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ABBREVIATIONS USED IN THIS REPORT

AAIB	Aircraft Accident Investigation Board
AFIS	Aerodrome Flight Information Service
AMSL	Above Mean Sea Level
ARO	Airport Reporting Office
ATPL	Airline Transport Pilot's Licence
CAA	Civil Aviation Administration
CSI	Combined Speed Indicator
CVR	Cockpit Voice Recorder
DARU	Data Acquisition and Recorder Unit
DME	Distance Measuring Equipment
EKVG	Vagar Airport
FDR	Flight Data Recorder
FOM	Flight Operation Manual
FP	Flying Pilot
FR	Frame
FT	Feet
HCL	Havarikommissionen for Civil Luftfart
IMC	Instrument Meteorological Conditions
KT(S)	Knot(s)
LB(S)	Pound(s)
LLZ	Localizer
MDA	Minimum Descent Altitude
METAR	Aviation routine weather report
MHZ	Megahertz
MM	Middle Marker
mm	Millimetre
MPH	Statute miles per hour
NDB	Non-Directional Beacon
NFP	Non Flying Pilot
NM	Nautical Miles
OM	Outer Marker
PAPI	Precision Approach Path Indicator
PFT	Periodical Flight Training
P-i-C	Pilot-in-Command
PSI	Pounds per Square Inch
RH	Radio Height
RWY	Runway
SEC	Seconds
TAF	Aerodrome Forecast
UTC	Co-ordinated Universal Time
V_{REF}	Landing Reference Speed

REPORT ON THE ACCIDENT TO BAe 146-200A OY-CRG AT POSITION 620351N 071626W, THE FAROE ISLANDS.

Operator:		P/F Atlantic Airways, the Faroe Islands
Aircraft:	*Type and model:*	British Aerospace BAe 146-200A
	Nationality:	Danish
	Registration:	OY-CRG
Place of Accident:		Vagar Airport, the Faroe Islands
		Latitude: 620351 North
		Longitude: 071626 West
Date and Time:		2 August 1989 at 1827 hours

SYNOPSIS

The accident was notified to the Aircraft Accident Investigation Board (AAIB) on 2 August 1989 at approximately 1920 hours. As the reported circumstances did not necessarily call for the AAIB's "go team", it was decided to carry out the investigation on the basis of interviews with the crew, receipt of mandatory and requested reports, and factual information derived from the flight data recorder (FDR) and the cockpit voice recorder (CVR).
The accident occurred when the aircraft, which was on a scheduled passenger flight from Copenhagen to Vagar, after landing on runway 13, was turned on to the high speed turn-off area where it collided with rising terrain. The aircraft was landed in heavy rain on a wet runway. Touchdown took place 430-450 metres down the 1250 metres long runway with a speed of 121.68 knots (FDR read-out) or approximately 15 knots above the touchdown speed estimated by the aircraft manufacturer. As the reduced tyre friction on the wet surface produced insufficient retardation to stop the aircraft it was deliberately turned on to the high speed turn-off area to prevent overrunning the runway.
The passengers, who disembarked the aircraft within about 30 seconds, sustained no injuries. The aircraft was substantially damaged.

The investigation identified the following causal factors:

1. The approach to runway 13, which was never stabilized, was carried out with an excessive high indicated airspeed and without compliance with the mandatory call outs stated in the FOM.

2. The aircraft touched down on the wet runway with an indicated airspeed of 121.68 knots (15 knots above the touchdown speed estimated by the aircraft manufacturer, for the given mass) and between 430 and 450 metres from the beginning of the threshold.

3. The long touchdown distance was probably a result of two factors. One was the unstabilized approach, the other was the co-pilots overruling of the captains decision to arrest the approach and perform a go-around.

All times in this report are UTC.

1 FACTUAL INFORMATION

1.1 History of the flight

1.1.1 FLI 453 departed Copenhagen Airport, Kastrup at 1137 hours on a scheduled domestic passenger flight to Vagar Airport, the Faroe Islands. Approaching Vagar at approximately 1445 hours the weather conditions were below minima (300 ft/ 2 kilometres) and FLI 453 had to divert to Bergen Airport, Norway, where it arrived at 1522 hours.

1.1.2 In Bergen the cockpit crew visited the Airport Reporting Office (ARO) where they confirmed the flight plan for the return flight to Vagar. The flight plan had initially been filed during the flight from Vagar to Bergen. At the ARO the crew was issued the latest (1550 hours) METAR from Vagar. The report indicated a visibility of 100 metres in fog and a vertical visibility of zero. As a telephone conversation between the co-pilot and Vagar at 1558 hours confirmed that the weather still was below minima (TAF 1500-2100 hours), the flight was postponed. At 1635 hours the co-pilot made a new phone call to Vagar, as the 1620 hours METAR now gave a visibility of 200 metres in fog and a vertical visibility of 100 ft. He was told that there had been an improvement and that the present visibility was 5 kilometres and that the ceiling was 300-400 ft. As the AFIS-operator added information about the visibility being 2 kilometres to the east and 7-8 kilometres to the west, the co-pilot replied "as long as we have 2 kilometres and 300 ft, we are happy". The remark from the AFIS-operator was "yes, we have 400 ft".

1.1.3 FLI 453 departed Bergen at 1702 hours. The cockpit crew consisted of two captains. One was the Director of Flight Operations and the other one a line captain. The line captain was Pilot-in-Command (P-i-C) and was occupying the left-hand seat acting as flying pilot (FP) and the Director of Flight Operations was occupying the right hand seat doing the co-pilots duties (NFP). At 1746 hours the co-pilot radioed to Vagar, that they were estimating "NL" (NDB) in about 30 minutes. As they received information about the visibility being 3000 metres in rain and the ceiling being 700 ft, they replied that they would report again on final approach. At 1805 hours the co-pilot reported that they were established inbound (runway 31) and were leaving 7000 ft (LLZ/DME approach runway 31, refer Appendix A). Visibility and ceiling were then given as 2500 metres and 300 ft. The runway was reported clear and wet with standing water percentage 25. The wind was 240°/5 kt.
The captain has stated that a missed approach was carried out, as the aircraft's position in relation to the runway was not ideal for a landing. According to the AFIS-operator's statement to the local police, the missed approach was carried out due to visibility being below minima.
As the AFIS-operator at 1817 hours informed the crew about the visibility to the east being exactly 2 kilometres, unable to see the cloud base, and visibility to the

west being 3 kilometres, cloud base 400 ft, wind 05 knots, it was decided to make an approach to runway 13. The co-pilot radioed to the AFIS-operator, that they were able to take a 10 knots tailwind and was then told, that the wind at threshold 13 was 230°/11 kts and that threshold 31 was the same.

