CIVIL AVIATION DEPARTMENT

CIVIL AIRCRAFT ACCIDENT

Report on the Accident

to

Caravelle III HS-TGI

near Hong Kong International Airport

on

30th June, 1967

Price HK$7.50

C I V I L A V I A T I O N D E P A R T M E N T

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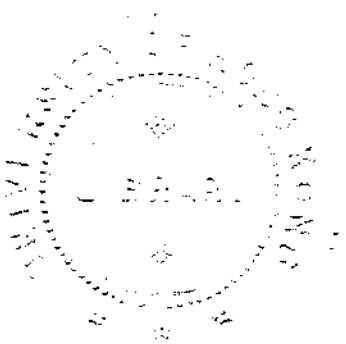

Civil Aviation Department,
Accident Investigation Division,
Central Government Offices,
Hong Kong.

August, 1968.

Your Excellency,

I have the honour to submit my report on the accident to Thai Airways International Caravelle III HS-TGI which occurred near Hong Kong International Airport on 30th June,1967.

I have the honour to be

Sir,

Your obedient Servant,

T.R. Thomson
Chief Inspector of Accidents

His Excellency the Governor,
Government House,
Hong Kong.

CIVIL AVIATION DEPARTMENT, HONG KONG
ACCIDENTS INVESTIGATION DIVISION

AIRCRAFT:	SE-210, Caravelle III Engines: Two Rolls Royce Avon, HS-TGI RA-29, MK 527
OWNER:	Scandinavian Airlines System, Stockholm, Sweden.
OPERATOR:	Thai Airways International, Bangkok, Thailand.
CREW:	Commander - Captain V. Thorsen Co-pilot - Mr. K. S'nit - seriously injured. System Operator - Mr. C. Siri Cabin Crew Air Purser - Mr. B. Vivet Air Steward - Mr. P. Thongai Air Hostess - Miss C. Nawarat Air Hostess - Miss K. Uesingi - seriously injured.
PASSENGERS:	73 - 24 Drowned 3 Seriously Injured 46 Uninjured
PLACE OF ACCIDENT:	Near Hong Kong International Airport, Hong Kong.
DATE AND TIME:	30th June, 1969 at 0710 hrs. G.M.T. (1610 hrs. Hong Kong Summer Time) All times in this report are G.M.T.

SUMMARY

Thai Airways International Flight TG 601, from Taipei, Formosa, crashed into the sea half a mile before the threshold of runway 31 at Hong Kong International Airport. 24 of the 73 passengers on board were drowned, three seriously injured and two of the seven crew members seriously injured.

The aircraft was making an instrument approach to land, during a heavy rainstorm, using ILS monitored by PAR. The Captain, who was preoccupied seeking visual reference, did not closely monitor the final stages of the approach, and did not observe that the co-pilot who was flying the aircraft had continued to descend through the minimum altitude of 415 feet (QNH). Whilst concentrating on the localiser indications, and without reference to instrument indications of glideslope, pitch attitude, altitude or rate of descent, the co-pilot made an abrupt heading change at a height of 300 feet and when already 80 feet below the glideslope.

The flight recorder shows that there was a rapidly increasing rate of descent during the final 15 second period before impact with the sea but

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no equivalent increase in airspeed is recorded. Performance calculations indicate that the recorded rates of descent are compatible with those which would have resulted from the final turn if it had been made without fully co-ordinated elevator control. Meteorological evidence suggests that there may have been downdraughts present in the final approach area.

The causes of the accident were:

(a) the pilots did not adhere to the Thai Airways procedure for a "Captain monitored" approach in bad visibility;

(b) the Captain did not monitor the approach adequately;

(c) the co-pilot mishandled the aircraft after descending below minimum altitude; downdraughts may have contributed to the height loss which resulted from this mishandling.

1. INVESTIGATION

1.1. History of the flight

Thai Airways International Flight 601, a scheduled passenger service from Taipei International Airport, Formosa, to Hong Kong International Airport, departed from Taipei at 0540 hrs. with an estimated en route time of 1 hr. 27 min., and an endurance of 4 hrs. 19 mins. The flight was made at flight level 260 and was entirely normal except that, because of turbulence expected from a severe tropical storm, the passenger seat belts were on for the majority of the flight. No turbulence of any importance was in fact experienced.

At 0638 hrs., when approximately 170 miles from Hong Kong, Flight 601 made contact with Hong Kong airways control and received clearance to descend to flight level 70. At 0658 hrs. they contacted Hong Kong approach control, which later cleared them to descend to 2,500 feet using an altimeter setting (QNH) of 999 millibars, and informed them that there was a heavy rain shower at Hong Kong and that the visibility was very reduced to 2 kilometres. The co-pilot flew the aircraft manually from the right-hand seat, whilst the Captain monitored the approach from the left-hand seat and handled the R/T communications; the third pilot, who was acting as the system operator, also monitored the flight instruments.

The approach controller provided radar guidance to position the aircraft for an ILS approach to runway 31 and, when it was at about 8 miles from touchdown, cleared the pilots to contact the precision controller. This controller cleared them to continue their ILS approach, informed them that there was heavy rain at the field and told them the overshoot procedure to be adopted should this become necessary. The aircraft remained well within the approach safety funnel (see Appendix E) 2° either side of the localiser centreline and ½° above or below the glideslope, until 3 miles from touchdown, the PAR Controller having provided information on weather, overshoot instructions and distance from touchdown as shown on the R/T transcript at Appendix C.

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In his 3 miles distance advisory the PAR Controller informed the pilot that he was just a little to the right; this appeared to be corrected and the aircraft returned to the centreline. At about 2¾ miles the aircraft descended momentarily below the glideslope safety funnel but returned quickly towards the glideslope before the PAR Controller had made any advisory comment. At 1½ miles the aircraft was again a little right of centreline and at this time also interference from the heavy rain began to obscure PAR reception, firstly in elevation and, shortly after 1 mile, also in azimuth.

Correlation of the flight recorder readout and the R/T transcript indicates that approximately 2 seconds after receiving the 1½ miles advisory that he was a little to the right, the co-pilot made a left turn of 14°. 8 seconds later the PAR Controller advised him that he was coming back to the centreline and almost immediately he began a right turn of similar dimensions. 5 seconds after this the PAR Controller gave the 1 mile advisory and the information that the aircraft was going left of centre after which the aircraft increased its rate of turn to the right. On hearing the 1 mile advisory the Captain reinforced it by telling the co-pilot to move to the right and a moment or two later, when looking across the cockpit, saw the sea about 100 feet below through the co-pilot's side window. He immediately attempted to make a pull up, but the aircraft struck the surface, bounced slightly, and settled on the water about 3925 feet before the ILS reference point of runway 31 and about 100 feet left of the ILS centreline.

According to the survivors the impact was not unduly greater than that of a heavy landing but the starboard wing and undercarriage broke away, the latter ripping open the underside of the fuselage; in addition, the rear end of the fuselage broke open. As a result of this damage the aircraft sank very rapidly and 14 of the passengers did not escape from the fuselage and were drowned, 6 were dead on arrival at hospital, four were missing and later found drowned. The remaining passengers and the crew were rescued by nearby surface vessels and a helicopter.

1.2. Injuries to Persons

Injuries	Crew	Passengers	Others
Fatal	0	24	0
Non-fatal	2	3	0
None	5	46	0

1.3. Damage to aircraft

On striking the water the aircraft sustained damage which destroyed its flotation capability so that it sank within three minutes. The damage prevented the opening of two of the window emergency exits and delayed the opening of the main cabin door. The wreckage was subsequently salvaged except for the undercarriage and right wing which were not recovered.

1.4. Other damage

None.

/1.5. Crew.....

1.5. Crew Information

Captain Viggo Thorsen, aged 43, held Danish airline transport pilot licence No.D-1705, endorsed for Caravelle aircraft in command, and issued 7th December 1954. His last periodical training was completed on 23rd May,1967, and his last Caravelle emergency drill training was on 26th June, 1967. His last medical examination was on 12th January, 1967, and his licence, valid until 24th July,1967, was endorsed with a requirement to wear glasses for close work whilst on flight duty. At the time of the accident he had a total flying time of 7,800 hrs. of which 3,700 hrs. had been in Caravelle aircraft. He had considerable experience as an instructor pilot on this type of aircraft since 1960, in Europe and S.E. Asia. He had flown 212 hrs. 51 mins. in the preceding 90 days and 64 hrs. 31 mins. in the preceding 30 days.

The co-pilot Mr. S'nit Khemanand, aged 50, held Thai airline transport pilot licence No.3 endorsed for co-pilot on Caravelle, DC4, and DC 6B aircraft and issued in 1950. His last periodical training was completed on 5th June,1967, and his last Caravelle emergency drill training was on 22nd June, 1967. His last medical examination was on 1st January,1967, and his licence was valid until 16th July,1967, with an endorsement that he must use glasses at all times. He had a total flying time of 18,400 hrs. of which 2,300 were in Caravelle aircraft. He had flown 196 hrs in the preceding 90 days and 75 hrs. 47 mins. in the preceding 30 days.

The system operator, Mr. Siri Chayattana, aged 33, held Thai commercial pilot licence No.78, endorsed for co-pilot on Caravelle aircraft and issued on 23rd November,1966. His last Caravelle emergency drill training was on 9th February,1967, and on 14th May, 1967, he had completed his initial base training for co-pilot on the Caravelle. He was on board the aircraft for route experience training, and had been the active co-pilot on the previous sector from Osaka to Taipei, but on this sector from Taipei to Hong Kong he was acting as system operator. He had a total flying time of 1500 hrs. of which approximately 50 hrs. were in Caravelle aircraft. He had flown 29 hrs. 52 mins. in the preceding 90 days and 66 hrs. in the preceding 30 days.

