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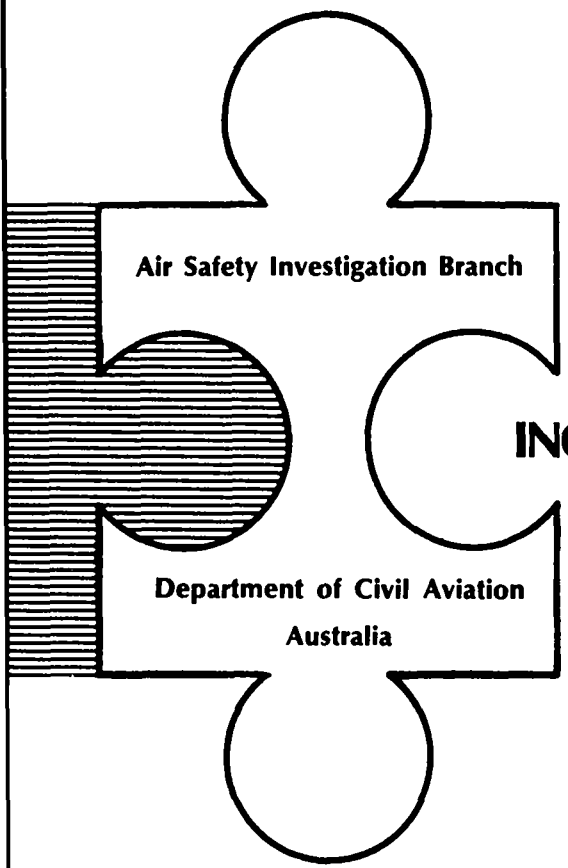
Air Safety Investigation Branch

Department of Civil Aviation
Australia

INCIDENT INVESTIGATION REPORT

Boeing 747 Aircraft N652 PA
at Sydney (Kingsford-Smith) Airport
New South Wales on 18 July 1971

SPECIAL INVESTIGATION REPORT 71-2



INCIDENT INVESTIGATION REPORT

Pan American World Airways Inc. Boeing 747 Aircraft N652 PA at Sydney (Kingsford-Smith) Airport New South Wales on 18 July 1971

The investigation of this incident was authorised by the Director-General of Civil Aviation pursuant to the powers conferred under Air Navigation Regulation 278.

Prepared by:
Air Safety Investigation Branch

July, 1972

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THE INCIDENT

At approximately 0912 hours Eastern Standard Time (EST) on 18 July, 1971, the Boeing 747 aircraft, registered N652PA, overran the end of Runway 25 and became bogged in soft earth whilst landing at Sydney (Kingsford-Smith) Airport, New South Wales. The aircraft was engaged in operating Pan American Airways Flight 811, a regular public transport service from Los Angeles to Sydney with intermediate stops at Honolulu and Nadi. The aircraft sustained no damage and none of the 15 crew members or 269 passengers on board was injured.

1 — Investigation

1.1 HISTORY OF THE FLIGHT

At 0506 hours EST on 18 July 1971 Pan American Airways Flight 811, radio call sign Clipper 811, departed from Nadi for the flight to Sydney. A crew change had occurred at Nadi and the aircraft was now under the command of Captain W. A. Thomas. The other flight crew comprised First Officer N. S. Simpson and Flight Engineer H. C. Schmidt. Captain Thomas occupied the left-hand control seat and operated the flight controls on this route sector.

At 0844 hours, following an uneventful flight from Nadi, Clipper 811 advised Sydney Arrivals Control that it was over the position-reporting point "Thresher" at Flight Level 350 and had received the Automatic Terminal Information Service (ATIS) broadcast, "Echo" (for details refer to Section 1.7). At 0848 hours, having been cleared to commence descent, Clipper 811 reported leaving Flight Level 350 and was advised by Arrivals Control that it would be making a straight-in approach to land on Runway 25.

At that time another Pan American Airways Flight, a Boeing 707 aircraft with the call sign CLIPPER 812, was approaching Sydney from the west and, in accordance with the Sydney noise abatement procedures, was being processed by Arrivals Control for a straight-in approach to land on Runway 07. The programmed landing time for CLIPPER 811 was several minutes prior to that of CLIPPER 812 and, to achieve this landing order, it became apparent to Arrivals Control that speed control of both aircraft would be necessary.

The noise abatement procedures applicable to arriving aircraft during the period of the day from 0645 to 1900 hours, specify that pilots should expect to land on the runway which most nearly affords a straight-in approach and air traffic control procedures will be applied to achieve this preferred procedure, having due regard to safety, wind and weather conditions.

At 0903:13 hours Sydney Approach Control instructed CLIPPER 811, which had transferred from Arrivals Control two minutes earlier, to "maintain" as fast a speed as possible for as long as possible". CLIPPER 811 replied "OK we're out of six for five, we'll maintain 250 knots."

At 0904:25 hours Approach Control instructed CLIPPER 811 to descend to 3,000 feet and to report when visual. CLIPPER 811 acknowledged this instruction and advised that the aircraft was then leaving 5,000 feet.

At 0905:12 hours, CLIPPER 811, notified that it was then reducing speed and the aircraft was instructed to descend to 2,000 feet.

At 0906:11 hours, CLIPPER 811 reported that the aerodrome was in sight. Sydney Approach instructed it to make a visual approach, straight-in and to call Sydney Tower on 120.5 MHz at 10 miles.

Meanwhile CLIPPER 812, which first reported to Approach Control at 0903:42 hours, on reaching a position 30 miles from Sydney, was given progressive descent instructions and speed reductions in order that the preferred straight-in approach for Runway 07 could be continued.

At 0907:24 hours CLIPPER 812 was instructed to descend to 3,000 feet and at 0907:32 hours the approach controller asked the aerodrome controller to advise him when CLIPPER 811 was assured of a landing so that further descent for CLIPPER 812 could be authorised.

At 0907.35 hours CLIPPER 811 reported at 10 miles on the aerodrome control frequency.

The aerodrome controller instructed CLIPPER 811 to report on short final but, at 0908:37 hours, before CLIPPER 811 had given this report, the aerodrome controller cleared the aircraft to land.

At 0908:53 hours, Approach Control told CLIPPER 812 "you will be number two to land, the number one aircraft is a 747 on five mile final for Runway 25, can you reduce any further?" CLIPPER 812 agreed to further reduce speed and at 0911:14 hours Approach Control instructed the aircraft to descend to 2,500 feet, which would still provide a safe vertical separation from CLIPPER 811 in the event of that aircraft making a missed approach.

At 0911:20 hours the approach controller again asked the aerodrome controller for advice on CLIPPER 811's progress and was told "advise in one!"

The aerodrome controller has stated that CLIPPER 811 appeared to be high during its final approach. He observed the aircraft touch down at approximately the intersection of the runways. At 0911:50 hours, when he was sure that the aircraft would not go around, he told the approach controller "he's down" and added at 0911:58 hours, "he got down at the intersection".

When the approach controller received the advice that CLIPPER 811 had landed (on Runway 25) he instructed CLIPPER 812 to make a visual approach straight-in (for Runway 07) and to call Tower on frequency 120.5 MHz.

The senior tower controller has stated that CLIPPER 811 crossed the threshold of Runway 25 at a height he estimated to be about 200 feet. The aircraft then levelled and appeared to float losing height slowly and passed the junction of Taxiway 'N' (see Appendix B). It appeared to him, at this point, that a go-around was imminent but the aircraft continued the approach and the main wheels touched down at the intersection of the runways with the aircraft in a nose high attitude. He has also stated that the nosewheels touched down abeam of Taxiway 'J' with the engines delivering reverse thrust. He observed what appeared to him to be a compressor stall in No. 3 engine and immediately, at 0912:04 hours, he alerted the airport fire service watch room on a direct inter-communication line — "Will you watch that Jumbo please . . . flame in number 3!"

At 0912:05 hours CLIPPER 812, which was approaching to land on Runway 07 made its first call on the aerodrome control frequency and reported — "SYDNEY TOWER, CLIPPER 812 about a four mile final". The aerodrome controller who was watching the landing run of CLIPPER 811, did not reply to this call.

The senior tower controller has stated that, whilst water spray and smoke enveloped the aircraft, it was difficult to see from the Tower whether or not CLIPPER 811 had run off the end of the runway but, at 0912:13 hours, he is recorded as saying, on the direct line to the airport fire service — "HIT! HIT IT! YES!" indicating a need to sound the crash alarm and, at the same time, he activated the combined crash call facility to alert the civil emergency services.

The surface movement controller in Sydney Tower has stated that he first observed CLIPPER 811 whilst it was still some distance out on final approach. His attention was next attracted to that aircraft when the senior tower controller commented that CLIPPER 811 appeared to be high. Although, to him, the aircraft did not appear particularly high at that time, he estimated it to be about three miles from the aerodrome. Its excessive height became apparent, however, as the approach continued and he estimated that the aircraft was at a height of between 150 and 200 feet when it crossed the threshold of the runway. He has stated that the aircraft continued its descent to about the junction with Taxiway 'N' where it appeared to commence a flare. The aircraft then appeared to float and passed abeam of the Tower position with the main body of aircraft at about his eye level. During this period of high float, which persisted to about the junction with Taxiway 'L', he had the impression that the aircraft was preparing to go-around. Beyond Taxiway 'L' he saw the aircraft commence to sink until the initial touchdown was made by the rear wheels of the outboard bogies just prior to reaching the intersection of the two runways.

The aircraft continued in a nose high attitude to the junction with Taxiway 'J' where it appeared to the surface movement controller that reverse thrust was applied before the

nosewheels actually touched down on the runway. He heard and observed what appeared to be a compressor stall in No. 3 engine when the aircraft was in the vicinity of the touchdown markings for Runway 07. Although the aircraft was three parts obscured by spray the flash from that engine was easily discernible. He had the impression, looking through the spray cloud, that the aircraft was commencing a turn into Taxiway 'C' at a slightly higher speed than normal but, when the aircraft stopped suddenly and the nose and left wing tilted down, he believed that it had left the paved surface and he immediately sounded the crash alarm.