1.1.4 At 1823 hours the co-pilot reported "MY" (NDB) inbound (runway 13). As to the captain's statement a LLZ/DME approach (refer Appendix B) was carried out in accordance with company procedures and with the combined speed indicator (CSI) bug set at the recommended speed (V_{REF}) of 119 knots (+5 knots) corresponding to the aircraft mass. At 1.2 NM DME, or just before the minimum descent altitude (MDA) of 680 ft, the crew obtained visual contact with the runway lights and the approach was continued with reference to the lights and to the PAPI. During the final approach phase, the captain had his doubt about a possible overshoot of the marked touchdown zone (refer Appendix C); however, there was no doubt in his mind that the landing would be successful.
Air brakes were deployed between 100 ft and 50 ft above the runway. After threshold-passage the captain was, due to the heavy rain, so occupied by aiming at the proper touchdown point, that he did not notice the airspeed. The touchdown was according to the two pilots statements within the prescribed touchdown zone. Neither of the two pilots recall the touchdown speed. According to information received from British Aerospace the estimated touchdown speed for V_{REF} 114 knots is 107 knots.
Further to the captain's statement braking action was felt normal in the beginning of the landing run, but about 2/3 down the runway the speed remained unchanged although both pilots applied full pressure on the brakes. Coming close to the runway end, the captain realized that an overrun was inevitable and turned the aircraft to the right on to the high speed turn-off area (refer paragraph 1.10.3). The deceleration of the aircraft was not as expected and the captain turned the aircraft further to the right into rising terrain. Although there was no instructions or procedures for the use of the high speed turn-off area, the captain had expected that the wheels of the aircraft would have penetrated the surface as the brakes were fully depressed.
The captain has explained that with the exception of a remark from the co-pilot that they were low, which he did not agree with, the approach was normal and as planned.
The co-pilot, whose statement was in accordance with the one given by the captain, has stated that the reduced braking action was caused by dynamic aquaplaning.

1.1.5 Among the witnesses (statements taken by the local police) those positioned in the tower and on the ground have described the approach of FLI 453 to be higher, steeper and with a speed higher than normal. Two of those witnesses have stated that their immediate reaction was that it would go wrong. They have stated the touchdown point to be between the last part of the yellow marked area (refer

paragraph 1.10.2) and 45 metres beyond that area. One witness onboard the aircraft noted the touchdown point to be opposite the new hangar building (refer Appendix C).
Witnesses onboard the aircraft have described the initial braking being from hard to violent.
One witness positioned in the tower has stated that it was not possible to see the aircraft after it came to a stop due to patches of low clouds hanging down the hill side. Another witness positioned on the ground who drove to the aircraft after it came to a stop has stated that he could not see the aircraft before he was within a distance of about 600 metres.

1.1.6 The accident occurred in daylight at 1827 hours at 620351 North, 071626 West at an elevation of about 280 ft AMSL in instrument meteorological conditions (IMC).

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	0	0	0
Serious	0	0	0
Minor/None	2/4	46	-

1.3 Damage to aircraft

The aircraft received substantial damage.

1.4 Other damage

None.

1.5 Personnel information

1.5.1 *Pilot-in-Command*

1.5.1.1 Licence, ratings and mandatory checks

The captain - aged 34 - was the holder of a valid Airline Transport Pilot's Licence (ATPL). Type rating was issued 13 July 1989. Last PFT (simulator) 15 March 1989.

1.5.1.2 Medical requirements

The captain was last medically examined on 3 July 1989 without remarks.

1.5.1.3 Flying Experience

	Last 24 hours	Last 90 days	Total
All types	5	220	5938
This type	5	216	840
As captain this type	5	150	190

1.5.1.4 Duty and rest period

His duty time before the occurrence was 8 hours and his rest period before duty was 50 hours.

1.5.2 *Co-pilot*

1.5.2.1 Licence, ratings and mandatory checks

The co-pilot - aged 53 - was the holder of a valid Airline Transport Pilot's Licence (ATPL). Type rating was issued 11 March 1988. Last PFT (simulator) 14 March 1989.

1.5.2.2 Medical requirements

The co-pilot was last medically examined on 17 April 1989 without remarks, except that suitable glasses for near vision had to be available during flight.

1.5.2.3 Flying Experience

	Last 24 hours	Last 90 days	Total
All types	5	155	17038
This type	5	144	983

1.5.2.4 Duty and rest period

His duty time before the occurrence was 8 hours and his rest period before duty was 41 hours.

1.6 Aircraft information

1.6.1 *General information*

Manufacturer:	British Aerospace Hatfield, England
Type:	BAe 146-200A
Year of construction:	1987
Airframe serial number:	E 2075
Registered owner:	P/F Atlantic Airways The Faroe Islands
Certificate of Airworthiness:	No. 2337
Total airframe hours:	4611
Engines:	4 x AVCO Lycoming ALF 502 R5

1.6.2 *General description*

The BAe 146 has a tricycle landing gear with twin wheels on each landing gear leg. Each mainwheel incorporates a carbon multi-disc hydraulically operated wheel brake assembly with a duplicated anti-skid system that operates when the aircraft speed is above 50 knots and remains operational until the drop out speed of approximately 15 knots is attained. The brakes may be controlled manually, with or without the anti-skid system. The mainwheel tyres were of type: Dunlop CR-4, 39x13, type VII, 22 plyrating, load 24600 lbs, 190 mph, pressure 140 psi. The nosewheel tyres were of type: Dunlop CR-4, 24x7.7, type VII, 14 plyrating, load 8200 lbs, 190 mph, pressure 115 psi.
There are four lift spoilers on each wing; three lift spoilers and one roll spoiler, all hydraulically powered. The lift spoilers are for ground operation only and are selected by the combined air brake/lift spoiler selector lever. Lift spoiler deployment is conditional upon three of the four thrust levers being below flight idle and two of the three landing gear oleos being compressed. The yellow spoilers (roll spoiler and the inboard lift spoilers) deploy immediately on compression of both main oleos or one main oleo and the nose oleo. The green spoilers (the two remaining adjacent lift spoilers) deploy after 1.5 seconds of the main oleo compression has been sensed. Nose oleo compression does not affect green spoilers deployment.

1.10.3 Each runway has a high speed turn-off area. The high speed turn-off area for runway 13 curves off to the right of the runway heading by approximately 17° beginning 1080 metres down the runway. Except for the first triangular part of the high speed turn-off area, which is covered by asphalt, the area is covered with gravel over a length of 150 metres. The thickness of the layer of gravel is 15 cm gradually rising to 35 cm.

1.10.4 Precision Approach Path Indicators (PAPI) are located at each runway. The slope to runway 13 being 3.15° with a nominal height at threshold of 65 ft.
The following restriction is placed on PAPI runway 13:
During approach in the fiord sufficient terrain clearance is provided only when flying close to the LLZ-course.

1.10.5 The approach light system to runway 13 consist of white high intensity lights for a length of 412 metres. Additionally, sequence flashing lights have been established at approximately 440 metres, 620 metres and 900 metres from threshold runway 13.
The runway lighting consist of adjustable high and low intensity white edge lights, green threshold lights and red runway end lights.
There are no centreline lights and no touchdown zone lights.