Following a rest period of 36 hrs. in Osaka the three pilots had been on duty for 6 hrs. at the time of the accident and had flown 4½ hrs. during this period.

The four members of the cabin crew had received Caravelle emergency drill training within the 6 months preceding the accident. They had had the same rest and duty times as the flight crew, except for Air Hostess Uesingi who had started duty in Taipei after 95 hrs. rest time.

1.6. Aircraft information

The aircraft was a Sud-Aviation Caravelle III, Constructors Number 25, owned by Scandinavian Airlines System since new and delivered to them in March 1960; at the time of the accident it was on lease to Thai Airways International and registered in Thailand. The Thailand Department of Aviation approved the operation and maintenance of the aircraft in

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accordance with the SAS Operations Manuals, Flight Manual and Maintenance Manuals; these manuals are approved by the Swedish Board of Civil Aviation.

The last basic overhaul (periodicity 3,500 hrs.) was completed in Stockholm in September 1966 and when the aircraft had flown 14,895 hrs; following this overhaul the aircraft was flown to Bangkok on a temporary Certificate of Airworthiness (Swedish). After inspection at Bangkok, Thai Certificate of Airworthiness No.25/09 was issued on 6th October, 1966, and was valid until 30th September,1967. The last 400 hrs. periodical check was completed on 26th June,1967, and the last "K" check (made every night-stop) was done at Tokyo on 29th/30th June; en route and pre-flight checks were made at Taipei before departure for the flight to Hong Kong. The aircraft had flown a total of 17,359 hrs. at the time of the accident.

Two Rolls Royce Avon RA-29, MK.5278, turbojet engines were installed:-

Position	Serial No.	Time since last complete overhaul
1	30719	1,350 hrs.
2	30724	1,450 hrs.

The weight of the aircraft at take-off from Taipei was 45,977 kg., of which 11,810 kg. was fuel; the estimated fuel consumption to Hong Kong was 4,740 kg. The load distribution and the centre of gravity were within the prescribed limits; VFA for the accident/landing weight of 41,237 kg. was 123½ knots.

The aircraft was equipped with duplicate panels of Sperry Integrated Instrument System flight instrumentation, for Captain and co-pilot. As installed, a single computer served both flight directors, but all other flight instrumentation on the Captain's and co-pilot's panels was operated from separate sources. Two VOR/ILS receivers were fitted each incorporating a glideslope receiver; when switched to the approach mode the IIS used the No.2. (co-pilot's) ILS receiver information to provide flight director guidance. This guidance enables the pilot to maintain the aircraft on the ILS localiser and glideslope but does not give an obvious representation of the position of the aircraft relative to the ILS. This relationship is displayed on the PDI, which is a combination of compass repeater and ILS deviation indicator. The Captain's and co-pilot's PDI obtained their ILS information from receivers No.1 and No.2 respectively; the heading information for each PDI was also independently provided from the Captain's and co-pilot's C-6 compasses.

1.7. Meteorological information

A severe tropical storm which had been centred about 150 nautical miles east of Hong Kong at 1800 hrs. on 29th June had moved to the north by 0600 hrs. on 30th June.

The forecast for Hong Kong for the period 00-09 hrs. on 30th June, received by the pilots at Taipei, read as follows:-

/Surface.....

Surface wind:	360°/15 knots, gusting to 30 knots
Visibility:	7 nautical miles
Weather:	Nil
Cloud:	5/8 cu. base 2000 feet
Intermittently:	
Visibility:	2 nautical miles (3 kilometres)
Weather:	Rain or thunderstorm and rain showers
Clouds:	3/8 cb. base 1200 feet 5/8 cu. base 1800 feet 7/8 as., base 8000 feet.

The 0630 hrs. weather observations for Hong Kong International Airport, for Cheung Chau (11 miles south west of the Airport) and for Cape Collinson (4 miles south-east), broadcast on the Mount Kellett VOR from 0637 hrs. to 0708 hrs., were as follows:-

	Cheung Chau	Hong Kong Airport	Cape Collinson
Surface wind:	220°/4 knots	250°/10 knots	190°/1 knot
Visibility:	10 km	9 km	6 km
Weather:	Rain	Rain	Rain
Clouds:	2/8 base 1200 ft.	1/8 base 900 ft.	2/8 bas 1000 ft.
Temp/Dew Pt.	----	27/25°C	----
Trend:	----	Gradu:- 360/15 knots Gusts 25 knots Vis tempo 4 km.	----

The Airport observations for 0700 hrs. and 0710 hrs. were the same as the 0630 hrs. observation, except for the wind and the visibility which were as follows:-

	0700 hrs.	0710 hrs.
Surface Wind:	280°/10 knots	250°/12 knots
Visibility:	4 km 2800 m. to S.E.	4 km 2800 m. to S.E.

The 0700 hrs. observation was not passed directly to the aircraft, and was not broadcast via the Mt. Kellett VOR until 0708 hrs., but, when the aircraft was about 10 miles from touchdown, the pilots were informed that there was a heavy rainshower over the field and that visibility was very reduced to 2 kilometres. At 6 miles on the approach they were informed that there was heavy rain at the field and at 3½ miles they were advised that there was heavy rain at 1½ miles from touchdown and all over the field. No visibility

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report was made to them after that which had been given at 10 miles. According to the pilot of a helicopter the visibility in the rainstorm was about 300 yards and this value was confirmed by witnesses who were in the immediate area of the accident; although the crash point was only some 500 feet from the outer strobe light, the pilots did not see it nor any of the approach lighting. Visibility at Hong Kong is measured from the control tower, which is at the north-west end of the airport, i.e. the opposite end of the aerodrome to the approach area of runway 31.

The Royal Observatory at Hong Kong prepared a report concerning the general weather circumstances relating to the accident. The relevant portions are as follows:-

Rainfall intensity: This is recorded by a number of Jardi instantaneous recorders in the area, and the peak reading was 144 mm/hr. at the Observatory itself; this is about three miles west of the accident site, and on the line of travel of the storm towards the approach area of runway 31. The peak value at the airport was 126 mm/hr. about six minutes after the accident occurred, although the heavy rain had started there some eight minutes previously. The report concludes that it was most unlikely that the intensity in the approach area at the time of the accident could have exceeded 200 mm/hr.

Downdraughts: Anemograph records show windsqualls at various points in the area. These were of one to two minutes duration in which the wind backed about 30° whilst the strength increased by about 15 to 20 knots and then fell again to 5 or 6 knots. Although there is no direct evidence to confirm it, there is a possibility that these squalls were the result of downdraughts associated with the storm.

QNH errors: Based on all available information, including a radio sonde ascent, it is concluded that the maximum error to altimeters, resulting from the use of the QNH of 999 mb. during the accident period, could have been 216 feet when the aircraft was at 4,500 feet, reducing to 10 feet when it was flying at 200 feet; the altimeter reading would have been always lower than the true height of the aircraft.

1.8. Aids to navigation

Runway 31 is equipped with ILS and with PAR, both aligned to a centreline of 315°M and with a glideslope of 3°. According to the monitoring equipment, these facilities, the Mt. Kellett VOR, the Tathong Point M/F beacon, the airport M/F beacon, and the Hung Hom M/F beacon and the Outer and Middle marker beacons of the ILS were operating normally throughout the accident period. When flight checked after the accident there were no deficiencies in any of these aids.

Flight 601 was cleared by approach control to make an ILS approach, and this clearance was confirmed by the precision controller in his initial contact. Although PAR monitoring was provided, the pilots were not informed that it was to be given; the Hong Kong Air Traffic Control Instructions require the PAR Controller to give this information during his initial transmissions to an aircraft whose approach he intends to monitor. When preparing for the approach, the Captain assumed that only ILS would be used, and that his mimimum altitude would therefore be 615 feet; the co-pilot and

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the system operator assumed 415 feet, the Thai Airways minimum altitude for an ILS approach with PAR monitoring.

During the final stage of the approach, interference from the heavy rain obscured PAR reception, and the controller was unable to observe the aircraft in elevation after about 1½ miles and in azimuth shortly after 1 mile. By the time this interference became too great to permit accurate monitoring the aircraft was at a point on the approach where the pilots were required either to have visual reference, or to have initiated an overshoot.

1.9. Communications

Communication between the aircraft and the ground stations was satisfactory throughout, although the Captain did not acknowledge the PAR Controller's advisories after 4 miles apart from transmission clicks which followed the 3½ miles advisory. All advisories up to and including that at 1 mile, were received in the aircraft, but it is probable that the final overshoot advisory, 12 seconds after 1 mile, was virtually coincident with the crash; none of the pilots had any recollection of this transmission.

Pilot reception of the ground transmission was via loudspeaker in the flight deck roof panels and headsets were not used; this is approved by Thai Airways for this type of aircraft. Although the Captain and the co-pilot heard all ground transmissions down to and including the 1 mile PAR advisory, the system operator does not appear to have heard anything after about 4 miles.

1.10. Aerodrome and ground facilities

Runway 31, the main instrument runway at Hong Kong, is 15 feet above mean sea level, 8350 feet long and is equipped with 2000 feet of centreline approach lighting, with a white strobe light at the promontory end and outer end. This lighting and the runway lighting was at 100% intensity and operating normally throughout the period of the approach.