A fireman on duty at the Airport Fire Station adjacent to the Control Tower also observed the approach and landing of CLIPPER 811. When he saw the aircraft flying above the runway in a tail down attitude and noticed that it did not touch down before reaching Taxiway 'L' he immediately alerted the Duty Fire Officer. The Duty Fire Officer, observing that the nosewheels were still not in contact with the runway at the intersection of the runways, ordered the fire crew to stand by their appliances in anticipation of an abnormal landing turn out.

The fireman on duty in the watchroom, which is an observation tower located on top of the Airport Fire Station, was monitoring the aerodrome control frequency. He has stated that he heard CLIPPER 811 call on that frequency and observed the approach and landing of the aircraft. The aircraft appeared to be high on final approach but he could not estimate its height when it crossed the runway threshold. When the aircraft passed abeam of his position in the watchroom tower, the bottom of the fuselage appeared to be at his eye level (i.e. about 20 feet). He saw the aircraft's main wheels first touch down at about Taxiway 'L' in a nose high attitude which was maintained to the runway intersection or shortly thereafter. He observed a large sheet of flame appear from the No. 3 engine when the aircraft was between Taxiways 'V' and 'J'. At the same time the Tower phoned him on a direct line to draw his attention to this occurrence. He noticed the spray which enveloped the aircraft from about Taxiway 'J' and recalls that, immediately after this, the Tower called him again. Although he could not remember the words used, the urgency of the voice indicated that the aircraft was in difficulties. He sounded the crash alarm and turned out all appliances to the threshold of Runway 07.

It is apparent that this fireman and the surface movement controller activated the crash alarm facility, simultaneously, immediately following the alert given by the senior tower controller at 0912:13 hours.

The aerodrome controller has stated that, after touchdown, he continued to watch the landing run of CLIPPER 811 and, as it approached the end of the runway, he saw the aircraft suddenly "skew to the right". The crash alarm then sounded.

At 0912:19 hours the aerodrome controller advised the approach controller that CLIPPER 812 would be making a missed approach, obtained a clearance for that aircraft and instructed it to transfer back to the Approach Control frequency.

At the time of this incident an airport safety officer was carrying out an inspection of the manoeuvring area for the presence of birds. His vehicle was equipped with a radio transceiver operating on the surface movement control frequency. He had positioned his vehicle on the grassed area between Runway 16 and Taxiway 'V' just outside the southern edge of the Runway 25 flight strip and he was facing towards the Tower (see Appendix B).

The safety officer has stated that he also observed the approach and landing of the Boeing 747 aircraft from a time shortly after the surface movement controller notified that the aircraft was on a ten mile final. This notification was recorded at 0907:39 hours. The safety officer says that the aircraft appeared to be higher than normal over the runway threshold and did not touch down until it was at a position between Taxiway 'L' and Runway 16. The landing appeared to be smooth and the aircraft did not bounce. The rear wheels of the main gear touched down before the front wheels and the nosewheels remained clear of the runway for some distance. When he saw the aircraft land so far down the runway he anticipated trouble and turned his vehicle about and followed the aircraft to the western end. He did not see the position at which the nosewheels first touched down as he was engaged in turning his vehicle at that time.

A few seconds after he observed the aircraft come to rest off the end of the runway and

before he could alert the Tower of the situation, he heard the crash alarm sound.

The safety officer proceeded immediately to the aircraft and, at 0913:22 hours, notified the Tower that there was no sign of fire and that the aircraft only appeared to be bogged. After the airport fire service appliances arrived at the aircraft, the safety officer returned to the runway and marked the position at which he observed the aircraft first touch down.

An examination of tyre marks on the runway indicate that the aircraft first made contact with the starboard body gear truck at a position close to the runway centre-line and 4,003 feet beyond the landing threshold. The aircraft then travelled a distance of some 1,945 feet before the nosewheel touchdown occurred. The first identifiable tyre marks associated with heavy braking appeared at a point shortly after nosewheel touchdown and they continued for a distance of 1,714 feet to the end of the runway as well as across a further 200 feet of sealed low strength pavement. Whilst crossing the low strength pavement the aircraft turned to the right through some 37 degrees from the runway alignment. As the aircraft left the sealed area it entered soft sandy soil and came to rest with the 16 main wheels bogged to varying depths up to 2 feet. The nosewheel assembly was buried to the level of the steering cylinders at a point 325 feet beyond the end of the runway proper (see Appendix C).

The captain has stated that the approach and landing were normal and that flap position 30 was used. He states that he was using a normal 2,000 foot aiming point and touchdown occurred shortly after passing Taxiway 'N' (i.e. at a point approximately 1,800 feet beyond the runway threshold). The target approach speed computed on the flight deck was 140 knots and the first officer called a speed of 144 knots just prior to the landing flare. The captain further stated that the approach slope closely approximated three degrees and that the threshold crossing height was normal for a visual approach. He did not use the T-VASIS system which was operating nor did he ask for the RED-WHITE VASIS, which was available on request.

The captain has also stated that, after touchdown, he immediately selected speed brakes and commenced the application of full reverse thrust from Nos. 2 and 3 engines at the same time applying wheel braking to put the nosewheel on the runway, after which full wheel braking was applied. The No. 1 engine thrust reverser was placarded "INOPERATIVE" and the captain elected not to use reverse thrust on either this engine or the No. 4 engine.

The captain has said that there was not any malfunction of the braking system and he believes that the anti-skid system operated normally. He has stated that he did not get normal deceleration, that he felt frequent brake releases and that he believed that this was due to the wet and slippery condition of the runway. As the aircraft neared the end of the runway, it was steered to the right off the end of the sealed surface to avoid running into a large concrete sewage outfall and a sunken perimeter road just off the end of the runway.

The first officer's evidence confirmed that provided by the captain and he further stated that, about one hour after the incident, the crew went back along the runway and examined it. There had been no rain since the incident and this examination revealed that the runway was wet and that there were scattered puddles of water up to 3/8 of an inch deep in depressions in the runway surface.

The flight engineer did not detect any malfunction of the anti-skid system during the landing roll, and after the aircraft had stopped, he satisfied himself that the system operated normally. At the same time a check of the brake temperatures revealed them to be in the normal or slightly below normal heat range.

1.2 INJURIES TO PERSONS

None of the occupants of the aircraft was injured.

1.3 DAMAGE TO AIRCRAFT

There was no damage to the aircraft, but both nosewheels were changed as a precaution against possible contamination by the sand in which they were buried.

1.4 OTHER DAMAGE

There was no other damage.

1.5 CREW INFORMATION

Captain William Ashbridge Thomas, aged 52 years, was the holder of an airline transport pilot certificate and a current first class medical certificate. He was authorised to fly Boeing 747 aircraft and had accumulated 532 hours on the type. His total flying experience amounted to 26,055 hours. Captain Thomas said that he had landed a Boeing 747 aircraft at Sydney on one previous occasion some months prior to this incident but that landing was not on Runway 25.

First Officer Norman Sidney Simpson, aged 40 years, was the holder of an airline transport pilot certificate and a current first class medical certificate. He was authorised to fly Boeing 747 aircraft and had accumulated 730 hours on the type. His total flying experience amounted to 11,990 hours.

Flight Engineer Harold Charles Schmidt, aged 54 years, was the holder of a flight engineer certificate and a current second class medical certificate. He was authorised to act as flight engineer in Boeing 747 aircraft and had accumulated 690 hours on the type. His total flying experience amounted to 27,947 hours.

1.6 AIRCRAFT INFORMATION

The aircraft, a Boeing 747, was constructed in the United States of America in 1970 and had been owned and operated solely by Pan American World Airways Inc. since manufacture.

It had flown a total of 886 hours since new and, with the one exception mentioned hereunder, there was no evidence in the aircraft records of any engineering deficiency which could have been relevant to this incident. The No. 1 engine thrust reverser, was placarded "INOPERATIVE" because the turbine thrust reversing element had been rendered inoperative by the maintenance staff but the pilot was able to use both the turbine and fan thrust reversers on the two inboard engines. Nevertheless, the effect of reverse thrust is not taken into account in determining the required landing distance and the FAA approved minimum equipment list permits both turbine and fan thrust reversers on the outboard engines to be inoperative without any addition to the required landing distance.

The maximum permissible gross weights for this aircraft, having regard to structural considerations only are 710,600 lb for take-off and 564,000 lb for landing. The anticipated fuel burn-off during this flight to Sydney was 110,400 lb which limited the maximum gross take-off weight at Nadi to 674,400 lb. The actual gross take-off weight at Nadi was 590,935 lb and the landing weight at Sydney was estimated to be 480,535 lb. The loading calculations also show that the aircraft's centre of gravity would have remained within safe limits during the whole of the flight. At the commencement of the descent the flight engineer calculated the landing weight to be 484,000 lb and this figure was used to compute the target approach speed.

The target approach speed used by Pan American Airways is termed the programmed speed (V prog). This speed is derived from a basic threshold speed (Vth) specified in the flight manual for the landing gross weight and the aircraft configuration. The Vth on this occasion was 130 knots. There was no adjustment required for wind gradient or gusts but the maximum permissible optional performance adjustment of 10 knots was added to the Vth, giving a target approach speed or V prog of 140 knots. Using the landing weight computed at the commencement of the descent, the existing conditions of surface wind, the flap setting, the runway pressure altitude and an additional 15% margin for wet runway surface, the required landing field length specified in the flight manual is 6,900 feet. The available length for landing on Runway 25 is 7,898 feet.

1.7 METEOROLOGICAL INFORMATION

Route and aerodrome weather forecasts prepared by the Sydney Area Meteorological Office are distributed on a routine basis to the Nadi Meteorological Office. The aerodrome weather forecast for Sydney covering the estimated time of arrival at Sydney of CLIPPER 811 was prepared at 2205 hours on 17 July. The forecast was valid for the period 0001 to 1200 hours, 18 July, 1971 and specified a wind velocity of 320 degrees at 5 knots; visibility 20 miles and 4/8 strato-cumulus cloud at 4,000 feet. It was also forecast that, during the period 0800-1000 hours, the wind direction would back to 290 degrees with the wind speed increasing to 12 knots and the cloud amount

would decrease to 3/8 cover. The crew of CLIPPER 811 received a copy of this forecast from the Meteorological Office, before departing from Nadi.