1.11 Flight recorders

1.11.1 Flight Data Recorder

The aircraft was equipped with a Plessey combined data acquisition and recorder unit (DARU), model PV1584J, serial no. FB 3524. After the accident the DARU was brought to Plessey Avionics Product Support Group in England where a replay of selected parameters from the accident landing and from the previous landing at Vagar runway 13 was obtained.

1.11.2 Read outs of the last 40 seconds before touchdown and a read out from touchdown until the aircraft came to a full stop (both flights) are shown at Appendix D1-D3.
Before the events shown at Appendix A, the aircraft was established on the localizer to runway 13. The heading trace shows that the aircraft maintained a fairly constant heading during the approach and during the ground roll.
Calculations of the FDR data show that the aircraft touched down with a speed of 121.68 knots and that the lift spoilers were fully deployed at a maximum of 3 seconds after touchdown. 13-14 seconds after touchdown or after a landing roll of 587-624 metres, with a recorded speed of 74-70.9 knots, the aircraft commenced the right turn on to the high speed turn-off area.

1.11.3 Cockpit Voice Recorder

The aircraft was fitted with a Fairchild Cockpit Voice Recorder part no. 93 A 100-30 model A 100 serial no. 53842.
A replay and a transcript of the radio correspondance between Vagar AFIS and FLI 453 and intercommunication between the captain and the co-pilot was made at the AAIB's facilities.
According to the read out the following conversation between the captain and the co-pilot took place within the last 32 seconds before touchdown (as the conversation mainly has been in the Danish language an unauthorized translation has been made):

time	position	conversation as recorded	English version
1826:53	co-pilot	så er lysene der...	here we have the lights
1827:03	co-pilot	now it's too low	
1827:06	co-pilot	low	
1827:10	co-pilot	okay	
1827:11	co-pilot	ikke for meget - ikke for meget pitch	not too much - not too much pitch
1827:13		minimum - minimum (audio alerts)	
1827:16	captain	det er svært du	its difficult
1827:17	co-pilot	ja	yes
1827:18	captain	det er for højt det der	this is too high
1827:19	co-pilot	nej det	no
1827:20	captain	pull up	
1827:21	co-pilot	nej - nej	no, no
1827:22		(sound like throttles moved to idle)	
1827:23	co-pilot	hold den roligt .... du	keep it steady
1827:25		(sound of touchdown)	
1827:26	co-pilot	åh, vi klarer den nok	we will make it
1827:28	co-pilot	max braking	
1827:30	captain	max braking - cut one engine	
1827:32	co-pilot	nej - nej	no - no
1827:34	captain	det klarer vi # ikke, du	# we will not make it

expletive deleted

1.12 Wreckage and impact information

1.12.1 *The accident site*

The surveying made by the local police shows that the aircraft left the runway (crossed the side strip marking with the left undercarriage) 105 metres from the

closest end of the threshold marking for runway 31. The aircraft had continued into the high speed turn-off area and had come to a stop on a heading of 218°. The nosewheel and the mainwheels had dug into soft rising terrain.

1.12.2 *Damage to the aircraft*

Damage was confined to vestibule keel skin FR 14 skin joint to FR 19 skin joint, and to centre fuselage keel skin FR 19 skin joint to FR 23 skin joint, to right and left side nose skin, left side keel skin, no. 1 engine cowling and left main landing gear.

1.12.3 *CAA inspection*

On 10 August 1989 two inspectors from the Civil Aviation Administration (CAA) arrived at Vagar. The objective of their visit was to investigate into the aircraft brake system, air brakes and lift spoilers.
Inspection of the tyres showed excessive wear on the shoulder of the left inner mainwheel. All tyres had typical flint cuts from the broken stones covering the high speed turn-off area. There were no signs of aquaplaning on the tyres (confirmed by Dunlop representative).
No sign of excessive heating of the brakes was observed.
A function test of the anti-skid braking system and the emergency braking system did not reveal any malfunction. All values were within limits.
No signs of leakage of hydraulic fluids from braking units or tubes in the wheel wells were present.
One of the inspectors noted on a later visit (17 August 1989) that the adjustment for the squat switch sensors on the outer main landing gears were above limits with respectively 1/4 inch and 3/8 inch. As the sensors for each system is series connected and the last activated sensor will cause deployment of the lift spoilers for that system, the inspector concluded in his report, that the misadjustment could have caused a delay in centre/outer lift spoilers.

1.13 Medical and pathological information

Not applicable.

1.14 Fire

There was no fire.

1.15 Survival aspects

According to the read out of the CVR the captain gave the order to disembark the aircraft to the left at 1827:58 hours. The crew have stated that the evacuation

was successfully carried out via the emergency evacuation slide system and complied with in about 30 seconds. There were no injuries to either the passengers or the crew.

1.16 Test and research

None.

1.17 Additional information

1.17.1 Operation of the wheel braking system

As mentioned in **paragraph 1.6 Aircraft information** each mainwheel incorporates a carbon multi-disc hydraulically operated wheelbrake assembly with duplicated anti-skid system.
When direct (non anti-skid) braking is in operation, the applied wheelbrake pressure is simply related to the force which the pilot exerts upon the brake pedal. If the wheel braking action which is generated in this mode of operation is too great for the conditions, the wheel will skid.
Skidding is sensed on the individual wheels by comparing the actual wheel deceleration, as sensed from rate of change of wheel speed, with a predetermined rate. When the anti-skid system is selected, each anti-skid control valve modulates the hydraulic pressure which the pilot has applied to the braking system via his brake pedals. If the applied pressure is high enough and the system has sensed that an individual wheel has started skidding, that anti-skid valve will instantly release much of the pressure on that particular brake so that the wheel stops skidding. It will then allow the hydraulic pressure to built up, at a controlled rate, until the wheel momentarily skids again. It will then reduce pressure, but at a lesser degree than before, until it senses that skidding has stopped and then starts to increase pressure until a momentary skid is again induced.
During the iterative process the braking action must, of necessity, be less than the optimum achievable for a finite time. Whilst working towards the optimum braking for the conditions, the system logic assumes that the potential friction force available, between the tyre and the runway, is constant but must also allow for the fact that it may change. In thus attempting to provide that pressure which will give the best braking, the system strives to achieve more braking by increasing the applied pressure, at a controlled rate. Thus if the friction available between the tyres and the runway suddenly improves, the brake pressure will continue to increase at this rate until a skid is sensed, at which point the controller has to re-enter the iterative process, reducing brake pressure.
Thus, the more varied the friction available, the more the anti-skid system will apparently reduce the braking effort available. However, it is optimised to still give the best braking performance achievable under these adverse conditions.

1.17.2 As mentioned in **1.1 History of the flight** the captain has stated that the deceleration in the high speed turn-off area was not as expected. Although no instructions or procedures were available for the use of the area he had expected that the wheels of the aircraft would have penetrated the surface as the brakes were fully depressed.