The runway is essentially an artificial causeway extending southeastwards into the sea; the approach is along the channel between Hong Kong Island and the mainland and is entirely over water after passing the outer marker. The SAS Route Information Manual, used by Thai Airways, contains a warning that, as a consequence of the surrounding terrain, the final approach area is frequently subject to some degree of turbulence and occasional downdraughts, and the wind is frequently variable both in direction and strength during the approach.

1.11. Flight recorder

A Fairchild 5424 - 201 Model D, installed on 17th May,1967, and located in the right-hand radio rack, recorded airspeed, height, heading and vertical acceleration. When recovered from the sea, although the casing and the mechanism were heavily corroded and contained sand particles, the foil record was undamaged and perfectly engraved. Readouts were prepared in Stockholm under the supervision of the Swedish Board of Civil Aviation who reported that the recorder appeared to have been operating correctly, except for the vertical acceleration recording; this was not considered sufficiently accurate to be of use in the investigation, apart from providing

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a valid impact/Zero, time/height datum. The limitation imposed by the failure of the acceleration recording combined with the lack of a recording of pitch attitude, elevator angle, or engine power made it impossible to prepare any valid integration of the flight path during the approach.

The times and distances of the PAR advisories were correlated with the recorder traces, and the theoretical glideslope was also related to the height trace, taking account of the PAR Controller's evidence. The correlation is considered to be accurate to within about 5 seconds.

An assessment of the approach flying as indicated by the recorder traces, was made by the Blind Landing Experimental Unit of the Royal Aircraft Establishment (RAE) in the United Kingdom, taking account of the type of flight instrumentation, the aircraft's flying characteristics and the meteorological information available. The information was inadequate for a really refined analysis, but down to about 400 feet the approach was assessed as of an adequate standard, apart from one brief excursion below the glideslope at about 2¾ miles, which was quickly corrected. The heading trace, although probably indicative of hard work by the pilot, suggests that until the final large corrections, the aircraft was well inside the one dot localiser displacement, despite wind change with altitude and possible side gust or turbulence effects.

Speed holding was assessed as quite good after the initial bleed-off to VFA + 10 knots in the early stages of the approach. It is noted however that during the final period when the rate of descent was increasing rapidly, after the minimum altitude of 415 feet, there was apparently no equivalent increase in airspeed. In the absence of more information on pitch attitude, acceleration or power setting, it is not possible to account for this with any certainty. However calculations made by the Aero Flight Division of the RAE indicate that these rates of descent are those which would be expected as a result of the final turn if it had been made without proper co-ordination of the elevator control.

1.12. Wreckage

The starboard wing and the undercarriage were not recovered, but the remainder of the aircraft was salvaged and removed to a site in the reclamation area of Kowloon Bay for detailed examination. From this examination it was concluded that the aircraft had been complete, with undercarriage and flaps extended, when it hit the water in an approximately level attitude laterally and longitudinally; the undamaged nose radome and the form of the water pressure damage suggest that it may have been slightly nose up at impact.

When the nose gear broke loose it ruptured the underside of the forward fuselage, resulting in damage to, and the upward deflection of, the cabin floor structure. As well as allowing water to enter the forward cabin, this resulted in the tilting of the seatbacks outwards, so that it was impossible to open the forward window emergency exit on each side of the aircraft. The nose gear also probably struck the rear fuselage, and weakened the structure at the rear end of the cabin. When the aircraft was slewed by the arresting influence of the starboard wing, which was deflected

/upwards.....

upwards and rearwards at impact with the water, the already weakened rear section of the fuselage, with empennage and engines, separated structurally and rolled to the left in relation to the remainder of the fuselage; it remained attached by hydraulic pipelines, control cables, and electrical wiring. The bottom of the rear fuselage and the air stairs had been torn out, the fore and aft nature of the separation indicating that this had occurred previous to the separation of the tail section of the fuselage. The damage to the forward underfloor structure also disarranged the bungee chains of the left-hand forward door opening mechanism; the crew experienced great difficulty in opening this door after the accident. The general nature of the damage sustained in the crash had virtually destroyed the flotation capabilities of the aircraft, as well as preventing the opening of two of the four escape exits and damaging the door mechanism.

Examination of the flaps on the left wing showed that the operating jacks were all at the 35° (full flaps) position thus agreeing with the control pedestal selector position. The airbrakes were closed and their operating jacks in the retracted position, this also was consistent with the flight deck selector position. The flying controls installation had been ruptured in association with the two main structural separations of the right wing and the rear fuselage; the investigation produced no evidence of any defect or failure of this installation which was not considered to be attributable to the impact sequence itself.

The radio and flight instrument selector switches were all correctly positioned for an instrument approach using the Hong Kong ILS and the approach mode of the IIS. All other electrical and ancilliary switches in the cockpit were correctly set for normal operating conditions during an approach to land.

The pitot static systems were examined in detail and found to be satisfactory. The co-pilot's flight instruments, together with the Flight Director Computer, the Captain's Horizon Flight Director, ASI and Altimeter and both three axis data generators, were removed and examined by SAS in Stockholm under the supervision of the Swedish Board of Civil Aviation. They reported that there was nothing to suggest that any of these items was not operating normally before the accident.

The separation of the rear fuselage resulted in damage and distortion in the engine control linkages, and made it impossible to determine the pre-crash settings with any real accuracy. From examination of the damage to the inlet guide vanes and '0' stage rotor blades, the manufacturers assessed the engine speeds as having been considerably more than 6,000 rpm. at impact. From the position of the damage where the inlet guide vanes had been impacted by these rotor blades, it appeared that the inlet guide vanes had been in the fully open position; in the circumstances prevailing at the time the manufacturers considered that this was an indication of at least 7,530 rpm.

Except for minor points discussed in the analysis section of this report the pilots stated that they were satisfied as to the integrity of the aircraft, its engines and its instruments before the crash. Detailed investigation has produced no evidence to the contrary and it is considered

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that the aircraft was structurally intact and in all respects operating normally prior to the impact with the sea.

1.13. Fire

There was no fire.

1.14. Survival Aspects

The aircraft was equipped with two R.F.D. 26 place inflatable rafts with canopies, stowed in the forward gallery area. A life jacket was available for each crew member and passenger, the passenger life jackets being stowed under each seat in plastic containers. The Cabin-Emergency Landing Check Lists were displayed correctly and a demonstration of the use of the life jacket was given to the passengers prior to take-off from Taipei. During the approach the "Seat-Belt" sign was illuminated and all passengers' seat belts were fastened for landing.

Each crew member had carried out ditching drill during the preceding twelve months and Emergency Procedure Training during the preceding six months; the Captain and Purser only four days before the accident and the co-pilot eight days before. The crew positions at the time of the accident were those for a normal landing and therefore when the aircraft struck the water there was an element of surprise. The flight crew evacuated through the flight deck emergency exit windows.

The rear end of the fuselage had broken away on impact at a point immediately behind the rearmost row of passenger seats, providing a quick and easy means of evacuation for passengers in the rear portion of the cabin; but this also permitted rapid ingress of water into the fuselage. The only crew member in the cabin, the air hostess, who was sitting on the occasional seat in the centre aisle immediately forward of the toilets, was thrown out of the aircraft and seriously injured when the tail section fractured. There was thus no direction of the passengers in the cabin by any crew member during the three vital minutes between impact and the aircraft sinking.

The Purser attempted to open the main passenger door on the port side but it was partially jammed and was eventually opened with the help of a passenger who had been seated in the front of the first class cabin section. The Purser then broke out one life raft with the help of the steward and air hostess and launched it through the main door without a tether. Water was then up to the door sill and a number of passengers expressed apprehension at the time taken by this operation which partially blocked the exit. No attempt was made to open the starboard exit door. The life raft proved invaluable inasmuch as survivors were able to have some means of support. Due to lack of tether, however, the raft moved quickly away from the aircraft by the action of wind and tide, making it difficult for indifferent swimmers to reach it. The hand holds of the raft were not easy to grasp and the presence of fuel, oil and hydraulic fluid made the entire raft very slippery. The sides of the raft proved awkward to negotiate for boarding for those survivors who failed to find the boarding step. Some did not realise that the raft had a canopy and several persons boarded on top of the canopy to the detriment of those sheltering underneath it.

/ The two.....

The two forward over-wing exits could not be opened because of damage sustained during the crash. The port rear over-wing was undamaged but had not been opened; the starboard rear over-wing emergency exit was opened by a passenger who assisted his wife through the opening and followed her on to the starboard wing stub. It is believed that these were the only two passengers to evacuate the aircraft by this means. The Captain later attempted to open the forward starboard over-wing exit from outside the cabin, but failed. Many passengers abandoned the aircraft without their life jackets, either because they took too long to find, or were difficult to locate and extract with the seats submerged or could not be removed quickly enough from their plastic cases. Some passengers who put on life jackets were unable to tie them properly or inflate them once they were in the water as they were helping others and could not perform these tasks with one hand.

There were several boats and one helicopter in the vicinity which assisted the airport fire launch in picking up survivers. The sea temperature was high enough to be ideal for survival and the water was comparatively calm. The majority of the passengers interviewed were reasonably proficient swimmers and this fact is considered to be partly responsible for the comparatively high survival rate. Fourteen bodies were recovered later from the wreckage and it is assumed that these were the only ones unable to evacuate the aircraft. None was restrained by a seat belt and the cause of death in every case was described as asphyxia by drowning.

From a passenger seating plan based on the evidence available an area of probability of non-survival was established, embracing seat rows 7 - 12; this is the area served by the window emergency exits.

1.15. Tests and research

None.