The routine aerodrome weather report prepared by the Sydney Meteorological Office observer at 0855 hours on 18 July, 1971 recorded a wind velocity of 280 degrees at 5 knots, visibility 30 nautical miles, 1/8 strato-cumulus cloud at 2,500 feet and 5/8 strato-cumulus cloud at 6,000 feet. The only changes appearing in the next routine aerodrome report at 0925 hours were in respect of wind velocity which had altered to 260 degrees at 8 knots and the total cloud cover to 5/8 strato-cumulus at 5,000 feet.

Routine broadcasts of selected meteorological information for use by aircraft in flight are made by Sydney Flight Service commencing on the hour and half hour. These broadcasts, designated VOLMET, are not recorded but it is probable that the amended Sydney aerodrome forecast, issued at 0527 hours on 18 July, 1971 was first included in the VOLMET Broadcast made at 0530 hours. This amended forecast, which was valid for the period 0600 to 1800 hours specified a wind velocity of 230 degrees at 12 knots, visibility 10 nautical miles, rain, 8/8 strato-cumulus cloud at 4,000 feet and 2/8 stratus cloud at 1,200 feet. It was further forecast that, gradually, between 1200 and 1400 hours, the wind direction would back to 200 degrees with a speed of 10 knots and the cloud cover would become 4/8 strato-cumulus at 5,000 feet.

The aerodrome controller, located in Sydney Tower, continually observes the existing weather conditions for the purpose of providing information to aircraft landing and taking-off. The observed weather conditions, together with pertinent aerodrome and operational information are contained in the Automatic Terminal Information Service (ATIS) broadcast on the Sydney VOR and NDB frequencies. The ATIS designated "ECHO" which was current until 0844 hours on 18 July, 1971 specified:

> "Runway 16 for departures, runways 16 or 07 for arrivals, wet, wind light and variable, downwind 3 on both runways, QNH 1015, temperature 11, low cloud 3/8 at 2,500, light rain in area, many birds on the aerodrome, on your first contact with Sydney Tower or Approach notify receipt."

The anemometer head which is located some 30 feet above the ground at a position on Sydney Airport indicated in Appendix B recorded at 0912 hours on 18 July, 1971, a mean surface wind velocity of 280 degrees 6 knots. About this time the recorded wind direction varied between 260 degrees and 290 degrees and the recorded wind speed varied between 5 and 8 knots. The upper wind velocities obtained from a balloon flight carried out at 0900 hours were: 500 feet — 246 degrees, 14 knots, 1,000 feet — 245 degrees, 20 knots and 2,000 feet — 245 degrees, 24 knots.

A pluviograph and a rain gauge are both located at Sydney Airport, as indicated in Appendix B. The pluviograph, which provides a progressive record of daily rainfall, recorded a total of 5 points of rain during the twenty four hour period from 0840 hours on 17 July, 1971 to 0845 hours on 18 July, 1971 and showed that the entire 5 points fell between 0630 and 0700 hours on 18 July, 1971. The rain gauge, which is read by the meteorological observer at three hourly intervals, registered a total of 6 points for the period 0600 to 0900 hours of 18 July, 1971. No further rain was recorded by either instrument during the remainder of 18 July, 1971.

1.8 AIDS TO NAVIGATION

Navigation aids were not a factor in the incident.

1.9 COMMUNICATIONS

Communications with the aircraft were normal in all respects and were not a factor in this incident.

1.10 AERODROME AND GROUND FACILITIES

Runway 25 at Sydney Airport is 8,298 feet in length and 200 feet wide, but the landing threshold is permanently displaced by 400 feet and, consequently, a distance of 7,898 feet is available for landing. The runway is aligned 242 degrees magnetic (254 degrees true) and its elevation above mean sea level is 20

feet at the eastern end and 16 feet at the western end. The surface is composed of bituminous concrete material with the exception of 500 feet at the western extremity which is composed of portland cement concrete. The Runway 07 threshold stripes and identification number have been painted on the cement concrete area with white paint on a painted black background. At the time of this incident it was evident that a number of layers of white paint had been applied to these markings and the surface exhibited the usual powdery condition. The painted, fixed distance, touchdown zone markings and runway centre-line markings were in a similar condition. The unpainted runway surface was in good condition except for heavy rubber deposits in the vicinity of the touchdown zones. At the western end, these were found in the area between 800 and 2,300 feet from the western threshold and the heaviest deposits were within the section of the runway 1,300 to 2,000 feet from the threshold. In this area there was partial to complete filling of the pavement texture in the central portion of the runway.

Runways 16 and 07 at Sydney Airport were equipped with full instrument landing systems whilst Runway 34 had a T-VASIS installed and Runway 25 had both RED/WHITE VASIS and T-VASIS installed to provide visual approach slope guidance to landing aircraft. In accordance with normal procedures, the T-VASIS on Runway 25 was illuminated for the landing approach of CLIPPER 811 and the RED/WHITE VASIS was immediately available on request by the crew of the aircraft.

1.11 FLIGHT RECORDERS

Flight Data Recorder The aircraft was equipped with a Lockheed Aircraft Service Model 109D Flight Recorder which records, on an aluminium foil, vertical acceleration, heading, indicated airspeed and altitude against a time base.

At Appendix D there is a graph presentation of the flight data record commencing at an altitude of approximately 1,200 feet during this landing approach. At Appendix E there is a profile of the final part of this approach and it is compared with the threshold crossing heights and touchdown points for 2½ and 3 degree approach slopes. It should be noted that the touchdown points for the 2½ and 3 degree approach slopes are for "no flare" landings and that the implementation of a normal landing flare would extend the touchdown points by about 500 feet.

From these Appendices it can be seen that the early part of the final approach from 1,200 feet to 650 feet above the runway elevation was well controlled in respect of airspeed, heading and slope angle. At about 650 feet, however, the aircraft diverged slightly above the desired approach slope and remained above it for the remainder of the approach. Below 200 feet the achieved approach slope tended to flatten somewhat to an angle of about 2½ degrees and the aircraft crossed the threshold with a wheel height indicated to be 123 feet instead of with the desired wheel height of 62 feet specified by Pan American Airways for the 30 flap configuration and a 3 degree approach slope. The Operator has also specified a minimum recommended approach slope of 2.5 degrees which, in conjunction with the specified aiming point of 2,000 feet beyond the threshold and flap 30, will produce a minimum mainwheel height at the threshold of 44 feet.

Below a height of about 50 feet above the runway the aircraft's static system is subject to pressure changes arising from ground effect and, consequently, the shape of the altitude graph and absolute height values depicted in Appendix D are unreliable in this area. Similarly, during deceleration the airspeed record is subject to a rapid dynamic change and the graph suffers from the lag characteristic which the recorder is subject to under such conditions.

Cockpit Audio Recorder A Fairchild Industrial Products Model A100 Cockpit Audio Recorder was installed in the aircraft. The tape from this recorder which provides a record of the cockpit audio programme including audio communications, over a 30 minute period was taken into custody following the incident. The tape was subsequently returned to Pan American World Airways whence a copy was made available to the National Transportation Safety Board in the U.S.A. who read it out. A transcript of the recording for a period of about 5½ minutes embracing this incident was made available to the investigation and appears at Appendix G.

1.12 WRECKAGE

Not applicable to this occurrence.

1.13 FIRE

There was no fire.

1.14 SURVIVAL ASPECTS

The accelerations to which the occupants were subjected during the landing roll were of a low order and the question of injury did not arise. Mobile stairways were used for the disembarkation of the passengers and crew.

1.15 TESTS AND RESEARCH

Expected Landing Performance Although there is no certification test data relating to the landing performance of Boeing 747 aircraft on wet runways, some data on wet runway landings carried out by The Boeing Company has been included in their Performance Engineers Manual. From this data the performance chart at Appendix I covering landings on wet and dry runways using brakes, spoilers and 2 reversers has been constructed.

Obviously, in the landing case, the air distance from 50 feet and the transition distance (i.e. the runway distance consumed after touch down up to the point where spoilers are deployed and wheel braking applied) will not be affected by the state of the runway surface. The braking distance is the only variable to be accounted for in any comparison of the overall landing distances on wet or dry runways.

Appendix I indicates that, for a gross weight of 484,000 lb, the landing ground roll distance on a dry runway will be 2,460 feet including 2,030 feet of braking distance. On a wet runway, the ground roll will be 3,770 feet including 3,340 feet of braking distance. This implies a braking distance factor of 1.64 for wet surfaces which, as a matter of possible relevance, is in quite close agreement with the certified results of wet landing tests carried out on the Boeing 727/200 aircraft at the time of its certification.

Evidence from Motion Picture Film The touchdown of CLIPPER 811 and the first 24 seconds of the landing roll were recorded by an amateur photographer using a clockwork-driven 8 mm movie camera from a known position on the observation deck of an airport building. Landmarks within the camera's field of view confirm the touchdown position established from eye-witness and other evidence. From an examination of the film and, after application of a correction to the film's running speed obtained by calibration of the camera, calculations indicated that the aircraft's ground speed at touchdown was 129.6 knots to which a tolerance of plus or minus 1 knot to accommodate any possible variation in the clockwork spring tension of the camera may be applied. The body angle at touchdown was measured and found to be 4.7 degrees nose-up. One second after touchdown it was 4 degrees nose-up, 2 seconds after touchdown it had reduced to 2.8 degrees and 3½ seconds after touchdown it was down to 2.1 degrees nose-up. This body angle was substantially maintained until 5½ seconds after touchdown and then it decayed at a uniform rate until the nosewheel contacted the runway 9.5 seconds after touchdown. The film indicated that nosewheel contact first occurred at a point 2,038 feet beyond the mainwheel touch down point and the ground speed of the aircraft at that time was between 105 and 110 knots.

2 — Analysis

2.1 GENERAL

The circumstances of this incident present three principal questions for consideration. Why did the aircraft touch down so far along the runway?; why did the aircraft fail to come to a halt in the runway length remaining after touchdown?; and why did the pilot not go around at some time before the overrun became inevitable? Before considering these three questions in detail, however, it is necessary to examine the circumstances in which this landing approach was carried out.

There were no meteorological conditions which could have adversely affected the capacity of the pilot to carry out a normal landing. The approach was conducted in clear, daylight visibility with no evidence of significant turbulence or wind shear and the pilot was aware that the runway surface was wet.