As a consequence of an incident to a BAe 146 on Vagar on 9. December 1986 (HCL 71/86-4-903), where the aircraft, due to deceleration problems during landing, was turned into the high speed turn-off area with a speed of 68 knots the operating airline forwarded its comments to their view on the sequence of events to the CAA.

The airline was of the opinion that the gravel surface did not fulfil the expectations as an emergency braking area, as the wheels of the aircraft did not penetrate the surface before they were blocked.

The airline stated that in their opinion there was no doubt that the blocking of the wheels in the high speed turn-off area caused the wheels to penetrate the surface of the gravel thereby improving the braking action, which prevented total damage to the aircraft.

The airline recommended that the gravel should be replaced by rolling stones.

1.17.3 Excerpts from Atlantic Airways Flight Operation Manual (FOM)

1.17.3.1 *7.7.9 Stabilized Approach*

An approach is stabilized when the aircraft is lined up with the runway and flown at the desired approach speed in the landing configuration maintaining an acceptable rate of the descent. Only small power changes should be necessary to maintain such a stabilized approach.

All approaches except circling must be stabilized not later than approximately 500 ft RH (radio height). It is the duty of the NFP to monitor that the aircraft is stabilized on the approach and to warn the FP if stabilization has not been attained.

1.17.3.2 *7.11.5. Go-around on visual approaches or visual part of circling approaches*

The approach shall be abandoned and go-around commenced if:

- the official visibility is below the applicable minimum

- the approach is not stabilized in good time before crossing the runway threshold

- at any time during a visual approach, or after establishing visual contact for a circling-approach, required visual contact is lost.

1.17.3.3 *7.12. Second Approach*

If a go-around has been made, another approach shall only be commenced if the P-I-C has reason to believe that a second approach will lead to a successful landing.

More than two approaches shall only be made if there is indication that the conditions have considerably improved, giving greater probability of successful landing.

7.13 Call out procedures

It is of utmost importance that standard procedures are followed. Any intentional deviation from a standard procedure shall be clearly announced by FP in order to facilitate the monitoring function of NFP.

In general, internal pilot to pilot communication shall ascertain that the pilots are in full agreement regarding the progress of the flight.

However, it is important to avoid any unnecessary conversation which can distract attention.....

The following call-outs are mandatory and shall be made by the pilot specified. Call-outs marked "FP" shall normally be made by FP. If for any reason the call-out is not made by FP, the call-out shall be made by NFP.

Among the call-outs that are mandatory are the following:

CALL OUT	*BY*	*CALL INDICATES*
"APPROACH LIGHTS" "RUNWAY" PLUS DIRECTION	*NFP*	*APP. LIGHTS OR RWY IN SIGHT AND "CONTACT" NOT YET CALLED BY FP*
"CONTACT"	*FP*	*ABLE TO CONTINUE APP. BY VISUAL REFERENCE*
"HIGH SPEED"	*NFP*	*DESIRED IAS EXCEEDED BY MORE THAN 10 KT OR FINAL APP. AND THRESHOLD SPEED BY MORE 5 KT PLUS ACT. SPEED DEVIATION*
"NOT STABILIZED"	*NFP*	*A/C NOT STABILIZED ACC. TO DEFINITION IN 7.7.9 AT OR BELOW 1000 FT RH*
"NOT STABILIZED, PULL UP"	*NFP*	*SAME AS "NOT STABILIZED" BUT BELOW 500 FT RH*
"PULLING UP"	*FP*	*STARTING PULL UP*

1.17.3.5. *10.4 Standard Terminology*

In all normal and emergency situations English language shall be used.

The terminology of the checklist shall be adhered to. Thumb signs or other signs must not be used as an answer to a checklist item.....
The FP shall during all stages of operation clearly state his intentions as the flight progresses.....
All verbal orders shall receive an immediate response.

1.17.3.6 On the 22. December 1988 the CAA issued upon request from Atlantic Airways a permission to operate with a weather minima of 300 ft ceiling and 2000 metres visibility for landing at Vagar with the BAe 146 on the condition that the captain had a minimum of 100 hours as captain on BAe 146.

1.18 Useful or effective investigation techniques

None.

2 ANALYSIS

On the first approach to Vagar (runway 31) FLI 453 had to carry out a missed approach. As to the captain's as well as the co-pilot's statement the missed approach was carried out at 1817 hours due to the aircraft's misalignment with the runway. Contrary to these statements, the AFIS-operator has explained that the weather was below minima. At 1806 hours he had reported ceiling 300 ft and at 1809 hours visibility 2000 metres, both values equivalent to company minima.

After the missed approach the aircraft was set up for a new approach, this time to runway 13. According to the transcript of the radio correspondance the ceiling and visibility to the west was at 1817 hours reported as 400 ft and 3 km.
When FLI 453 at 1824 hours reported "MY" inbound, the visibility was given as unchanged, which according to the 1817 hours radio transmission was 3 km. No information about the ceiling was given.
The recorded ceiling at the time of the accident was between 250 ft and 350 ft.

The FDR data shows a rather unstable approach phase. The speed maintained was not the selected approach speed of 119 knots as stated by the captain and the co-pilot, but varied with speeds of 118-140 knots. In the approach phase, none of the mandatory calls, but the one made by the captain "pull up" was announced as stated in FOM, refer paragraph 1.17.1.4. However, this call was overruled by the co-pilot (Director of Flight Operations and Chief Pilot) and the captain was more or less ordered to keep the aircraft steady (no flare) and continue with the landing.

As to the procedures stated in the company FOM § 1.17.2.3:

> *If a go-around has been made, another approach shall only be commenced if the P-I-C has reasons to believe that a second approach will lead to a successful landing. More than two approaches shall only be made if there is indication that the conditions have considerably improved, giving greater probability of successful landing*

it is likely to assume that FLI 453 would have had to divert to another airport if this approach had not lead to a successful landing.

Although no measuring of friction coefficient will take place or no braking action will be estimated, when only water is present on a runway, pilots may assume that wheel braking may be affected by aquaplaning and appropriate operational adjustments should be considered. In such conditions a landing should only be attempted if there is an adequate distance margin over and above the normal landing distance required. At the accident flight of FLI 453 the required landing distance was 4.100 ft (1.250 metres).
On the approach that led to the accident no such appropriate operational adjustment was made. The crew were aware of rain and standing water 25% (informed by the AFIS-operator), and on the last part of the final approach the

captain was, due to heavy rain, so occupied by aiming at the proper touchdown point that he did not notice the airspeed. Therefore the crew should have expected that the runway was wet to a degree that could have some influence on the wheel braking.

Nevertheless, and presumably as a direct consequence of the co-pilot's overruling of the captain's decision to execute a pull-up, the aircraft touched down on the runway at about 430-450 metres beyond the beginning of the threshold or 70-90 metres beyond the touchdown point if the PAPI had been followed. The touchdown speed was 122 knots or 15 knots above the touchdown speed that have been estimated by the aircraft manufacturer (BAe).