1.16. Thai Airways Instrument Approach Procedures

In Thai Airways International, when the co-pilot is appropriately qualified, it is customery for him to share the flying, including the take-offs and landings, on a more or less equal basis with the Captain and to do this flying from the right-hand seat; their Caravelle aircraft are equipped with duplicated flight instrument panels which facilitate this arrangement. The operating standards of the airline, and the manuals which define them, are those of Scandinavian Airlines System and are approved by the Thailand Department of Aviation. The flight crews include both Thai and Scandinavian nationals who are required by their Flight Operations Manuals to use the English language whilst operating the aircraft; the Thai Airways manuals are written in that language.

The Flight Operations Manual specifies two methods of instrument approach procedure, known respectively as "Normal" approach and "Captain monitored" approach; both are intended to overcome the problem of divided attention between instrument and visual flight during the transition from instrument approach to visual reference for landing. No mixing of the two methods is permitted. The first is to be used when the weather conditions will permit visual reference at a reasonably early stage of the approach; in this method either the Captain or the co-pilot may make both the instrument approach and the subsequent visual reference landing.

/The.....

The nonactive pilot acts as monitor and lookout, and informs the active pilot of the position of the approach lighting or the runway when those become clearly visible; the active pilot then changes to flight by visual reference and completes the approach and landing.

The "Captain monitored" approach is to be used when visual reference is not expected until late in the approach, thus allowing only a very brief time for the evaluation of the references which may be obtained. In this method the instrument flying is always done by the co-pilot whilst the Captain monitors the approach. When nearing minimum altitude the Captain divides his time between monitoring and seeking visual reference; when he obtains this he says "my controls", takes over control and completes the approach and landing. The co-pilot is not required to participate in seeking or assessing the visual reference but is required to continue to watch the flight instruments until the flare out for the landing. The changeover of of control must necessarily take place at or before minimum altitude and the procedure to be used when it proves impossible to complete the approach in this manner is defined as follows:-

> "Flight Operation Manual 3.1.8., item 3.4.2. (part):-
>
> If visual guidance is obtained but the aircraft is in a position <u>not</u> permitting a safe landing (ref. 3.7. below) the approach shall be abandoned and a pull-up procedure initiated by the Pilot-in-Command ordering the co-pilot: "pull-up".
>
> If no or not enough visual guidance is obtained when reaching minimum altitude the co-pilot shall initiate and perform a pull-up procedure by calling "pulling-up".
>
> During this phase the Pilot-in-Command shall be prepared to take over the control of the aircraft but shall not interfere as long as everything is working out normally."
>
> (The reference in the text to 3.7. is not relevant to this accident analysis. The expression "Pilot-in-Command" is synonomous with "Captain" as used in this Report).

The Manual also includes instructions that during both methods of approach the non-active pilot is required to call out two height warnings, in the form "Minimum plus hundred" and "Minimum Altitude", at the heights appropriate to the particular approach.

2. ANALYSIS AND CONCLUSIONS

2.1. Analysis

The accident occurred during an instrument approach which commenced in reported weather conditions well above the authorised limits but was continued without visual reference below the minimum altitude authorised by Thai Airways International for instrument approach to runway 31 at

/Hong Kong.....

Hong Kong. When examining the evidence relating to the accident it is appropriate to consider the principle aspects under separate headings, as follows:-

2.1.1. Meterological Aspects

Consideration is given to whether there was any deficiency in the weather information passed to the pilots and whether the information provided, or any lack of weather information could account for the Captain's failure to order overshoot action when the aircraft reached minimum altitude without visual reference being obtained.

The pilots had made their preparations for the approach with the reported weather better than their authorised minima which were 1.5 kilometres visibility and a minimum altitude of 615 feet using only ILS, or 415 feet if using ILS monitored by PAR. When they were about 10 miles from touchdown they were informed that there was a heavy rainshower over the field and that the visibility was very reduced to 2 kilometres. This was in keeping with the terms of the forecast they had received at Taipei.

During the approach they received further information from the PAR Controller which included advice that there was heavy rain at the field and notification as to the overshoot procedure to be used if necessary; at 3½ miles from touchdown they were further advised that the heavy rain was at 1½ miles from touchdown and all over the field. Shortly before the aircraft reached 2 miles from touchdown the Tower Controller informed the PAR Controller that there was solid rain about two-thirds down the runway; since this was some 1850 metres from the Tower there was, by definition, no significant change from the previously reported visibility of 2 kilometres. The PAR Controller did not pass the information concerning the solid rain to the pilots. Independent evidence from eye witnesses confirms that the actual visibility in the approach area at the time of the accident was less than 700 yards and probably about 300 yards in very heavy rain.

Had the PAR Controller passed on the information concerning the presence and position of the solid rain this might have served to make the pilots more alert for a visibility in the final stages of the approach appreciably below the 2 kilometres which had been reported as the aerodrome visibility. In particular if the co-pilot had appreciated that the visibility in the final approach area was not necessarily of this order, and indeed might at times be virtually nil, it is unlikely that he would have formed the mistaken belief that the Captain had visual reference; this belief was one of his reasons for continuing the descent below the minimum altitude.

However, the co-pilot could not have continued the descent in any mistaken belief that the Captain had visual reference if the latter had monitored the co-pilot's flying, as required. This continued descent was not therefore attributable to any misconception on the part of the co-pilot brought about by a lack of weather information.

In any case the limited visibility which can occur in tropical rainshowers, even of small dimensions, is well known to professional pilots therefore air traffic control do not provide any specific warning other than to report the presence of heavy rain and its relationship to the flight

/path.....

path; the PAR Controller had given precisely this information during his 3½ miles advisory. A realisation that he might encounter a serious deterioration of visibility in this heavy rain may reasonably be considered a matter of normal cautionary anticipation by a Captain qualified on this route. From the position of the rain area as given to him by the PAR Controller it should also have been apparent that the potential visibility deterioration would apply at or about the minimum altitude position.

International practice is to limit visibility reports to what can be observed at the point from which the report emanates and not to estimate what it may be elsewhere. At Hong Kong there are no facilities or methods by which the visibility in the approach area can be measured or estimated from the tower position, nor is there any requirement for such measurement or estimation. Under the terms of Annex 6 to the Convention on International Civil Aviation, the general situation concerning the methods and limitations of weather reporting in his specific operating area is within the required knowledge of the pilot in command of an aircraft as part of his route qualification requirements.

Except in emergency a pilot must not descend below his minimum altitude during an instrument approach unless he has adequate visual reference at that time; neither reported weather conditions nor the lack of any such reports alter this basic requirement for the decision to overshoot or to continue descent. Any departure from this principle would contradict internationally accepted standards and lead to the inference that the operator's standards were at an inferior level. No such criticism is considered to apply to Thai Airways International.

In summary the reported weather information, in particular that received when the aircraft was at 3½ miles from touchdown, was adequate for the Captain's purposes. The failure to make an overshoot cannot be attributed to any lack in weather reporting; weather reporting had also no relevance to the subsequent events.

2.1.2. Flight-deck Aspects

Consideration is now given to the pilots' activities during the approach down to the time of passing minimum altitude.

In his pre-approach briefing during the descent to join the ILS the co-pilot was required to state the approach aids he intended to use and to give the actual value of the minimum altitude that would apply; during this briefing he did not mention PAR nor did he state the value of the minimum altitude. The Captain correctly assumed a value of 615 feet appropriate to the ILS approach for which they had been cleared; the co-pilot and the system operator took it as 415 feet appropriate to an ILS approach with PAR monitoring although no such clearance had been given to them, nor had it been discussed.

At this briefing the Captain was required to decide which method of approach should be used and to inform the co-pilot accordingly. The co-pilot had been flying the aircraft since leaving Taipei and the approach preparations were made with the reported weather such that a "Normal" approach was obviously adequate; it would seem that a "Normal"

/approach.....

approach was assumed by the co-pilot rather than specifically ordered by the Captain. At about 7 miles from touchdown, after receiving the information that the visibility was reduced to 2 kilometres, the Captain ordered the co-pilot to make a "Captain monitored" approach. He subsequently became disturbed by the co-pilot's apparent inattention to instrument flying and therefore ordered him to concentrate on this and stop looking out of the aircraft. In doing this the Captain was indirectly emphasising the principle behind the "Captain monitored" approach and affirming his own responsibility for seeking and assessing the visual references.

When the pilots were re-examined twelve days after the accident it proved impossible to reach any completely clear understanding of the circumstances which had led the co-pilot to his confused thought and action at minimum altitude. He said that he knew he had been ordered to make a "Captain monitored" approach and knew this required him to make an overshoot at minimum altitude if the Captain had not said anything by that time; he also said that he knew the overshoot procedure applicable to the runway in use. In stating his reasons for not taking overshoot action, he said he knew the runway was clear and knew he was going to make the landing himself; he also thought the Captain was visual and that he would also become visual before reaching the runway and because the Captain said nothing he continued the descent. This confusion of the two approach methods and the assumptions concerning visibility may have originated in a combination of language difficulty and a weakness in the Flight Operations Manual procedure for a "Captain monitored" approach.

This procedure makes it quite clear that the only approved method of continuing to a landing requires the Captain to say "my controls" and take over the controls for the final stage and the landing. The procedure to be followed by the co-pilot when the Captain does not do this is not so clear and presents the possibility of confusion. During the re-examination it was by no means obvious whether a requirement for his own overshoot action had been completely clear to him at the time of the accident or had become so afterwards during discussion. The defined procedure appears to require a decision that the visual reference is insufficient before the co-pilot initiates an overshoot. If the procedure is to retain its basic principle of eliminating division of attention by the instrument flying pilot then obviously the Captain must make this visibility assessment and inform the co-pilot of his decision. A clearly defined fail-safe step, such as one that requires the co-pilot always to start an overshoot if the Captain has not taken control by minimum altitude is missing from the procedure as it existed at the time of the accident.