There is no evidence of any condition of health or of fatigue affecting the pilot's normal judgment. The only item of aircraft unserviceability having any possible signifi-

cance to this occurrence was the INOPERATIVE status of the No. 1 engine thrust reverser. Because of the need to use symetrical reverse thrust this condition limited the captain to the use of reverse thrust on the inboard engines only during the landing roll. Undoubtedly the availability of reverse thrust on all four engines would have improved the aircraft's stopping capacity but the fact that only two engines could be used in this role was well known to the captain prior to his commencement of the landing approach and the landing distance available was more than adequate for a safe landing to be completed in this condition.

In accordance with the prescribed noise abatement procedures the pilot was assigned the landing runway which was most closely aligned with the aircraft's arrival track and a straight-in approach was made from cruising altitude. The crew was given adequate notice of the runway on which the aircraft could be expected to land and, except for some requests for speed adjustments to facilitate traffic separation, the air traffic control instructions during the landing approach were routine. The pilot-in-command has not suggested that the required speed adjustments in any way affected his landing approach.

The assigned Runway 25 was the most "into-wind" runway. It is accepted that, in the absence of an instrument landing system glidepath, a straight-in landing approach calls for the exercise of a high degree of pilot judgment. Nevertheless, a straight-in approach cannot be regarded as an abnormal procedure. Pilots are trained in carrying out this type of landing approach and the instrumentation in this type of aircraft provides an adequate assistance to their visual judgment. Alternatively, on this occasion two other runways which were suitable for landing and equipped with electronic glidepath guidance were available and, on request from the pilot, the aircraft would have been cleared to land on either of them.

In order to define the proper approach slopes to be used under visual conditions, the Department of Civil Aviation has installed visual approach slope indicating systems (VASIS) on most of the runways not served by instrument landing systems at the major airports. The two best known VASIS are the RED-WHITE System and the Australian T-VASIS, both of which were installed on Runway 25 at Sydney at the time of this occurrence. These systems were originally designed and aligned for use by smaller aircraft. With the advent of the wide-bodied jets, of the Boeing 747 type, where the vertical distance between the pilot's eye and the main landing gear is significantly greater and, in the normal approach attitude, is of the order of 40 feet, it became apparent that, in the original concept of their use, the existing VASIS installations provided inadequate mainwheel clearance at the runway threshold. Examination and testing of existing installations has shown that, for the RED-WHITE system to be fully usable by the wide-bodied jets, a modification in the form of a further light bar up-wind of the standard system must be installed. Subject to a procedural change, however, the T-VASIS is quite satisfactory for use by the larger aircraft without modification of the standard installation. In the case of the Boeing 747, it is necessary for the pilot to maintain an approach slope indication of two-lights "fly down" instead of the "on slope" indication applicable to the smaller aircraft. This has the effect of increasing the height over the threshold without significantly affecting the approach slope angle. It presents no undue difficulties to the pilot and ensures adequate mainwheel clearance at the threshold.

The T-VASIS installation on Runway 25 at Sydney was commissioned during February, 1964. The commissioning of the aid was notified to all operators, including Pan American World Airways, and its availability was subsequently reflected in the Approach and Landing Charts issued in respect of Sydney Airport. Pan American World Airways, therefore, had adequate advice of the installation and availability of the aid and information on its characteristics was readily available to them. Furthermore, on 17 September, 1970, shortly before Pan American World Airways commenced Boeing 747 operations into Sydney, a letter containing information on the T-VASIS and its applicability to Boeing 747 operations was sent by the Department of Civil Aviation to the Pan American World Airways Executive Director for Australia. The Director has stated that this letter was not received by him and it is apparent that the suitability of the T-VASIS for Boeing 747 operations was not brought to the attention of Pan American flight crews.

2.2 THE APPROACH TO TOUCHDOWN

The weight of evidence leaves no doubt that the first touchdown occurred at a point 4,003 feet beyond the runway threshold and, as is shown in Appendix B, this is some 2,500 feet beyond the touchdown zone delineated by the fixed distance markers. It is also grossly beyond any description of the normal or expected touchdown point contained in the Pan American "Aircraft Operating Manual".

The reasons for this delayed touchdown may be found in an examination of Appendices E and F. The approach profile at Appendix E shows that the aircraft crossed the threshold with a wheel height of 123 feet and with an approach slope angle of 2¼ degrees. Appendix F, a graph supplied by The Boeing Company, indicates that this combination of excessive threshold height and shallow approach slope will result in overshooting the normal touchdown point by some 2,200 feet. Since the normal touchdown point from a 3 degree approach slope in this type of aircraft, with due allowance for 500 feet consumed during the landing flare, is specified by the manufacturer as being 1,675 feet beyond the threshold, a touchdown in this case at about 4,000 feet beyond the threshold is not a surprising result.

With due allowance for the prevailing wind velocity, an integration of the speed and altitude data at Appendix D shows that the approach, down to a height of about 700 feet, was consistent with a three degree approach slope appropriate to the normal, permanently displaced, landing threshold on Runway 25. At a height of about 700 feet there was a substantial flattening of the approach slope which coincided in time with the initiation of a discussion in the cockpit, between the captain and first officer, as to the existence or otherwise of a displaced threshold. The evidence of this discussion is in the transcript of the cockpit audio record at Appendix G. In the course of the discussion, the captain provided a possible explanation for the change in approach slope in his statement "I'm going to give it a little room . . ." Appendix D shows that the flattened approach slope was maintained for a period of approximately 30 seconds and then steepened at a time which was approximately coincident with references, by the first officer to a "foreign kind of VASI", the indications of which he interpreted as showing their aircraft to be too high on the approach.

The landing threshold for Runway 25 is permanently displaced 400 feet in from the end of the runway and the displaced threshold and runway markings were in accord with internationally prescribed standards. There was no current NOTAM advice which indicated or suggested a further temporary displacement of the threshold from its normal permanently displaced position. The fact that the threshold proper is displaced, however, could have been the factor which prompted this cockpit discussion, either as a result of a visual observation at the time or as a result of some memory cue. On the other hand the cockpit discussion could have been prompted by some other visible feature and, notwithstanding some intelligibility problems in the transcription of the audio record, the possibility that the "on-slope" bar of the T-VASIS system, in association with the nearby 1,000 foot fixed distance markers (see Appendix H) was mistaken for an indication of a displaced threshold is tenable in the light of the terms of the recorded conversation. The available evidence does not permit further resolution of the reason for the displaced threshold discussion and it was not practicable for the investigation to further pursue this aspect. Nevertheless, it can be concluded that some doubts did arise on the flight deck as to the position of the landing threshold, that there was an adoption of a flight path more cautious in respect of any possible undershoot and that the adjustment of the flight path, apparently to achieve this purpose, was substantial.

The available landing distance, as determined in relation to the permanently marked threshold, provided a margin of 998 feet in excess of the computed landing distance required in the prevailing circumstances. Any assumption of a further displacement of the threshold or any action to give the threshold proper "a little room" by deliberately setting out to land further into the runway than is normal would have reduced this margin. For example, the margin existing in relation to a landing predicated on an assumed threshold at the T-VASIS would have been only 98 feet. It can be argued that the touchdown zone marking provided a relatively precise basis for the assessment of any diminution of the available landing distance arising from an assump-

tion of a displaced threshold but, having regard to the consequential reduction of available margins, continuation of the operation on this premise would demand an increased vigilance directed to achieving touchdown at the optimum position. Alternatively, it should have been apparent that any doubts as to the true position of the landing threshold could have been resolved by an interrogation of Sydney Tower and this would have been a prudent action even at the expense of abandoning the current approach. The captain did not make any attempt to follow such a course of action.

Whilst the available evidence is not such as to allow a firm determination of the factor generating the flight crews' discussion as to a displaced threshold, it is reasonable to assume that any doubts which they had, did not involve an assumption of displacement beyond the first 1,000 foot fixed distance marker. In this, the worst case, the expected touchdown point for a normal landing, including due allowance for the flare, would be at approximately 2,700 feet beyond the landing threshold proper. Thus, the relationship of the actual touchdown point at 4,003 feet to the touchdown points which would result from properly judged approaches, based on thresholds at or within the first 1,000 feet of runway, represents a minimum judgment error of 1,300 feet and a possible error of up to 2,300 feet. The marking on Runway 25 provided ample reference data for a properly judged approach to the single landing threshold displayed. Furthermore, within the pilot's visual reference area, the physical features of the airport were such that he should have been able to accurately assess the misjudgment which followed the approach slope adjustment before he finally committed the aircraft to a full stop landing.

2.3 THE FAILURE TO STOP ON THE RUNWAY

The performance data at Section 1.15 of this report and at Appendix I indicates that, on a wet runway, using brakes, spoilers and the thrust reversers from two engines it is possible to stop a 484,000 lb gross-weight aircraft in a ground roll distance of 3,770 feet. From the position at which the aircraft first touched down on the runway, 4,003 feet beyond the threshold, the runway distance remaining in which to bring the aircraft to a halt was 3,895 feet. In addition there is 200 feet of low strength pavement beyond the end of the runway which is not considered suitable for normal operations, but which can be used for stopping in an emergency situation even though the surface might be damaged or even penetrated.

Despite the apparent existence of an excess of 325 feet of sealed surface in the available stopping distance, there are, first of all, some reasons why the capacity of the aircraft to stop in the available distance should be regarded as marginal. Although the data basic to the wet runway performance chart was obtained from actual tests conducted on wet runways, it is not possible to reliably compare the degree of wetness of the test runways with that pertaining at Sydney at the time of this incident. Similarly, it is not possible to accurately compare the surface texture of the test runways with that of the Sydney runway. It is, however, reasonable to assume that the tests were landings in which the touchdown occurred at the normal position on the runway and that the braking zone comprised relatively clean pavement unaffected by touchdown rubber deposits and painted areas. In this particular landing, however, the pavement in the braking zone comprised a large area of rubber-filled surface and some painted areas where the braking co-efficient was almost certainly lower than that achieved under the test conditions.