The average deceleration from the touchdown to the point on the runway where the turn onto the high speed turn off area was initiated has been calculated to 6.13 ft/sec/sec or 0.19 G. Presuming that deceleration had been maintained the aircraft would have continued for approximately 370 metres before it had come to a complete stop i.e it would have passed the end of the runway with a speed of approximately 43 knots. Regardless of the weather and runway conditions the aircraft would presumably had come to a complete stop within the runway boundaries if the landing (speed or touchdown point) had been executed in a more cautious manner.
With an average deceleration equal to the calculated one of the accident flight i.e. 6.13 ft/sec/sec or 0.19 G the remaining runway length would have been sufficient to bring the aircraft to a complete stop on the runway if the touchdown had been executed with the touchdown speed estimated by BAe. Even with the actual touchdown speed the average deceleration would have been sufficient to bring the aircraft to a complete stop if the touchdown point had been within 200 metres of the threshold runway 13.

Although the co-pilot has stated, that the reduced braking action was caused by dynamic aquaplaning, it is not likely to assume that the captain would have been able to turn the aircraft into the high speed turn off area with a speed of 74-71 knots if the aircraft had been in an aquaplaning situation. Further neither the CAA inspectors nor the Dunlop representative found any signs of obvious aquaplaning on the aircraft tyres.

When the aircraft entered the high speed turn-off area the deceleration was not as expected and the captain turned the aircraft into rising terrain. The captain had expected that the wheels of the aircraft would have penetrated the surface as the brakes were fully depressed. The AAIB believes that published instructions or procedures for the most advantageous use of the high speed turn-off area could have been rather beneficial for the crew.

As stated in paragraph **1.12 Wreckage and impact information** no technical defects were found at the inspection performed by the two CAA inspectors at their visit to Vagar between 10 August and 13 August 1989.
However, as the sensors for each lift spoiler system are connected in series the inspector concluded that the misadjustment could have caused a delay in centre/outer lift spoilers.
This possible delay has not been recognized during the investigation. As stated in paragraph **1.6 Aircraft information** the green spoilers will deploy after 1.5 seconds of the main oleo compression has been sensed. The recorded and calculated data from the FDR show that the lift spoilers were fully deployed at a maximum of 3 seconds after touchdown. As spoiler position is only sampled every 2 seconds the fully deployment could have taken place after 1.5 seconds, as mentioned before.

A function test of the anti-skid braking system and the emergency braking system did not reveal any malfunction and all values were within limits.

3 CONCLUSIONS

3.1 The flight crew were properly licensed, rested and medically fit to conduct the flight.

3.2 The aircraft had a valid Certificate of Airworthiness and was properly serviced and maintained for the flight.

3.3 The aircraft weight has been calculated to be 33.998 kg at the time of the accident. The centre of gravity was within limits.

3.4 The maximum landing weight for landing distance available (4.100 ft wet runway/zero wind) was 34.020 kg.

3.5 The approach to runway 13, which was never stabilized, was carried out with an excessive high indicated airspeed and without compliance with the mandatory call outs stated in the FOM. (Cause factor).

3.6 The captain's decision to arrest the approach and perform a go-around was in accordance with the procedure specified in the company FOM.

3.7 The aircraft touched down on the wet runway with an indicated airspeed of 121.68 knots (15 knots above the touchdown speed estimated by the aircraft manufacturer for the given mass) and between 430 and 450 metres from the beginning of the threshold. (Cause factor).

3.8 The long touchdown distance was probably a result of two factors. One was the unstabilized approach, the other was the co-pilot's overruling of the captain's decision to arrest the approach and perform a go-around. (Cause factor).

3.9 There were no signs of aquaplaning on the tyres.

3.10 It is likely to assume that the aircraft's anti-skid braking system has functioned normally and the limited braking achieved was a result of the reduced tyre friction on the wet surface during the landing roll.

3.11 Under the circumstances given the aircraft could not have stopped on the runway distance available.

3.12 The non-existence of published instructions or procedures for the most advantageous use of the high speed turn-off-area is believed to have been rather crucial for the sequence of events in that area.

4 SAFETY RECOMMENDATIONS

4.1 Action Taken

4.1.1 Following the accident the Director of Flight Operations, Atlantic Airways issued on 12 August 1989 the following safety actions:

When the runway is reported wet:
- The wind component shall either be zero or above at landing
- The landing shall be firm and the touchdown not later than the wide part of the yellow touchdown zone.
- During approach and below 500 ft the co-pilot shall announce any deviation from BUG ±5 knots.
- If the touchdown speed is above BUG +5 knots a go-around shall be initiated.
- Positive spoiler extension shall be confirmed by the co-pilot at touchdown. If the spoiler extension is slow (5 seconds +) a go-around shall be initiated.
- The brakes shall be tested immediately after touchdown. If braking action is reduced a go-around shall be initiated and a new approach shall not be initiated before the reason for the reduced braking action has been established.
- The wind in the touchdown zone shall be normative for landing.

4.2 Action Required

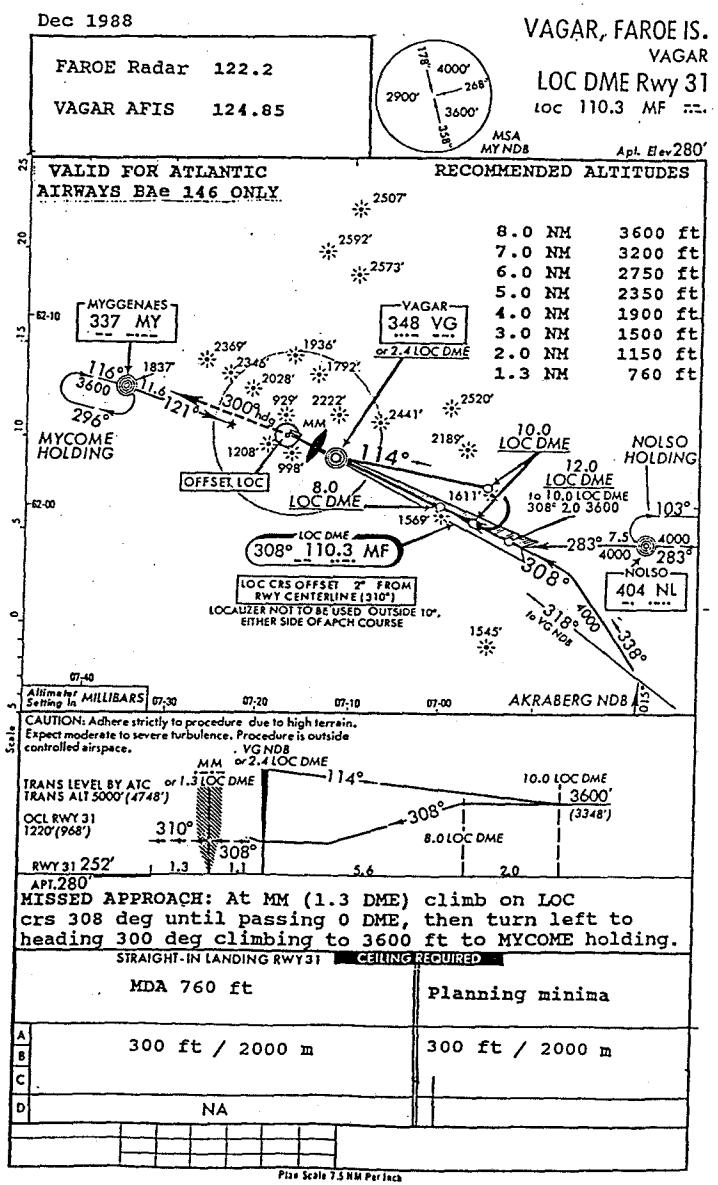
As the Aircraft Accident Investigation Board consider the non-existence of published instructions or procedures for the most advantageous use of the high speed turn-off-area to be rather crucial for the sequence of events (damage sustained to the aircraft) it shall be recommended that the Civil Aviation Administration evaluates the need for the publication of such instructions or procedures (REC-02-94).