During re-examination the system operator was insistent that the Captain's final words to the co-pilot had been "cleared to land" but he was unable to recall the PAR transmissions after the one made at 4 miles in which the controller informed them "you are clear to land I say again clear to land". They were slightly less than one minute from minimum altitude when the Captain repeated this across the flight deck to the co-pilot. The wording of the transmission is standard phraseology to inform pilots that the runway is not obstructed or otherwise hazardous to a landing aircraft; it has no other significance. On this occasion the system operator certainly misinterpreted the Captain's repetition of this phrase as signifying approval that the approach be continued through to a landing;

/the.....

the lowest reported visibility value had been 2 kilometres and therefore it is possible to see how the copilot may also have come to misunderstand the Captain's words. In deciding that he himself was to do the landing he departed from the principles of the method he was supposed to be using, reverting partly to the "Normal" method; however he also continued to fly solely by instruments which is the "Monitored" method.

During the critical period approaching minimum altitude the Captain was preoccupied in seeking visual reference and did not hear the system operator call minimum altitude when the aircraft reached 415 feet although he had heard the previous call one hundred feet earlier. Under the terms of the Flight Manual he should have been making his own warning calls; had he been doing this it is unlikely that the co-pilot's confusion would have resulted in a continued descent without the Captain being immediately aware of it and taking action to prevent it.

In summary, there was a lack of co-ordinated activity between the Captain and the co-pilot, and neither of them adhered to the terms of their Flight Operations Manual. This resulted in the co-pilot becoming confused and continuing to descend, unnoticed by the Captain, after reaching minimum altitude although neither pilot had visual reference at that time.

2.1.3. Instrument flying aspects

Consideration is given to the validity of the flight instrument indications and to the use made of their instruments by the pilots after passing minimum altitude.

It has not been possible to decide what part, if any, a late realisation that PAR was being used may have played in contributing to the Captain's preoccupation and apparent inattention to his flight instruments during the critical period between about 600 feet and 200 feet. In his evidence the Captain maintained that he had initially accepted the approach as being solely on ILS with a minimum altitude of 615 feet, and that although he had subsequently become aware that a PAR monitor was being given he nevertheless did not alter his chosen minimum from 615 to 415 feet. However his own evidence was somewhat contradictory on this point since although he stated that he could recall having seen 600 feet on his altimeter, it is evident that no overshoot action was then taken.

All the ground radio aids were operating normally and, apart from the co-pilot's doubts concerning the QNH, the pilots expressed themselves as satisfied concerning the integrity of the flight instruments. The Captain and the system operator confirmed that there had been no discrepancies between the two flight instrument panels during the approach, the last such check having been made at 520 feet by the system operator; nothing was found during the post-accident examination to suggest any of the relevant flight instruments had not been operating normally before impact.

The co-pilot's suggestion that altimeters set to the QNH originated at Hong Kong Airport would have been in error during the approach is discounted by the Royal Observatory at Hong Kong, whose calculations indicate that the error would have been only about 10 feet when the aircraft

/was .....

was at 200 feet, with the altimeter reading lower than the true height of the aircraft. Had the pilots conformed to their Flight Operation Manual, they would have checked this by the use of the radio-altimeter; although this instrument was serviceable they did not do so. The co-pilot also said that he believed that there was always a 5 knots difference between the airspeed indicators in this aircraft, although he could not recall which was the lower on this flight. The flight recorder shows a reasonably constant value of about VFA + 7 knots throughout the final minute of the approach, and it is not considered that a difference of 5 knots could have been of significance in causing the height loss.

Neither the Captain nor the co-pilot could have noted the indications of glideslope, altimeter or rate of descent during the final critical period. Had they done so corrective action in relation to the glideslope would have been obvious to them by the time the aircraft had reached 300 feet. Similar inattention to these instruments and therefore failure to apply corrective action must have continued until very late in the rapid descent sequence; indeed the co-pilot and system operator indicated that during the final turn they were concentrating on the localiser indications of the PDI.

In such circumstances it would obviously have been impossible for the pilots to have been misled by any erroneous indications on these instruments; there is also no evidence that there were any such erroneous indications.

In summary there is no reason to doubt the integrity of the flight instruments up to the time of impact. The pilots did not give full and proper attention to the indications of glideslope, altitude, rate of descent and pitch attitude during the final stage of the approach.

2.1.4. Engine power aspects

Examination of the engines revealed no evidence of any pre-crash failure or malfunction and, although the Captain expressed some doubt concerning engine response when he had attempted to apply full power, he qualified this with his feeling that there may well have been insufficient time for the power to take effect. These doubts raised implications of a possible power reduction or flame-out during the late stage of the approach and this matter was pursued with the engine manufacturers. Based on their evidence there is no reason to consider that the amount of rain experienced by Flight 601 was sufficient to have resulted in either a power reduction or a flame-out. If either occured then it was for some other reason than the rain encountered on the approach.

From the nature and extent of the damage to the engines, in particular to the inlet guide vanes and the "0" stage of the compressor, the manufacturers considered that the engines had been running at well above 6,000 rpm at impact, and probably at least 7,530 rpm. This confirmed the impossibility of flame-out at least until about 1. 2 seconds before impact, this being the time an engine takes to run down from take-off rpm. to the 6,000 rpm. value; flame-out cannot therefore account for the height loss. Considered against the evidence that the co-pilot had made only minor adjustments to his approach power setting of 6,5000 rpm., the

/impact.....

impact rpm indicate that the Captain's attempt to apply power had been partially successful but had terminated on impact with the water.

In summary the possibility that the co-pilot unwittingly reduced the power during the final manoeuvring cannot be entirely ruled out but except for this possibility it is not considered that a power reduction could have contributed to the height loss.

2.1.5. Aircraft handling

The remaining explanation for the height loss is that it resulted either from inaccuracies in the co-pilot's flying whilst manoeuvring the aircraft during the final turn or from the effect of downdraughts or from a combination of both causes. The flight recorder evidence does not include sufficient data to permit a definitive assessment of these possibilities. The height loss which took place during the course of the final turn began at a height of approximately 300 feet and the Captain has stated that he thought the co-pilot may have allowed the nose to drop during this turn. The turn was of an abrupt nature and was made without reference to flight instrument indications of pitch attitude, glideslope, altitude or rate of descent. Although the rates of descent achieved are entirely compatible with those which would result from such a turn if made without proper co-ordination of elevator control, there is also a possibility that downdraughts may have been present in association with the wind squalls which were affecting the final approach area.

Whatever the cause, it is apparent that the height loss passed completely unnoticed by the co-pilot at the controls because of his inattention to his flight instruments during the final turn; it was not until the Captain took over control at about 100 feet as a result of seeing their proximity to the sea that any attempt was made to arrest the descent; manoeuvring of this order at such a critical stage in an approach when having no visual reference and without full and proper attention to the flight instruments must be considered as mishandling of the aircraft. If there had been any unwitting power reduction such as mentioned in the preceding section of the analysis this would also constitute mishandling.

There is no evidence, on the flight recorder or elsewhere, of a rate of descent which, at the airspeed prevailing throughout, was not well within the power/climb performance capabilities of the aircraft, had these been applied at the appropriate time. The aircraft had responded normally to control applications made throughout by the co-pilot, and those by the Captain when he attempted the final pull-up. Both pilots considered the aircraft fully serviceable and the investigation and examination of the wreckage confirms the integrity of the aircraft. When the Captain attempted the final pull-up he was very nearly successful, and failed only because of the very limited height remaining in which to arrest the relatively high rate of descent.

In summary the height loss was the result of the co-pilot manoeuvring the aircraft during the final stage of the approach without visual reference and without full and proper attention to all the relevant flight instruments. There is no reason to doubt a proper regard to these instruments by the Captain would have provided a realisation of the situation

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in time to permit recovery; this was well within the performance capability of the aircraft.

2.1.6. P.A.R. Monitoring Aspects

The relevant content of the Hong Kong Aeronautical Information Publication, which is within the route certification required knowledge of the Captain, is given at Appendix E. It will be seen that the PAR Controller is required to advise an aircraft if its approach is being monitored; the Controller did not do this.

The pilots were specifically cleared to make an ILS approach and later to continue making their ILS approach. However, because they were also cleared to contact precision on 119.5 MHz (the PAR frequency) and because the form of service they then received was that of a normal PAR monitoring, it is considered that they had every reason to believe that such a service was being provided.

The terms of this service are clearly defined and were unquestionably fulfilled except possibly in respect of item (c) i.e. "To warn the aircraft of its displacement when outside of the Safe Approach Funnel, and to give advice if a dangerous situation arises, or if it appears to the Controller that a missed approach may result if a certain action is not taken." To this must be added a further item, not shown in the Hong Kong AIP, but required of all radar controllers under the terms of the ICAO Procedures for Air Navigation Services relating to Rules of the Air and Air Traffic Services. This requires that a controller shall inform an aircraft immediately when, for any reason, radar control service is interrupted or terminated. (DOC 4444-RAC/501/8, Part X, as amended). These matters are now considered in some detail, for which purpose it is desirable to show clearly the time scale of events.