In addition to these considerations as to the capacity of the aircraft to stop, there is also some evidence that the aircraft's full braking potential was not utilised in this landing. The nosewheel remained off the ground for a period of 9.5 seconds after mainwheel touchdown and, in this time, the aircraft traversed a distance of approximately 1,945 feet. In all of the landings carried out during certification of the aircraft type the nosewheel was on the runway within two seconds of mainwheel touchdown and a sampling of 36 landings in an airline training operation produced an average interval between mainwheel and nosewheel touchdown of five seconds.

The chart at Appendix C indicates that the discernible braking marks commenced at a point on the runway 1,714 feet from its end

and thus some 236 feet beyond the mainwheel position at the time of nosewheel touchdown (the distance between the nosewheel and rear mainwheel axes in this aircraft is 92 feet). The film has shown that the aircraft's ground speed at the time of nosewheel touchdown was 105 to 110 knots which suggests a rather low degree of retardation between mainwheel touchdown and this point. Discussions with The Boeing Company indicate that the very powerful elevator control on this aircraft permits a large proportion of the available braking capacity to be employed before the nosewheel is on the ground but it would seem that all of this capacity was not used by the pilot-in-command during the nosewheel hold-off period of 9.5 seconds.

From the point where the first wheel braking marks were evident on the runway, it is apparent that heavy braking was maintained continuously throughout the remainder of the ground roll on the runway and over-run. The cockpit audio record also suggests that the spoilers were deployed some 4-6 seconds after mainwheel touchdown (i.e. before there was nosewheel contact) and this is consistent with the adoption of a maximum deceleration mode. It is not possible to determine the speed at which the aircraft left the end of the runway and, later, the low strength pavement, but the lack of damage to the aircraft and the relatively short distance that the aircraft travelled through the sand attest that a very substantial decrease in speed occurred beyond the point where it is first evident that mainwheel braking was being employed.

Although no firm conclusion can be drawn it seems likely that, had the pilot placed the nosewheel on the ground earlier and thereafter applied maximum braking, the aircraft would not have over-run the runway or at least it may have been brought to a stop on the low strength pavement. The available margin was so small, however, and the variables affecting the result so significant, that the ability of the aircraft to stop in the runway length remaining cannot be determined with certainty.

2.4 THE GO-AROUND CONSIDERATION

A straight-in approach without electronic or visual glideslope guidance is more demanding of accurate visual judgment from the pilot than one carried out with such an aid or following a normal visual circuit and, in these circumstances, the possibility is heightened that the approach may have to be abandoned and a go-around carried out. There are a number of factors which will determine the last point from which a go-around can be safely accomplished, but The Boeing Company recommends that a go-around shall not be attempted from the landing roll once the reverse thrust levers have been actuated.

When asked if he considered a go-around at any stage during this approach and landing the captain said that he did not think such an action was necessary. It is apparent, nevertheless, that the aircraft was inordinately high crossing the threshold proper and still had a main wheels height of 78 feet above the runway at the position of the 1,000 foot distance marker. In fact, before a normal threshold height of say 50 feet above the runway was achieved some 2,000 feet of its length had already been consumed. In these circumstances it is just as difficult to understand the captain's belief that a touchdown was achieved shortly after passing Taxiway 'N' as it is to understand why he failed to appreciate the excessive height of the aircraft at whichever threshold he was using.

There can be no doubt that this was an approach which should have been abandoned perhaps as early as the point at which doubt arose on the flight deck as to the real position of the landing threshold. Certainly in the ensuing 78 seconds to touchdown there was no impediment to the initiation of a go-around and the rapidly dwindling safety margins implicit in the excessive height of the aircrait made this action imperative. Perhaps the employment of a maximum deceleration effort after touchdown might still have brought the aircraft to a halt on the runway but such a persistence with an operation from which all safety buffers had disappeared cannot be condoned, particularly, when a safe alternative course of action was available.

3 — Conclusion

1. The flight crew members of the aircraft were properly licensed and experienced to carry out their duties.

2. There was no evidence of any defect in the aircraft which could have contributed significantly to the incident.

3. In the relevant circumstances of this landing and, after the addition of the appropriate factor for a wet runway surface, the landing distance required was some 1,000 feet less than the landing distance available on Runway 25.

4. At the time of this incident a visual approach slope indicating system (T-VASIS) suitable for use by aircraft of this type, was operating on Runway 25. The Department of Civil Aviation, on 17 September 1970, forwarded to the Executive Director for Pan American World Airways in Australia advice as to the availability and characteristics of this system. The Director has said that he did not receive this advice. Consequently, it did not become available to the flight crew and this visual aid was not used, as such, by them during the landing approach.

5. When the aircraft was approximately two miles from the end of the runway, at a height of about 700 feet, the captain flattened the approach slope apparently in the belief that this action was necessary to allow for the existence of a displaced threshold. The captain misjudged the approach slope alteration and the aircraft crossed the landing threshold and the whole of the marked touchdown zone at an excessive height and with a shallower-than-normal approach slope, to finally touch down 4,003 feet beyond the landing threshold or 3,895 feet from the upwind end of the runway.

6. It is probable that the spoilers were deployed within 4-6 seconds of a mainwheel touchdown but the nosewheel touchdown did not occur until 9.5 seconds after the first mainwheel touchdown.

7. There was no evidence of braking marks on the runway until the aircraft had travelled a distance of 2,181 feet beyond the mainwheel touchdown or 236 feet beyond the nosewheel touchdown point. Thereafter, there was evidence of heavy brake application during the remainder of the aircraft's ground roll.

8. The aircraft over-ran the runway and, after turning 37 degrees to the right, became bogged in soft ground with its nosewheel 325 feet beyond the end of the runway.

9. It has not been possible to determine with certainty whether or not, even with optimum retardation actions, the aircraft could have been stopped in the runway distance remaining after mainwheel touchdown.

Cause

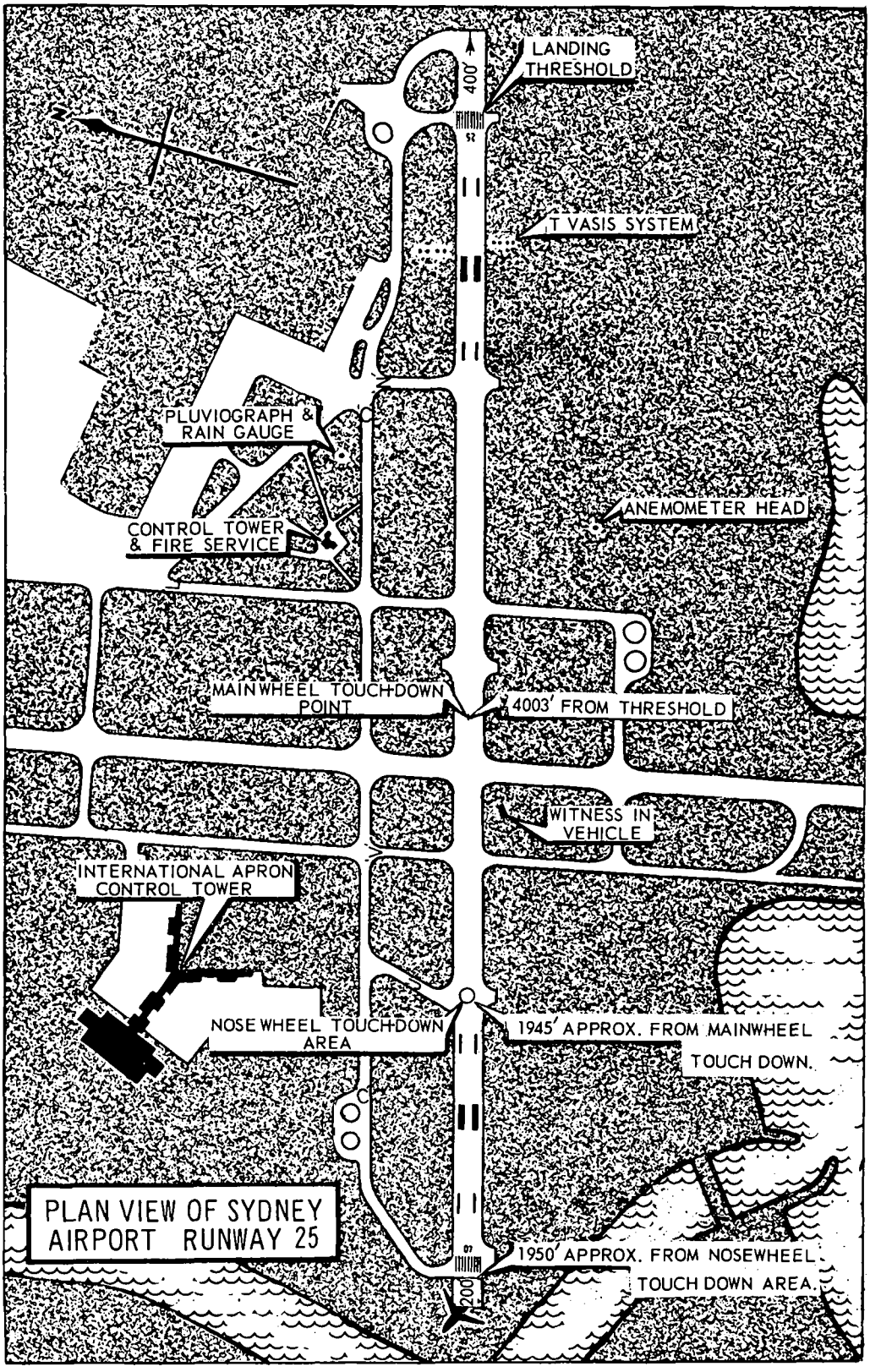
10. The cause of the incident was that the pilot-in-command did not take a timely decision to initiate go-around procedures in the circumstances of a misjudged landing approach.