5 APPENDICES

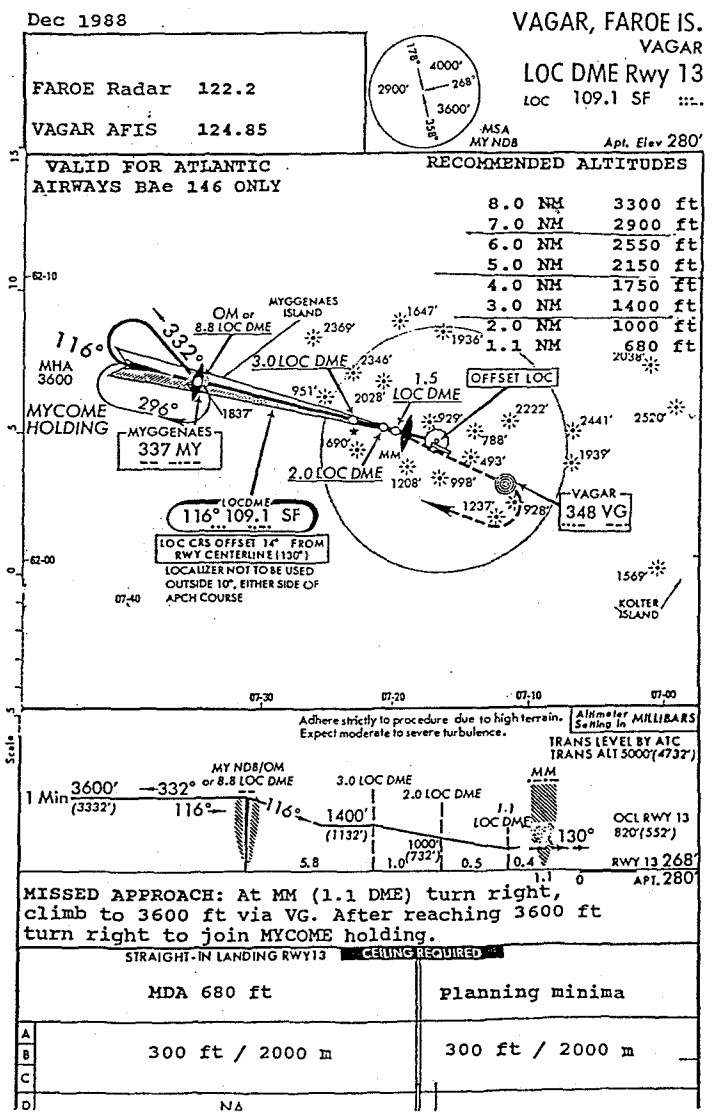
A: Instrument Approach chart Vagar, the Faroe Islands LLZ/DME RWY 31.
B: Instrument Approach chart Vagar, the Faroe Islands LLZ/DME RWY 13.
C: Vagar Airport, the Faroe Islands.
D1: Flight Data Recording (altitude vs.time/final approach).
D2: Flight Data Recording (speed vs.time/final approach).
D3: Flight Data Recording (speed vs.time/ground roll).
E: Landing reference Speed, V_{REF} (from BAe 146-200A Flight Manual).
F: Maximum landing weight for landing distance available (from BAe 146-200A Flight Manual).