Seconds before impact	Nature of events
27 to 25:	PAR Controller advises: "One and a half miles you're slightly right of centre." Aircraft reaching minimum altitude of 415 feet (QNH).
25 to 17:	Aircraft begins to turn left at a height of about 410 feet, 50 feet below glideslope. Controller loses elevation contact in heavier precipitation but concentrates on retaining azimuth contact whilst assessing aircraft's alignment situation.
17 to 15:	PAR Controller advises: "Coming back to centreline now."
15 to 12:	Aircraft begins to turn right at a height of about 300 feet, now 80 feet below glideslope. Rate of descent simultaneously beginning to increase rapidly.

/12 to 10.....

Seconds before impact	Nature of events
12 to 10:	PAR Controller advises: "One mile going left of centre". Aircraft continues to turn right, height now about 220 feet, now 100 feet below glideslope. Rate of descent now about 1000 feet/minute.
10 to 0:	PAR Controller experiencing difficulty monitoring in azimuth and coming to conclusion that aircraft will not be able to regain centreline by touchdown unless indeed flying visually.
3 to 0:	Captain realises situation when aircraft is at about 100 feet, turning right, with rate of descent about 1300 feet/minute. Recovery attempted but aircraft hits sea.
0:	PAR Controller advises:"Well left of centre-line if you're not visual climb immediately on your present heading."

It will be seen that at the time the Controller lost elevation contact the aircraft was still inside the Safety Funnel and therefore the only relevant question is whether he could have contributed to the safety of the operation by notifying the pilots of the loss of elevation monitoring. Considered in the absence of PAR operating pressures and environment, and also with the benefit of hindsight, it might appear that from 25 to 17 seconds before impact there was possibly time for the Controller to have informed the pilots of this loss.

However, during this brief period he was concentrating on preserving the azimuth contact and adjusting his controls to counteract the effects of the increased intensity of the rain. Any transmission notifying the loss of elevation monitoring could only have been made at the expense of the azimuth requirements. In all normal circumstances the azimuth information was the most useful information since at this time the aircraft had reached minimum altitude and should have been either overshooting or continuing visually to a landing in adequate but possibly poor visibility.

The question as to whether the pilots would have been alerted to their subsequent glideslope situation had they earlier been informed of the loss of elevation monitoring is in any case somewhat hypothetical. Throughout the approach the co-pilot had successfully maintained his descent on the glideslope solely by reference to his flight instruments. This is apparent from his actions during the momentary disturbance at about 2¾ miles and also from the fact that no monitoring advisory was made by the PAR Controller throughout the descent. It would be quite unreasonable to consider that this successful glideslope relationship had been maintained purely by chance and not by conscious efforts on the part of the co-pilot. This was an indication that he was utilising the ILS as the primary aid which is the correct

/interpretation.....

interpretation of an ILS approach with PAR monitoring. The subsequent final rapid divergence from the glideslope can only have been the result of having relaxed his previous efforts.

In summary, at the time the PAR Controller could in theory have reported the loss of elevation monitoring the aircraft was at minimum altitude and also within the safety funnel. At that time such information would have been a neutral fact to a Captain whose attention was concentrated on proceeding visually to a landing or on ordering an overshoot. It would have been equally of no significance to a co-pilot concentrating on his instruments during the overshoot. The fact that the Captain and co-pilot were not so concentrating their attention does not make the lack of this PAR report a cause of the accident.

2.1.7. Summary of Analysis

Examination of all the evidence indicates that there was a series of deficiencies by both pilots in respect of the requirements of their Flight Operations Manual, and that the co-pilot mishandled the aircraft in the final stage of the approach. Had the pilots conformed to the required procedures, and applied the normal standards of flight-deck co-ordination and attention to flight instruments, it is considered that this accident would not have occurred.

2.2. Conclusions

(a) Findings

(i) The flight crew were properly licensed and all the crew members were sufficiently experienced to carry out the flight.

(ii) The aircraft, its engines, flight instruments and radio installation had been properly maintained and there was no pre-crash failure or malfunction.

(iii) The weight of the aircraft and its centre of gravity were within the authorised limits.

(iv) There was ample fuel on board the aircraft for the flight to Hong Kong and for the necessary reserves to cover all contingencies including return to Taipei which was the nominated alternative aerodrome.

(v) The visibility reported to the pilots had been measured from the Tower which is at the northwest end of the aerodrome; it did not represent the visibility encountered in heavy rain during the final stage of the approach to runway 31. The actual visibility in the final stage of the approach was very much below the visibility limits specified by Thai Airways.

(vi) Whilst preparing for the approach, and during

/the.....

the approach itself, the pilots did not adhere to the procedures defined in Thai Airways Flight Operations Manual. This resulted in the co-pilot continuing the descent below the minimum altitude of 415 feet without visual reference and without the Captain being aware this had occurred.

(vii) After passing the minimum altitude, the co-pilot manoeuvred the aircraft to maintain the localiser centreline without referring to his flight instrument indications of glideslope, height, rate of descent or pitch attitude.

(viii) During the final turn, initiated when the aircraft was at a height of about 300 feet and 80 feet below the glideslope, the rate of descent increased rapidly, attaining a maximum value of approximately 1,300 feet per minute. As a result of the height loss the aircraft struck the sea 200 feet below the glideslope and about 3,925 feet before the ILS reference point of runway 31.

(ix) It is not possible to decide whether the height loss should be attributed to an uncoordinated turn without proper reference to flight instruments or to downdraughts or to a combination of both.

(x) Although recovery from the maximum rate of descent attained was within the performance capabilities of the aircraft no attempt at recovery was made by the co-pilot. The Captain's attempt at recovery was not initiated until a height of approximately 100 feet and was therefore too late to be completely successful.

(xi) Although the impact was not severe, the nature of the damage to the aircraft resulted in it sinking rapidly and injuries to crew members led to a breakdown in the evacuation procedures. Probably because three of the over-wing emergency windows were not opened, the majority of the mid-cabin passengers did not escape from the fuselage and were drowned.

(xii) The airport emergency services were alerted promptly, but the very poor visibility hampered rescue operations; these were confined to the vessels in the immediate area of the accident, together with a helicopter directed to the site by the airport authorities.

/(b).....

(b) Causes

The causes of the accident were :

(i) The pilots did not adhere to the Thai Airways procedure for a "Captain monitored" approach in bad visibility.

(ii) The Captain did not monitor the approach adequately.

(iii) The co-pilot mishandled the aircraft after descending below minimum altitude; downdraughts may have contributed to the height loss which resulted from this mishandling.

3. RECOMMENDATIONS

No recommendations are made.

4. COMPLIANCE WITH REGULATIONS

In conducting this investigation, the provisions of Regulation 8(5) of the Hong Kong Air Navigation (Investigation of Accidents) Regulations, have been complied with.

Captain V. Thorsen and M. K. S'nit were informed in April, 1968, of their rights under the above regulations. Their legal adviser made verbal representations on their behalf at an interview in Hong Kong on 17th July, 1968, which have been taken into consideration in the preparation of this Report.

The pilots did not exercise their right to avail themselves of the opportunity under Regulation 8(5) to give or call evidence or to examine witnesses.

T.R. THOMSON
Chief Inspector of Accidents

Civil Aviation Department

August, 1968.