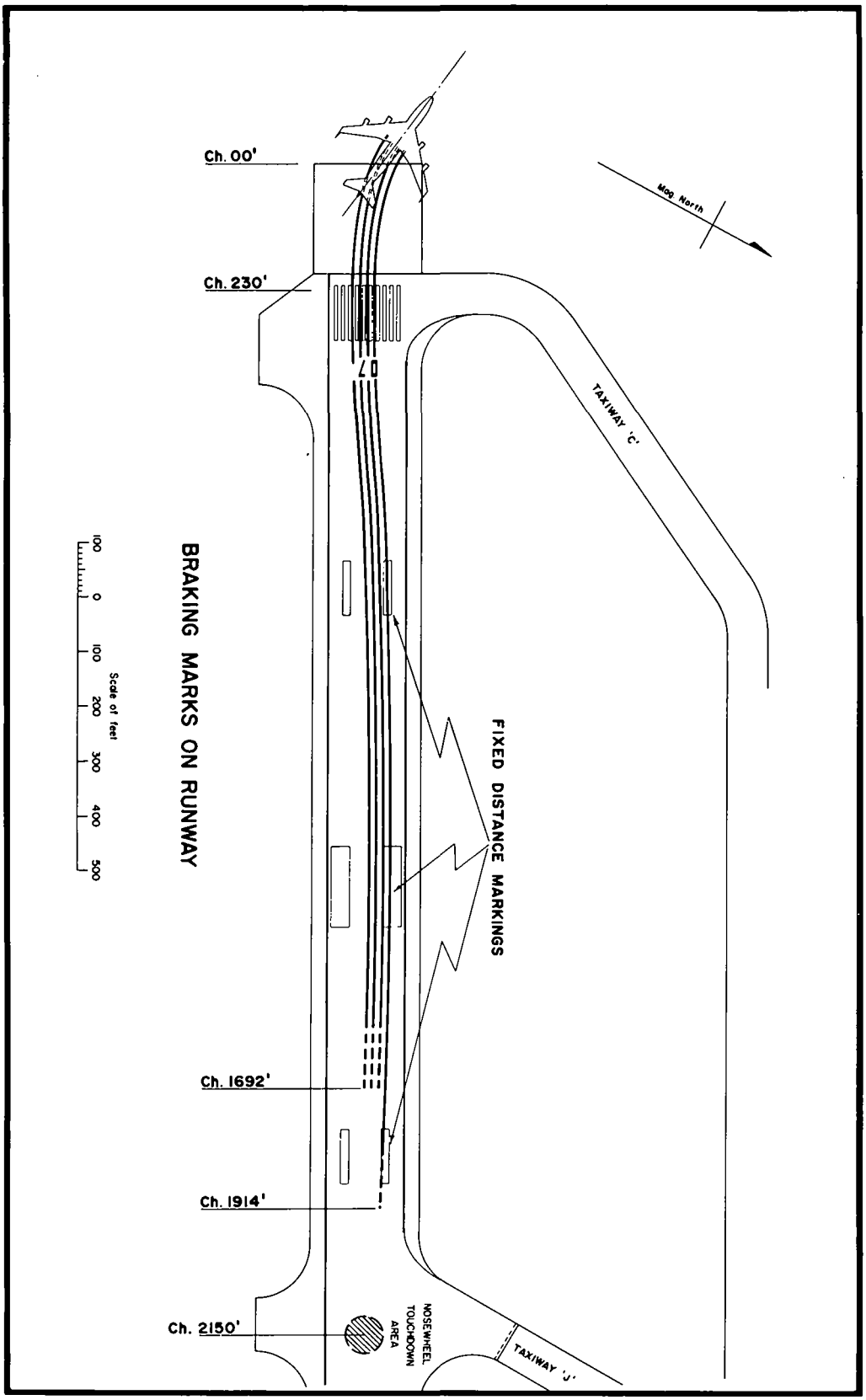
Appendix A

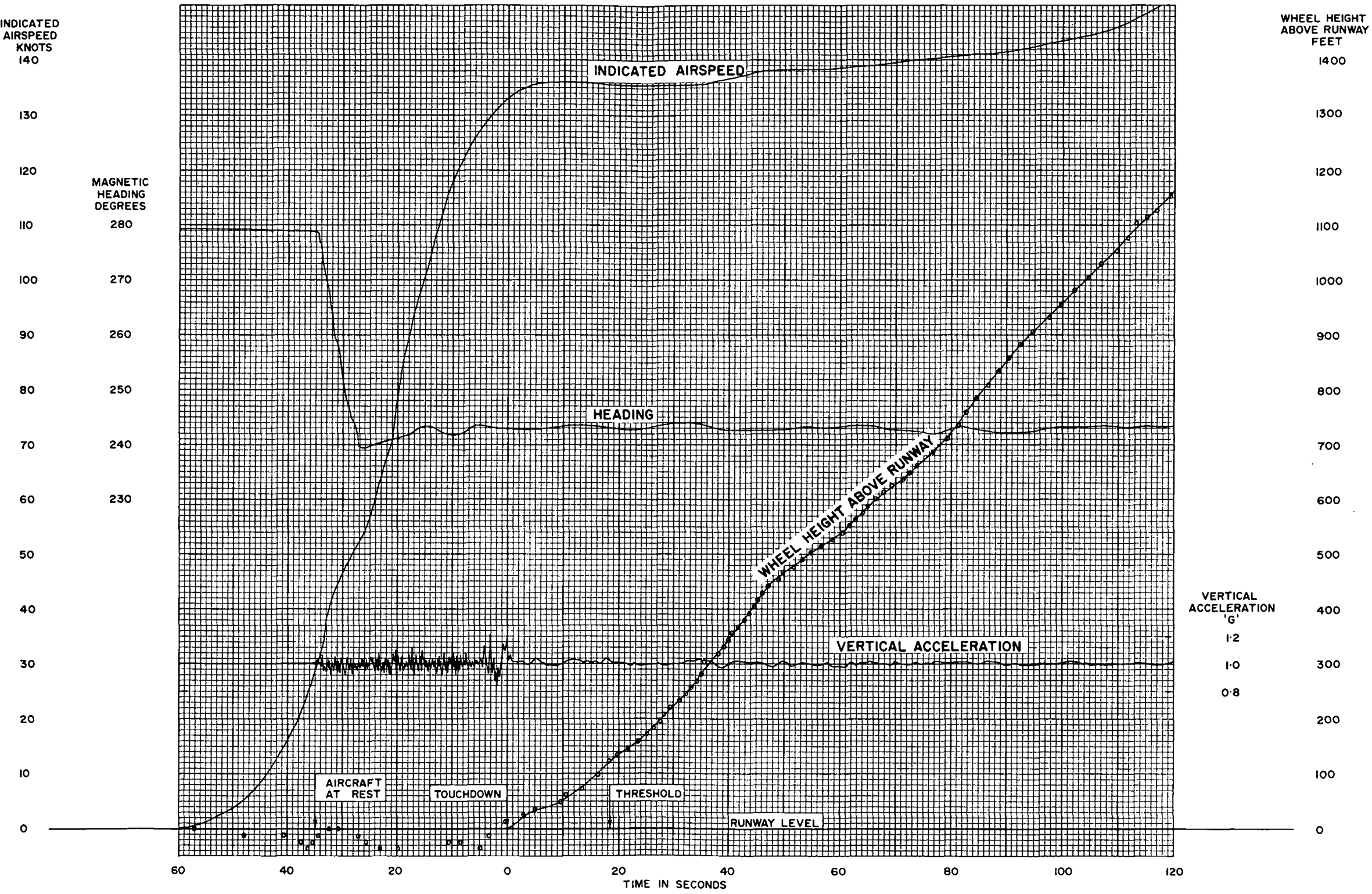
The nose undercarriage of N652PA showing the depth to which the wheels penetrated the soft earth.

The aircraft as it came to rest a short distance beyond the end of the runway.
Note the sunken perimeter road and the sewage outfall.