AIRCRAFT ACCIDENT INVESTIGATION BOARD
JULY 1994

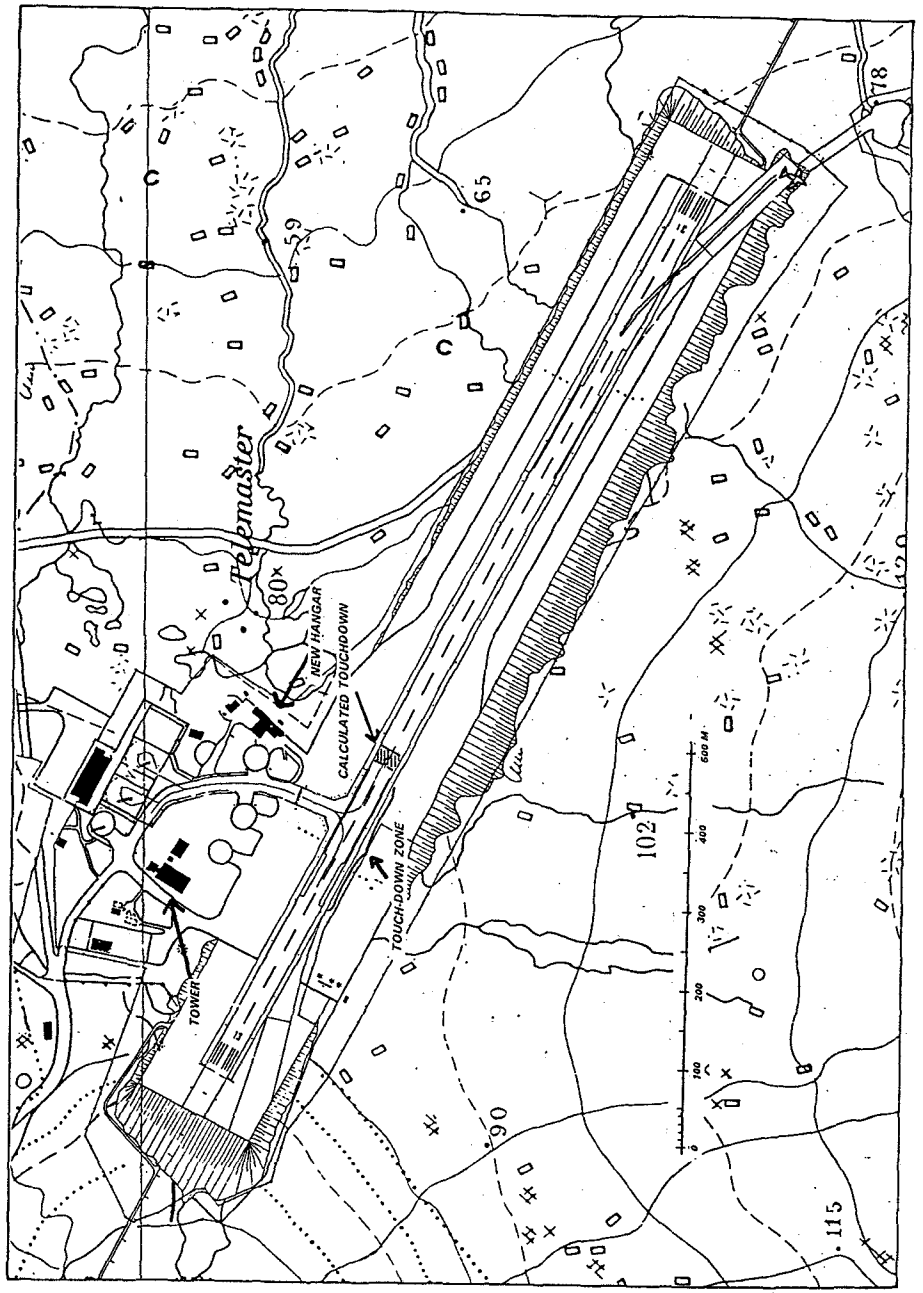
APPENDIX A



APPENDIX B

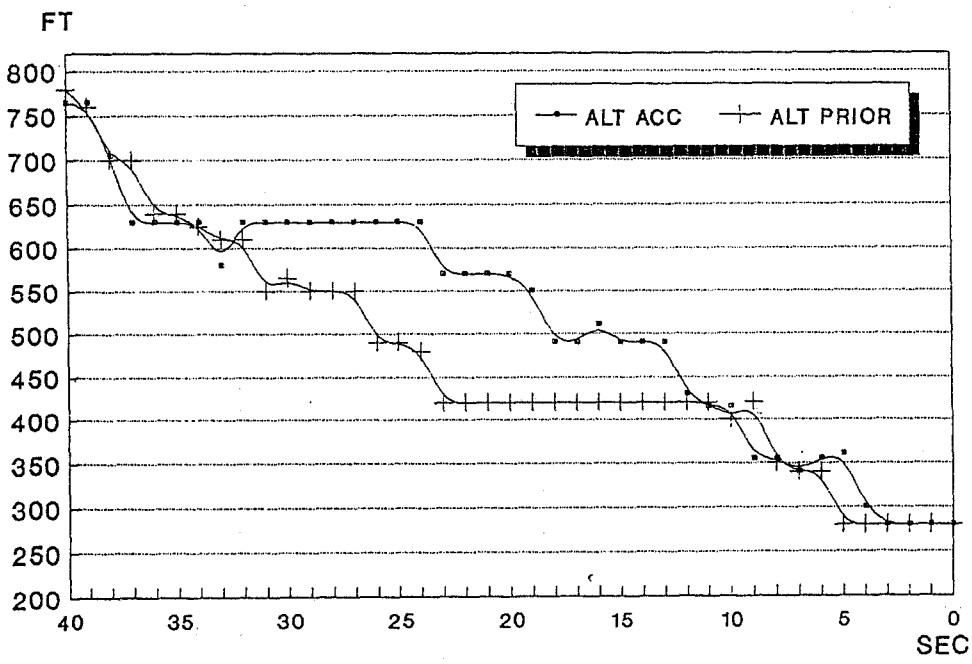


APPENDIX C



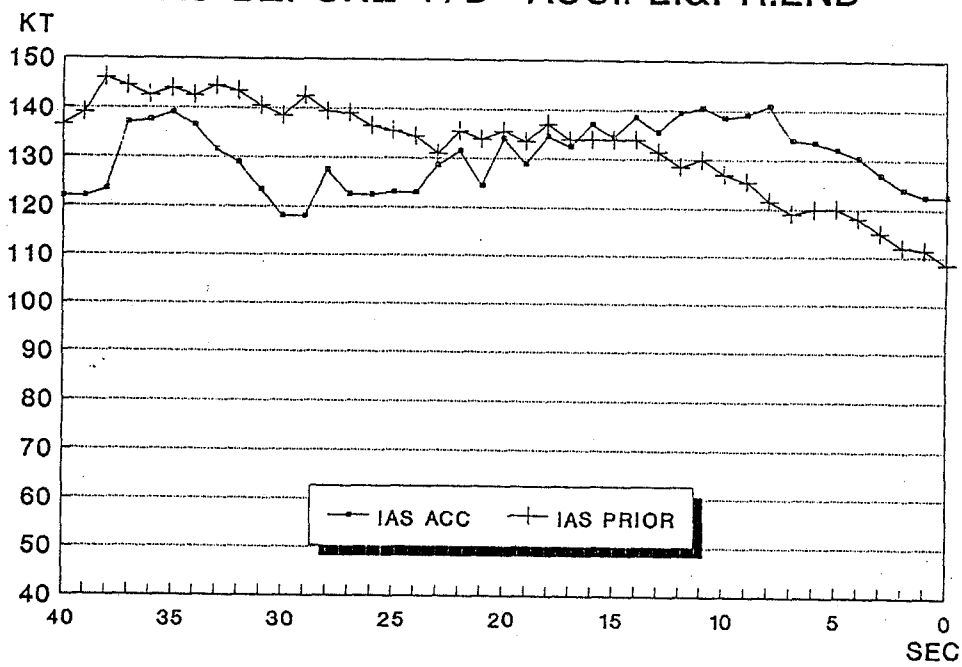
BA 146 OY-CRG

ALT BEFORE T/D ACC.FL.&PR.LND

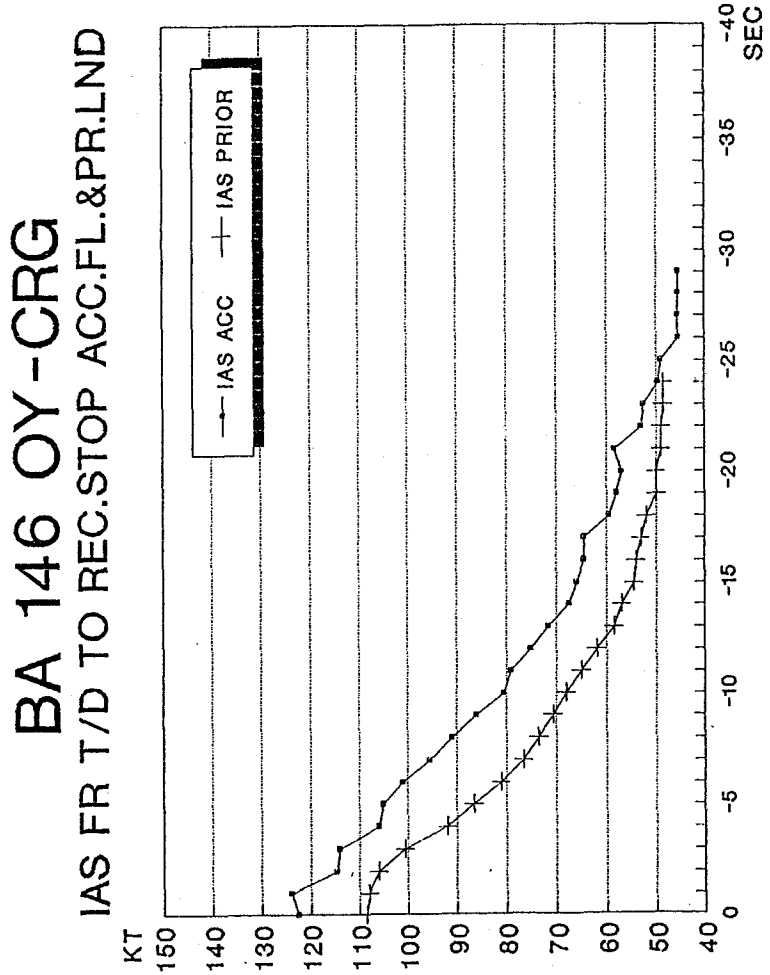


BA 146 OY-CRG

IAS BEFORE T/D ACC.FL.&PR.LND



APPENDIX D3



APPENDIX E

BAe 146 Series 200A

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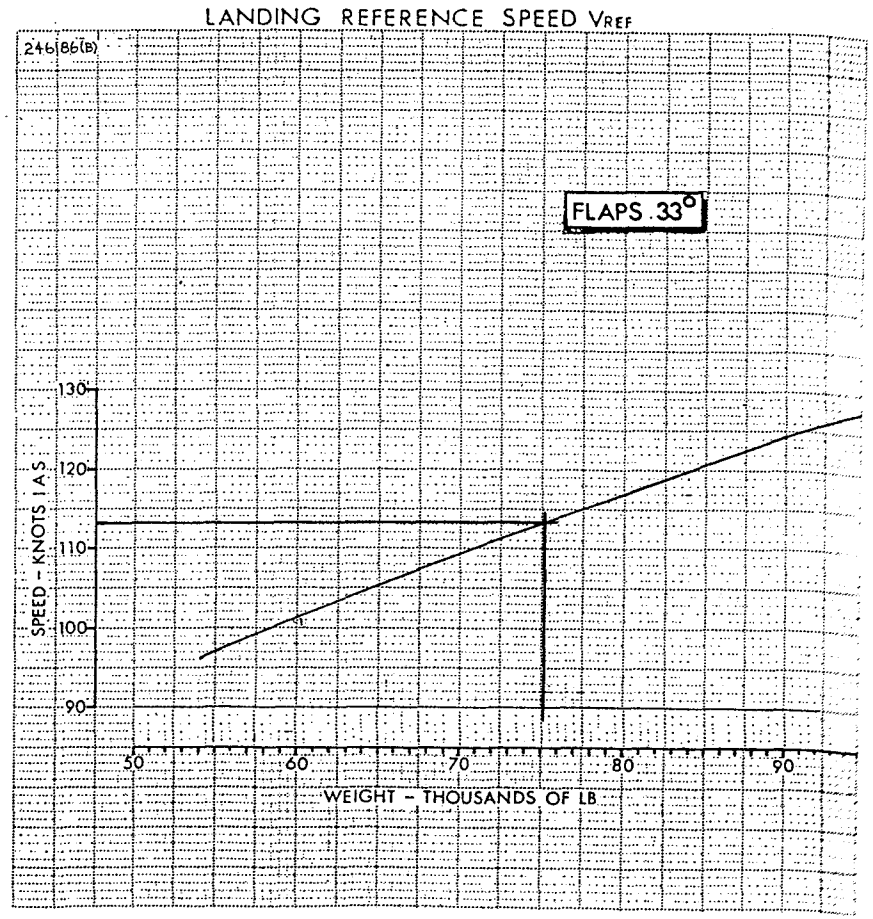
LANDING



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CAA Approved