List of Appendices

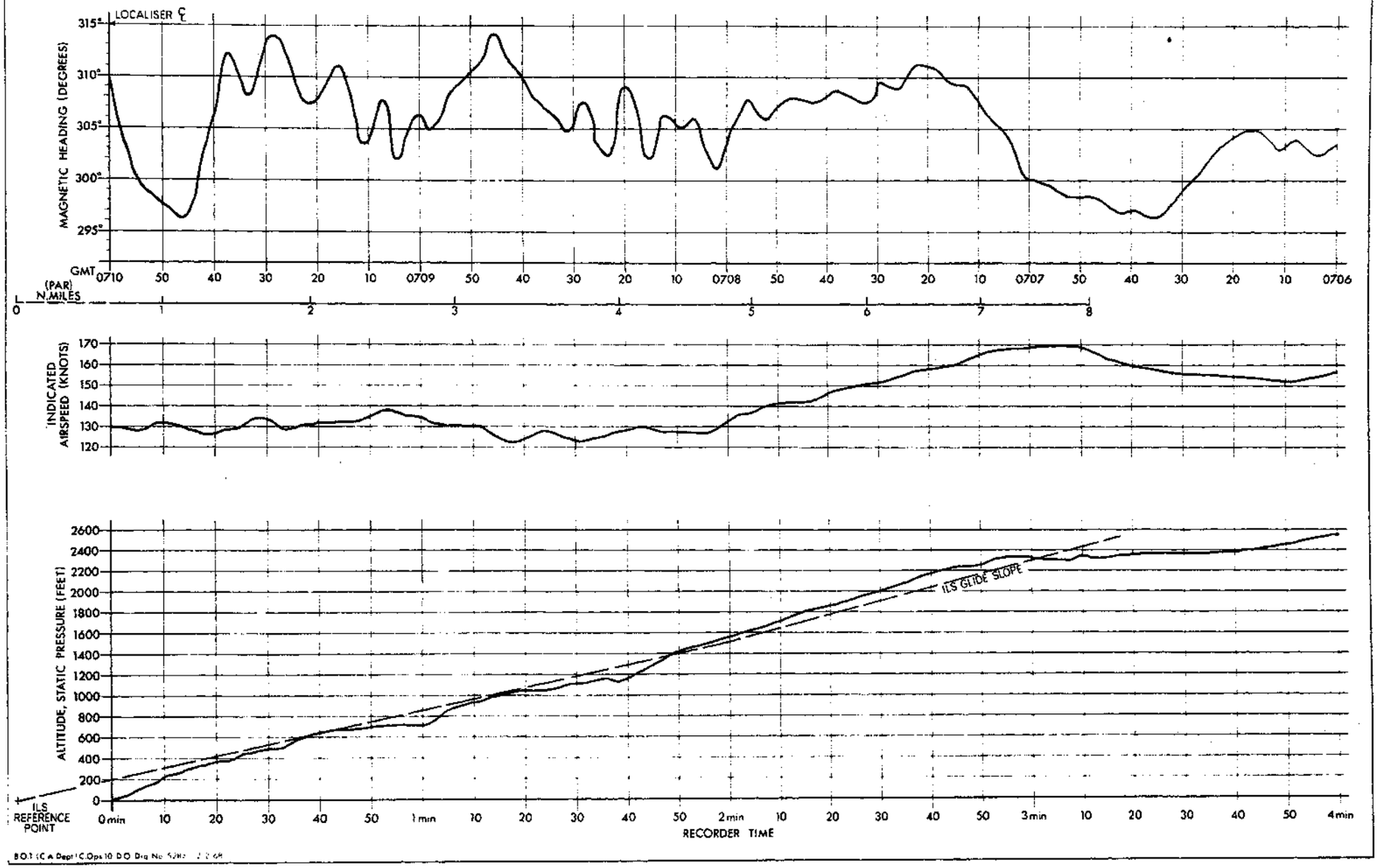
Appendix A

List of Abbreviations used in the Report

ASI	Airspeed indicator.
Flight level	Altitude, expressed in hundreds of feet, using the standard altimeter setting of 1013.2 millibars.
GMT	Greenwich Mean time.
IIS	Integrated Instrument System.
ILS	Instrument Landing System.
M/F	Medium Frequency
PAR	Precision approach radar.
PDI	Pictorial deviation indicator.
QNH	The atmospheric pressure value to be set on the subscale of the aircraft's altimeters so that they will indicate the height of the aerodrome above sea level when the aircraft is on the ground at the aerodrome to which the pressure refers.
R/T	Radio telephony.
VFA	Airspeed over the runway threshold during the final approach to a landing. In relation to this report it is 130% of the stalling speed, with full flaps, and with speed brakes extended.
VHF	Very high frequency.
VOR	VHF Omni-Directional Radio Range
^{o}C	Degrees centigrade.
^{o}M	Degrees magnetic.
mb	Millibars.
mm	Millimetres.
kg	Kilogram(s).
kt	Knot(s). Speed expressed in nautical miles per hour.

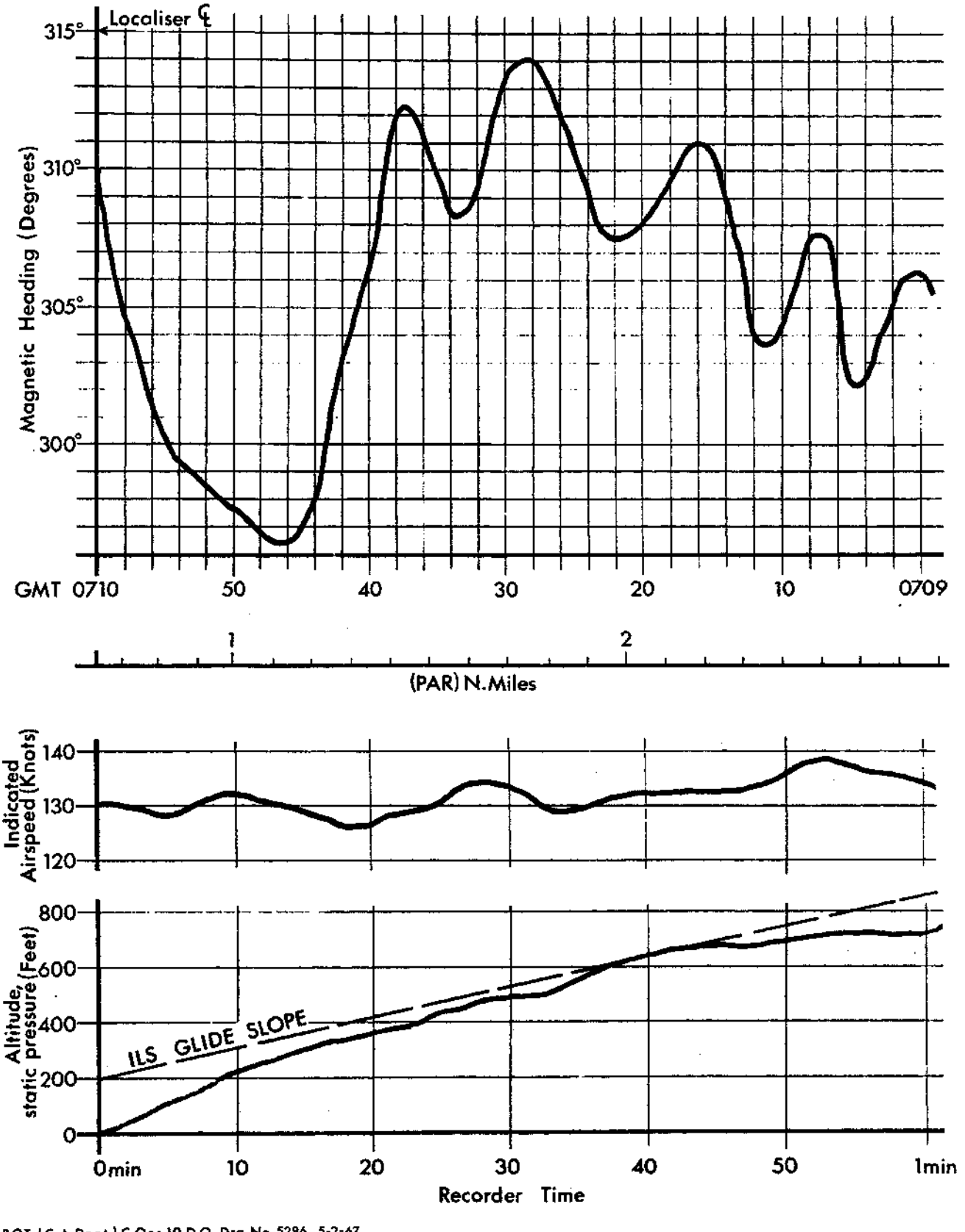
FLIGHT RECORDER READOUT HS-TGI 30th JUNE, 1967

APPENDIX 21



B.O.T. (C.A. Dept) C.Ops.10 D.O. Drg. No. 5282 - 2.2.68

FLIGHT RECORDER READOUT HS-TGI
30th. JUNE 1967



B.O.T. (C.A.Dept.) C.Ops.10.D.O. Drg.No. 5286 5-2-67

Appendix C

Transcript of impounded tape of Precision Radar Frequency 119.5 MHz and PAR/Tower interphone from 0704 G.M.T. 30th June, 1967.

Time GMT		From	To	Message
0704	16	PAR	TWR	Is there any sign of this rain breaking or not
	19	TWR	PAR	Ah no it seems to be very intense getting heavier eh approaching from the west vis is two kilometres at the moment.
	34	TWR	PAR	Eh I can't even see the hazard beacon at Hung Hom
	39	PAR	TWR	Eh OK
	46	PAR	TWR	Better standby for an overshoot Six Zero One
	49	TWR	PAR	Roger
	58	TWR	PAR	Should er get the fire section to standby for him
0705	03	PAR	TWR	Yes have a visibility standby
		TWR	PAR	Yeh
	48	PAR	TWR	No sign of any improvement
	51	TWR	PAR	Negative no
0706	57	601	PAR	Hong Kong Precision Thai International Six Zero One ILS inbound passing White Cliff
0707	00	PAR	601	Six Zero One continue your ILS approach you're seven miles from touch down the surface wind (10) two nine zero at eighteen knots over
		601	PAR	Thank you sir
0707	30	PAR	601	Six miles from touchdown there's heavy rain at the field in the event of an overshoot you'll be cleared for the emergency overshoot procedure
	35	TWR	PAR	Cleared to land
		PAR	601	RW beacon left turn to Stonecutters then to Cheung Chau climbing immediately to three thousand five hundred feet Six Zero One (45)
		601	PAR	Understand sir
	52	PAR	601	You're now five miles from touchdown

/601.....

Appendix C

Time GMT		From	To	Message
		601	PAR	Thank you sir
		PAR	TWR	Visibility
		TWR	PAR	Visibility is two kilometres to the south east
0708	05	PAR	TWR	OK
	20	PAR	601	Four miles check your wheels are down and locked and you are clear to land I say again clear to land
0708	24	601	PAR	Thank you
	35	PAR	601	Three and a half miles the heavy rain is at one and a half miles from touchdown (40) all over the field
				(Transmission clicks heard)
0708	51	PAR	601	Three miles you're just a little to the right of centre
	56	TWR	PAR	It's clearing now the rain to the southwest I can get about four kilometres
		PAR	TWR	To the southwest
		TWR	PAR	Yes southwest towards Stonecutters
		PAR	TWR	I see
		TWR	PAR	To the southeast solid rain about two thirds down the runway
0709	10	PAR	TWR	OK
	19	PAR	601	Two miles
	33	PAR	601	One and a half miles you're slightly right of centre
	43	PAR	601	Coming back to the centre line now
	48	PAR	601	One mile going left of centre
0710	00	PAR	601	Well left of the centre line if you're not visual climb immediately on your present heading
0710	19	PAR	601	Six Zero One I have no radar contact with you
	25	PAR	TWR	I can't see what he's done

/TWR.....