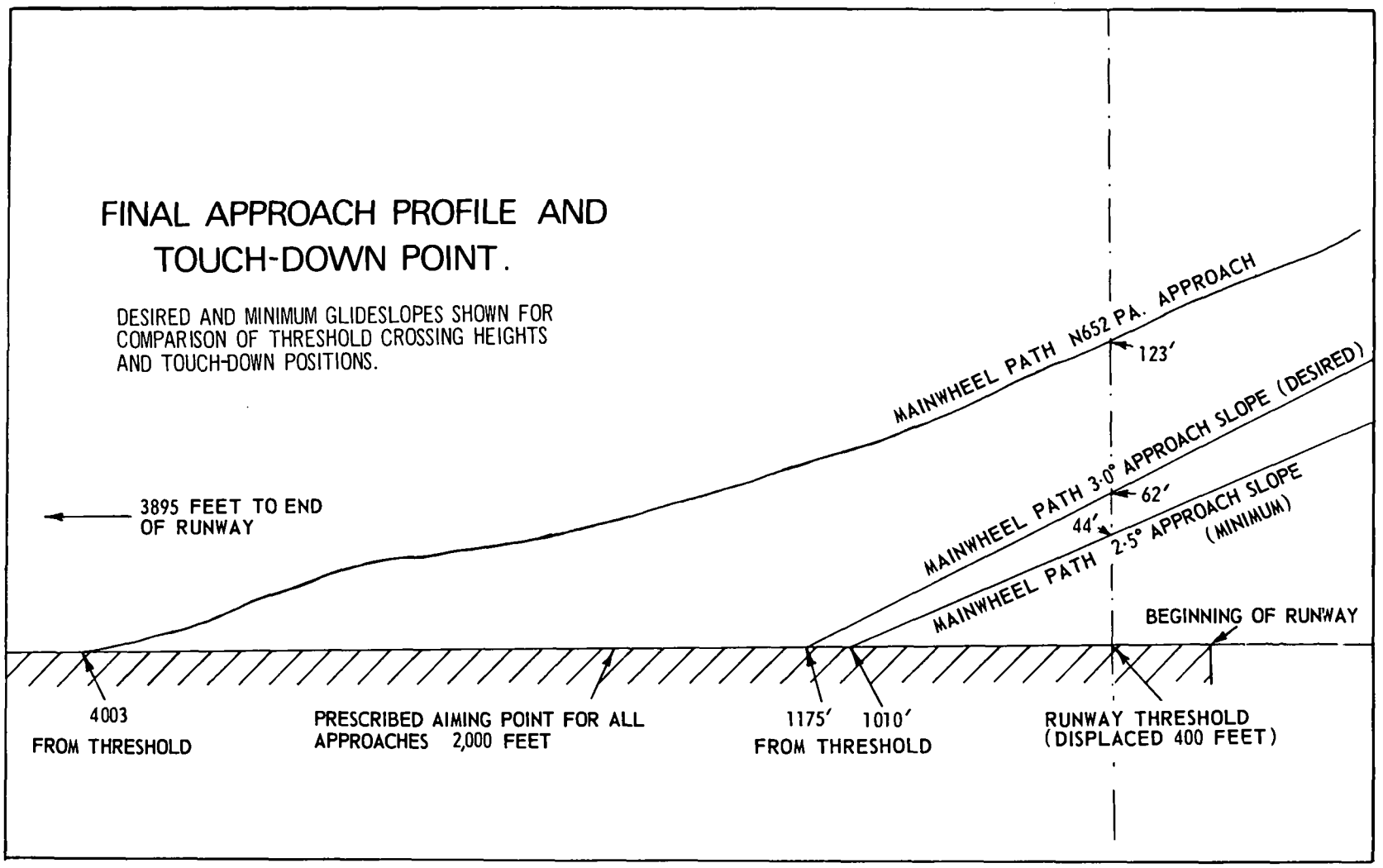
Appendix B

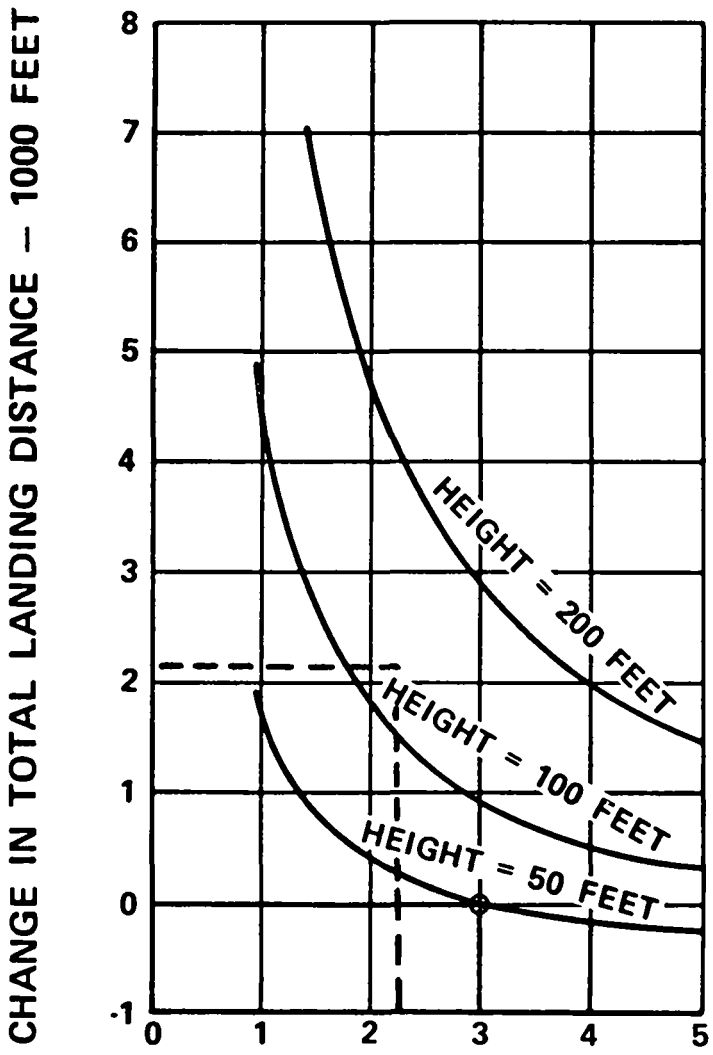

LANDING THRESHOLD
400'
T VASIS SYSTEM
PLUVIOGRAPH & RAIN GAUGE
ANEMOMETER HEAD
CONTROL TOWER & FIRE SERVICE
MAINWHEEL TOUCH-DOWN POINT
4003' FROM THRESHOLD
WITNESS IN VEHICLE
INTERNATIONAL APRON CONTROL TOWER
NOSEWHEEL TOUCH-DOWN AREA
1945' APPROX. FROM MAINWHEEL TOUCH DOWN.
PLAN VIEW OF SYDNEY AIRPORT RUNWAY 25
1950' APPROX. FROM NOSEWHEEL TOUCH DOWN AREA.


Ch. 00'
Ch. 230'
Mag North
07
TAXIWAY 'C'
BRAKING MARKS ON RUNWAY
100 0 100 200 300 400 500
Scale of feet
FIXED DISTANCE MARKINGS
Ch. 1692'
Ch. 1914'
Ch. 2150'
NOSEWHEEL TOUCHDOWN AREA
TAXIWAY 'J'



Recorded flight data during approach and landing.


FINAL APPROACH PROFILE AND
TOUCH-DOWN POINT.
DESIRED AND MINIMUM GLIDESLOPES SHOWN FOR
COMPARISON OF THRESHOLD CROSSING HEIGHTS
AND TOUCH-DOWN POSITIONS.
MAINWHEEL PATH N652 PA. APPROACH
123′
MAINWHEEL PATH 3·0° APPROACH SLOPE (DESIRED)
62′
44′
MAINWHEEL PATH 2·5° APPROACH SLOPE
(MINIMUM)
3895 FEET TO END
OF RUNWAY
BEGINNING OF RUNWAY
4003
FROM THRESHOLD
PRESCRIBED AIMING POINT FOR ALL
APPROACHES 2,000 FEET
1175′ 1010′
FROM THRESHOLD
RUNWAY THRESHOLD
(DISPLACED 400 FEET)



FLAT GLIDE SLOPE PATH AND EXCESSIVE HEIGHT OVER END OF RUNWAY COMBINE TO EXTEND LANDING DISTANCE REQUIRED DUE TO RUNWAY USED BEFORE TOUCH DOWN.

BROKEN LINE INDICATES SITUATION OF N652PA DURING THE LATER STAGES OF THIS APPROACH.

APPROACH HEIGHT EFFECT

NATIONAL TRANSPORTATION SAFETY BOARD

Bureau of Aviation Safety
Washington D.C.
October 26, 1971

SPECIALIST'S FACTUAL REPORT OF INVESTIGATION
COCKPIT VOICE RECORDER

A. INCIDENT

Location: Sydney, Australia
Date: July 18, 1971
Aircraft: Boeing 747, Pan American World Airways Flight 811

B. GROUP

Not applicable.

C. SUMMARY

Not applicable.

D. DETAILS OF INVESTIGATION

The transcription, which appears as an attachment hereto, was prepared at the request of the Department of Civil Aviation, Commonwealth of Australia. The data source was a copy of the original cockpit voice recorder (CVR) tape provided to the undersigned by the operator at the request of the Investigator-in-Charge. The copy was of the cockpit area microphone channel only.

The CVR was a Fairchild Model A-100, serial number unknown. Its condition was unknown. The tape copy provided was satisfactory in respect to intelligibility of communications recorded thereon. Investigation disclosed that the original tape had been operating from 5 to 7% faster than nominal speed. According to the manufacturer, this could have occurred if the CVR was recording at the upper limits of its speed tolerance (2-3%) and the frequency of the aircraft generated electrical current was 3-4% above its nominal 400 Hz level.

Subsequent to the landing roll-out and the incident concurrent therewith, the recorder was allowed to operate for some ten minutes or so prior to being shut down. Thus, the attached description does not reflect the last 5½ minutes of recording but rather a 5½ minute segment of flight along the final approach course, the landing and roll-out, the departure from the paved runway surface and about 3/4 minute thereafter.

Robert D. Rudich
Chief, Audio Laboratory

Attachment

Appendix G (Continued)

TRANSCRIPTION OF 5½ MINUTES OF COCKPIT VOICE RECORDING
PAN AMERICAN WORLD AIRWAYS BOEING 747, FLIGHT 811
SYDNEY, AUSTRALIA, JULY 18, 1971

LEGEND

CAM	Cockpit area microphone voice or sound source
RDO	Radio transmission from Flight 811
-1	Voice identified as Captain
-2	Voice identified as First Officer
-3	Voice identified as Second Officer (Flight Engineer)
-?	Voice unidentified
*	Unintelligible word
( )	Questionable text
(( ))	Editorial insertion
	Note: Times shown are cumulative, from beginning of transcription.

SOURCE & TIME	CONTENT
0:00	
CAM-1	Might as well try to make these altitudes
0:02	
CAM-2	Sure, okay, you have, ah, two thousand feet and another mile and a half to go
0:06.6	
CAM-3	Gear is down, no smoking's on, VOR-ADF selectors?
CAM-2	VOR -- VOR approach
CAM-1	Correct position
CAM-3	You want to check me on that gear down?
CAM-2	Gear is down, one green light
CAM-3	Speed brake
CAM-2	(Forward)
CAM-3	Wing flaps
0:25.6	
CAM-2	They are at ten degrees right now
CAM-3	Standing by
CAM-2	Okay
0:30.3	
CAM-1	Seven miles
CAM-2	Seven miles, two thousand feet
CAM-2	'kay, you're seven hundred and fifty feet to minimums
CAM-?	(Guess) we're not here
CAM-2	That's just for three miles
0:47.5	
CAM-1	Okay, flaps twenty
CAM-2	Flaps going two zero
CAM-2	Hell of a place for a graveyard -- prime real estate

1:07.0
CAM-1 Flap twenty-five
CAM-2 Flap twenty-five
CAM *Sound similar to flap handle entering detent*

1.17.0
CAM-1 And flap thirty
CAM-2 Goin' to thirty
CAM-3 Okay, wing flaps

1:23.7
CAM-2 They're set for twenty-five, they won't go down yet
CAM-2 Gate switch
CAM-? There - -

1:27.5
CAM-2 There they go - - -
CAM-3 Okay
CAM-2 - - - set for thirty
CAM-? 'kay, I got a green light
CAM-3 Hydraulic pressure and quantity are normal, engine ignition at flight start, landing checklist is complete
CAM-2 Absolutely beautiful
CAM-2 This thing * * going right to the right, 'n off we go
CAM-? (Sorry about that)
CAM-? * * (O'Hare)

2:19.4
CAM-1 There's a displaced threshold, (Ron)
CAM-2 Not on this one - - oh, we do * *
CAM-? ((multiple voices)) * yeah, marked, yeah * *
CAM-2 No * * * not used to that, that may mean a VASI, you know
CAM-1 Well, it could at that, but - - - yeah, it could
CAM-1 Well, I'm going to give it - - -
CAM-2 * * * has VASI
CAM-1 I'm going to give it a little room and - - -
CAM-2 No, that's just got the thousand foot marker on the runway, I don't see any displacement there, if it is displaced.