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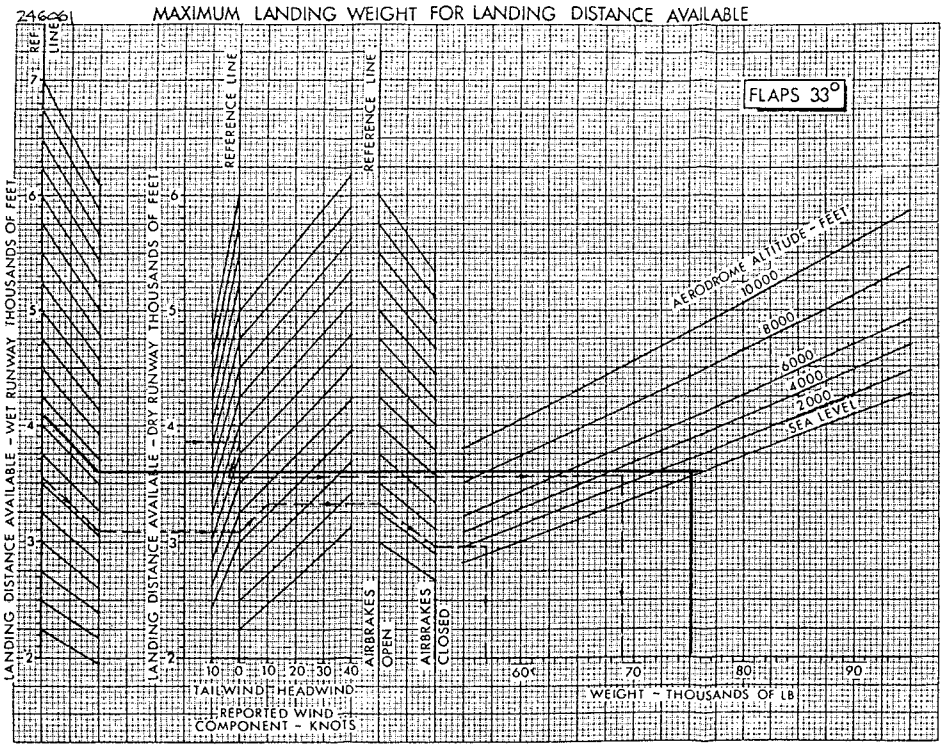
APPENDIX F


246061
MAXIMUM LANDING WEIGHT FOR LANDING DISTANCE AVAILABLE
FLAPS 33°
REF LINE
REFERENCE LINE
REFERENCE LINE
LANDING DISTANCE AVAILABLE - WET RUNWAY THOUSANDS OF FEET
LANDING DISTANCE AVAILABLE - DRY RUNWAY THOUSANDS OF FEET
AIRBRAKES - OPEN
AIRBRAKES - CLOSED
AERODROME ALTITUDE - FEET
10000
8000
6000
4000
2000
SEA LEVEL
TAILWIND HEADWIND
REPORTED WIND COMPONENT - KNOTS
WEIGHT - THOUSANDS OF LB