Appendix C

Time GMT		From	To	Message
		TWR	PAR	Is he overshooting I can't hear anything
	30	PAR	601	Six Zero One are you overshooting
	40	PAR	601	Siz Zero One Hong Kong Precision
	49	PAR	601	Six Zero One Hong Kong
0710	52	PAR	TWR	I can't even raise him ask the launch if they heard anything
		TWR	PAR	They didn't hear anything over there
0711	04	PAR	601	Six Zero One Hong Kong Precision
	07	PAR	TWR	Call him up (16) you'd better call the crash crew out
		TWR	PAR	Tell them to proceed to the end of the runway eh
		PAR	TWR	Yep
	28	PAR	601	Six Zero One Hong Kong do you read
	33	PAR	TWR	Better have a full emergency I think he must have gone in
	47	PAR	TWR	Have a full emergency
		TWR	PAR	Ya doing it now
		PAR	TWR	Coming up (0711 50)

Transcript of Conversation between TG 601 and Hong Kong Approach on 119.1 MHz
Other conversations have been excluded.

Frequency 119.1 MHz/256.4 MHz from 0658 GMT 30th June,1967

Time GMT	From	To	Message
0658	601	APP	Hong Kong Approach Thai International 601 good afternoon
	APP	601	Thai International 601 good afternoon go ahead

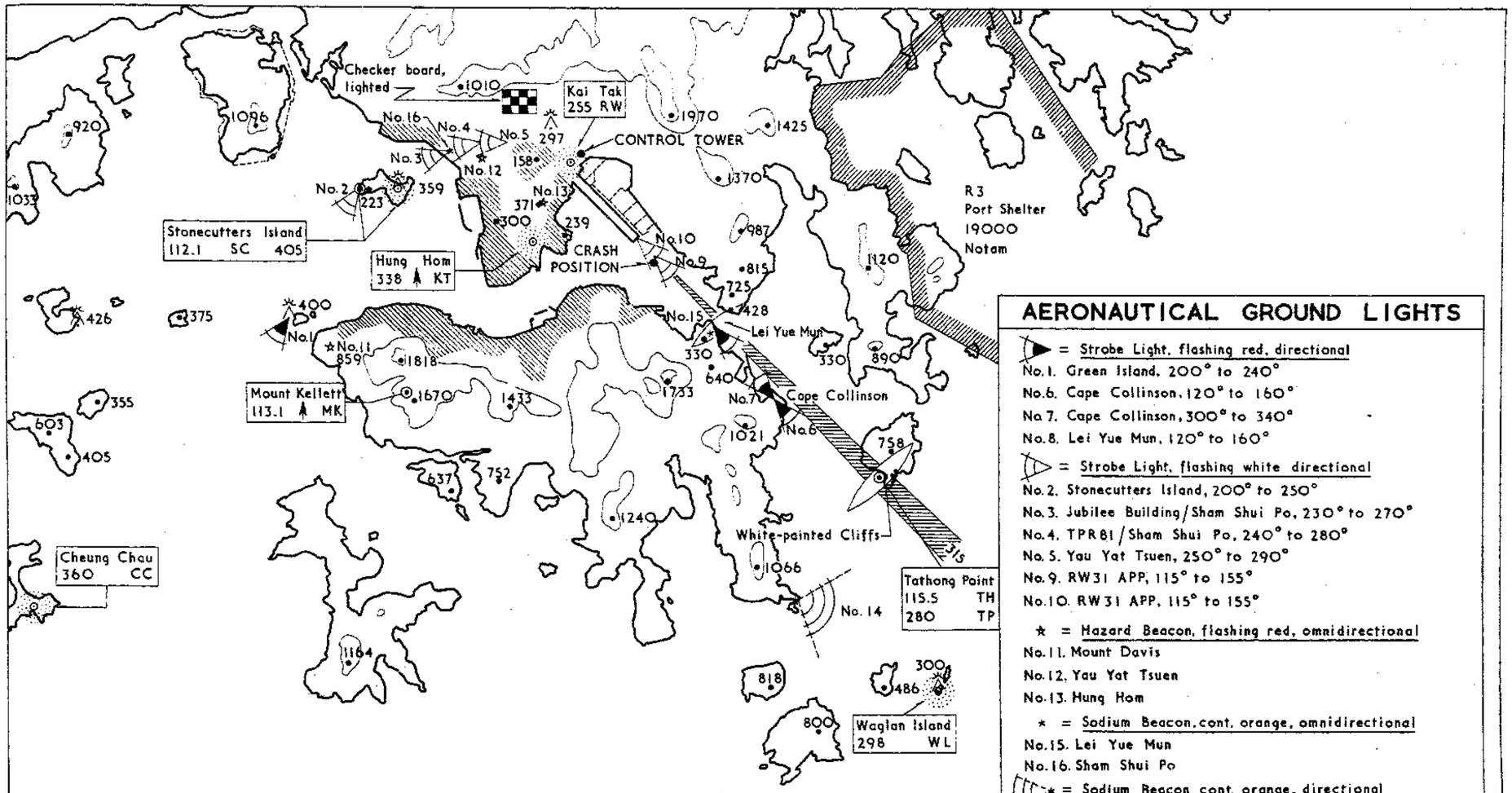
/20.....

Appendix C

Time GMT		From	To	Message
	20	601	APP	Four zero miles leaving one two zero for seven zero
	30	APP	601	Roger six zero one what is your present heading
	33	601	APP	Inbound on radial er zero nine eight
	39	APP	601	Roger six zero one runway in use three one turn left heading two five zero radar positioning for ILS approach over
	46	601	APP	Thank ycu turning left two five zero we are leaving heading er two six eight
	51	APP	601	Roger
0700	50	APP	601	Thai International six zero one your level
	54	601	APP	Leaving eight zero
	55	APP	601	Roger six zero one descend to and maintain four thousand five hundred feet on QNH niner niner niner millibars
0701	04	601	APP	Four five zero feet niner niner niner leaving eight zero now
	09	APP	601	Roger you are number one in traffic for ILS approach
	11	601	APP	Thank you sir
0703	35	APP	601	Thai International six zero one turn right heading two seven zero
		601	APP	Turning right two seven zero
	48	APP	601	Six zero one when steady on heading two seven zero descend to and maintain two five zero zero feet for ILS approach one four miles touch down
		601	APP	Roger we're steering two seven zero leaving four thousand five hundred for two five zero zero feet
0704	57	APP	601	Thai International six zero one turn right now heading three one five adjust on the ILS report established

/0705.....

Time GMT		From	To	Message
0705		601	APP	Roger sir
	30	APP	601	Thai International six zero one be advised there's a heavy rain shower over the field visibility er very reduced two kilometres
0705	39	601	APP	Thank you sir
0706	40	APP	601	Thai International six zero one your altitude
	44	601	APP	Two five zero zero feet established
	47	APP	601	Roger siz zero one you're eight miles from touchdown continue ILS approach contact precision one one nine decimal five (51)



AERONAUTICAL GROUND LIGHTS

= Strobe Light, flashing red, directional

No.1. Green Island, 200° to 240°

No.6. Cape Collinson, 120° to 160°

No.7. Cape Collinson, 300° to 340°

No.8. Lei Yue Mun, 120° to 160°

= Strobe Light, flashing white directional

No.2. Stonecutters Island, 200° to 250°

No.3. Jubilee Building/Sham Shui Po, 230° to 270°

No.4. TPR81/Sham Shui Po, 240° to 280°

No.5. Yau Yat Tsuen, 250° to 290°

No.9. RW31 APP, 115° to 155°

No.10. RW31 APP, 115° to 155°

★ = Hazard Beacon, flashing red, omnidirectional

No.11. Mount Davis

No.12. Yau Yat Tsuen

No.13. Hung Hom

★ = Sodium Beacon, cont. orange, omnidirectional

No.15. Lei Yue Mun

No.16. Sham Shui Po

★ = Sodium Beacon, cont. orange, directional

No.14. Cape D'Aguilar, 060° to 160°

All lights operating HO

Appendix E

E X T R A C T

FROM

AERONAUTICAL INFORMATION PUBLICATION

PAR Monitoring

Whenever possible, ILS approaches will be monitored by PAR when the cloud ceiling is 2,000ft or less and/or, the visibility is less than 9KM (5NM).

(a) To advise each aircraft that its ILS approach is being monitored by PAR.

(b) To monitor the flight path of the aircraft until a "Visual Contact" report is received, or until the aircraft is known to have landed or overshot.

(c) To warn the aircraft of its displacement when outside the Safe Approach Funnel, (i.e. a funnel subtended by lines from the touch-down point diverging by 2 deg on either side of the extended centre-line in azimuth and by half a deg above and below the glide-path in elevation), and to give advice if a dangerous situation arises, or if it appears to the Controller that a missed approach may result if certain action is not taken.

(d) To pass ranges from touch-down point.

(e) To pass landing clearance, and any supplementary information which may be considered helpful to the pilot.

Pilots will be instructed to change frequency to PAR (119.5Mcs) prior to commencing their approach. Aircraft capable of listening out on two frequencies should monitor 119.1Mcs to guard against failure of the PAR frequency.

Civil Aviation Department
Hong Kong

1 January 1967

NOTE: The dimensions of the Safe Approach Funnel at 1½ miles in elevation, referred to in (c) above would produce a tolerance of ± 23 metres (75ft)

Date Due

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