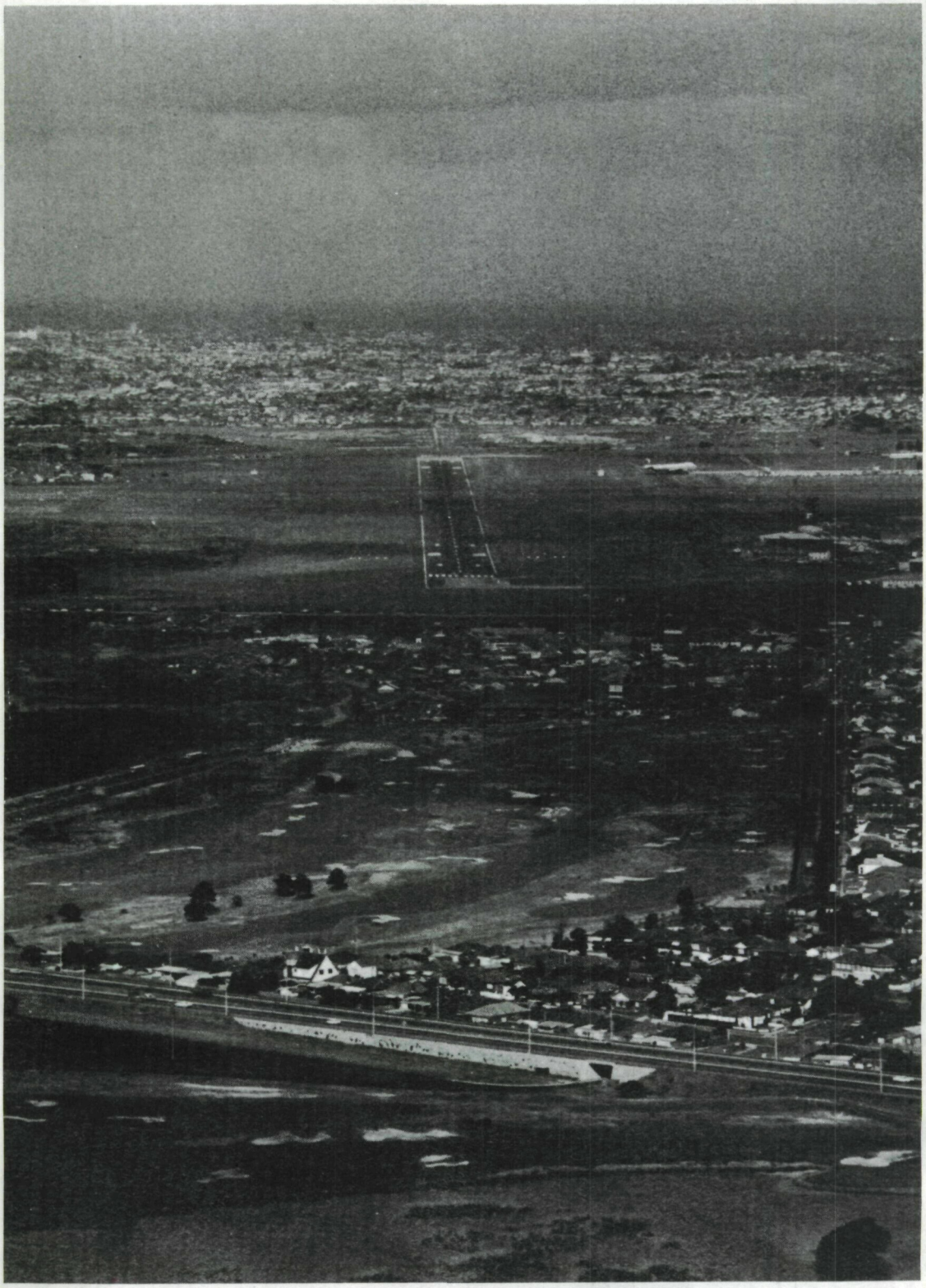
2:43.7
CAM-? The birds
CAM-2 Yeah - - that should show the VASI so that's the VASI. Could be it's that foreign kind of VASI - - shows too high, I guess

2:56.2
CAM-2 'kay, one forty-four, seven hundred feet a minute, three hundred feet above the ground.

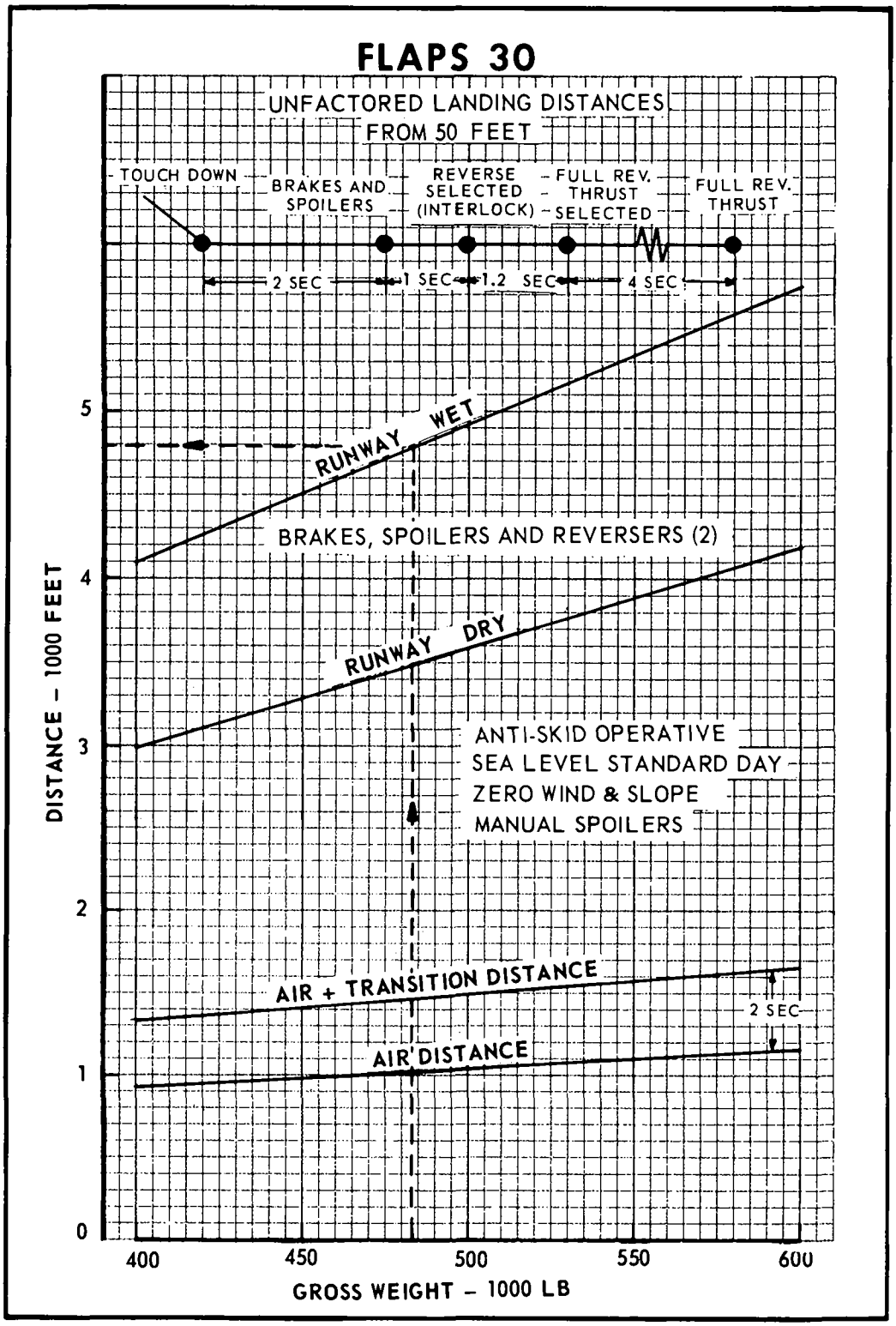
3:02.2
CAM-2 One forty-three, seven hundred feet a minute, two hundred feet above the ground.

3:08.4
CAM-2 One forty-two, two hundred feet

3:13.2	
CAM-2	One forty-four, six hundred feet a minute down, one hundred
3.13.2	
CAM-2	and fifty feet
3:20.7	
CAM-2	One four three, one hundred feet, six hundred feet a minute down
3:26.6	
CAM-2	One forty-eight, fifty feet
3:31.4	
	One forty-five, fifty feet
3:35.5	One forty ((spool-down commences))
3:38.7	
CAM	Light sound of lever click
3:45.1	
CAM	Heavier sound of lever click
3:49.2	
CAM	Multiple sounds of lever clicks
CAM-2	* *
3:51.2	
CAM-3	Inboards full reverse ((sound of engine spool up))
3:53.0	
CAM-2	You're at a hundred knots, get on 'em!!
4:03.5	
CAM-2	Sixty knots!
4:05.3	
CAM	Sound of first bang
4:06.9	
CAM	Sound of second bang followed by engine spool-down
CAM-3	Saved that one!
CAM-1	(Shut 'em)
CAM-?	Okay
CAM-1	((on public address system)) Do not evacuate, do not evacuate the airport
CAM-2	You want to cut 'em?
CAM-1	Yeah
CAM-1	You'll have to make some radio contacts
CAM-1	Ah, keep this one on
CAM-1	((on public address system)) Tower from Clipper eight eleven
CAM-2	You're on PA, you're on PA
4:49.9	
RDO-1	Tower from Clipper eight eleven, will you send the fire trucks out? We have, ah, run off the end of the runway, (done) practically no damage. However, send the, ah, trucks and evacuation ladder, please.
	End of pertinent recording.



Runway 25 as seen from a position on a three degree approach slope, approximately two miles from the landing threshold.



Boeing 747 landing performance chart.

71-2