation was reassessed as not urgent, passengers were allowed to remain on board until boarding steps were brought up.

One passenger subsequently reported a minor neck injury.

After recovery of the aircraft and engineering inspection of the brake systems, including precautionary replacement of the electronic control unit, no fault was found. The aircraft was ferried back to base.

Subsequent manufacturer's and base engineering inspections found no fault with the aircraft braking systems.

Examination of the runway showed no marks associated with this landing. The wheelmarks across the firm grass showed clear tyre patterns with little evidence of braking and no skidding. The tyres showed no evidence of aquaplaning or locked wheel braking.

The runway surface had been wet at 0940 hours but with no standing water.
The surface was coarse sharp stone chip which would provide a high value of surface friction and facilitate drainage of surface water. A moderate camber also assisted water run-off. Rubber deposits on the surface were present but were not heavy enough to fill the chip texture.

Nine millimetres of rain fell at Queenstown between 0500 and 1000 hours, of which 2.8 mm was in the 50 minutes before this incident. This rainfall intensity ensured that the surface was wet, but was unlikely to have caused a sufficient depth of water to permit aquaplaning.

The anemograph at Queenstown recorded considerable variation of the wind, with a peak of 19 knots and direction swings between 280° and 360° magnetic at around 0940 hours. A tail component of up to 9 knots could have occurred during the landing, but this could not be verified.

The aircraft's digital flight data recorder and cockpit voice recorder were taken to the Bureau of Air Safety Investigation, Canberra, for read-out and analysis. Good quality results were obtained from both.

The final approach profile was essentially recorded as described, but airbrakes were deployed only 50% on short final, rather than 100% as normal. Shortly after touchdown, the remaining airbrake was deployed, rather than lift spoilers as normal.

... (Cont)

The lift spoilers deployed some 16 seconds after touchdown, 3 or 4 seconds before leaving the runway. During the ground roll deceleration values up to 0.3 g occurred, increasing to 0.36 g after the spoiler deployment, confirming that wheel braking had been achieved.

It was likely that the aircraft's electronic anti-skid braking system had functioned normally and the limited braking achieved was a result of reduced tyre friction on the wet surface in the absence of lift spoilers during the majority of the landing roll. The lack of braking evidence on the firm wet grass may have resulted from the sensitive response of the anti-skid system to that surface.

The distance travelled during landing was calculated from the recorded longitudinal acceleration data. This placed the touchdown at approximately 530 m from the threshold, or 230 m past the "300 m " markers and gave an overrun speed of 30 knots.

The landing distance required was calculated from the Airline Operating Manual, for the relevant conditions with a wet runway. This LDR, which included a 67% safety factor, was 1300 m. The landing distance available at Queenstown was 1342 m.

Performance data from the aircraft manufacturer showed that the ground roll distance would increase 41% from 540 m to 762 m with no lift spoilers deployed.

The manufacturer's performance data also showed that the aircraft was capable of stopping within the landing distance available if the lift spoilers failed to deploy, providing a normal touchdown distance had been achieved.

This longer roll of 762 m, with the long touchdown distance of 530 m, effectively consumed most of the distance available. The remaining 50 m may have been consumed by some unquantifiable factor such as a tailwind gust, or less than firm initial braking.

The long touchdown distance was probably a result of two factors. One was the unstabilised approach which followed the late hand over of control to the Captain, with the aircraft high on the PAPI. The power increase which followed the sink on short final allowed the aircraft to cross the threshold at normal height, but probably not descending normally to the aiming point. The other factor was the partial deployment of airbrakes.

The Airline Operating Manual required the First Officer, after touchdown, to observe lift spoiler operation and to call "No spoilers" if not selected or a malfunction had occurred. No such call was made on the incident landing.

After the incident, the Airline amended this procedure to require a positive "spoilers - yellow/green" call to confirm normal operation.

The cockpit indication of lift spoiler operation on the 200 series aircraft was a pair of green annunciators "SPLR Y" and "SPLR G". The 300 series aircraft in the fleet however, had

... (Cont)

In addition to amber "SPOILERS NOT DEPLOYED" annunciator. The operator proposed to modify the 200 series aircraft to this later standard.

The standard procedure specified for landing the BAe 146 type produced touchdown "from the 150 point to approximately 450 m. Ideally touchdown should occur in the area of the aiming point in use to the aiming point plus 150 m".

The Airline Operating Manual specified for Queenstown and Rotorua "if touchdown is not achieved by 300 m, a go-around must be initiated". This implied that the target touchdown zone should be short of the 300 m markers, or PAPI datum, so that the normal distribution of touchdowns were achieved by 300 m.

No different procedure was specified or taught for the touchdown requirement at Queenstown or Rotorua other than the accurate maintenance of approach speeds.

This absence of a specific procedure to meet this non-standard landing requirement meant that crews were likely to either develop individual techniques of variable effectiveness, or to treat the go-around requirement as advisory only.

The procedure specified for landing on wet runways emphasized a firm touchdown at the aiming point, selection of ground idle thrust and lift spoilers without delay and prompt wheel braking at a moderate to firm level.

Although Queenstown Flight Service had advised NZB of continuous light to moderate rain, no specific information was passed that the runway was wet. While this should have been self-evident, such specific advice might have reinforced the crew's perception of what to expect on landing.

Queenstown Aerodrome lies in the lee of adjacent high terrain in north to north-west winds. The ensuing turbulent flow typically produces variable surface wind directions across the runway. An additional remote reading anemometer sited at the eastern boundary of the aerodrome would provide useful information for the captains of landing aircraft.

The presence on the extended centreline at Queenstown of the ditch and substantial concrete gateposts and strainers both presented unnecessary extra hazards for any aircraft suffering an overrun and had the potential to turn this incident into a serious accident.

As a result of the investigation of this incident it was recommended that:

The Manager: Queenstown-Lakes District Council Airport Corporation

- Remove the present substantial concrete gateposts on the extended runway centreline of runway 05 and replace them with a lightweight frangible structure to reduce the hazard to over-running aircraft,

- Fill in the drainage ditch which the aircraft passed through,

... (Cont)

The Manager: Airways Corporation

- Research the most appropriate location for the sensors for a system of anemometer to provide an accurate comparison of wind conditions at either end of runway 05/23 and install such a system as soon as practicable.

The General Manager of the Air Transport Division of the Ministry of Transport

- Implement a credible system of Mu-meter monitoring on a regular basis, of runway surfaces at all aerodromes used for air transport operation and with a runway length of 1200 m or more as per ICAO recommendation in Annex 14 to the Convention on International Civil Aviation paragraph 2.6.1 or otherwise,

- Revise immediately the information in the NZAIP Planning Manua; Page AGA 0-29 section 9 and in Civil Aviation Information Circulars GEN A19 and A20,

- Review the appropriateness of the company Operations Manual landing procedure which requires a deviation from the PAPI glide path indication to achieve the required touchdown point versus the manufacturers claim that the necessary landing distance safely margins can be achieved by maintaining the standard approach technique, and

- Ensure that a standard approach path monitoring technique is prescribed, taught and adhered to.

The General Manager, Ansett New Zealand

- Ensure that a standard approach path monitoring technique is prescribed, taught and adhered to,

- Ensure that the pilot who will do the landing takes over in sufficient time to accustom himself to the prevailing conditions, and

- Ensure that the pilot not flying has a responsibility during any approach to land to monitor the aircraft's speed, height, distance to go and configuration of air brakes and spoilers to advise the pilot flying if any of these factors are not within the limits.

The Manager of the Airways Corporation has since advised that the Corporation will implement in full the recommendation made to them.

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