No. 11

British Overseas Airways, Lockheed Constellation, aircraft crashed on landing at Kallang Airport, Singapore on 13 March 1954. Report of Public Inquiry published for the Colonial Office by H.M. Stationery Office London

Circumstances

At 1132 hours (2132 hours Standard Australian Time) on the evening of 12 March the aircraft (hereinafter referred to as Able Mike) took off from Sydney on a scheduled flight for London. The aircraft landed at both Darwin and Djakarta, which are scheduled stops, taking off from the latter in good weather conditions at 0512 hours on 13 March for Singapore, with a crew of 9 and 31 passengers. At approximately 0734 GMT while carrying out an approach to land on Runway 06 the aircraft struck the ground short of the runway, became airborne and touched down on the runway some 80 yards further up the runway when the starboard undercarriage gear collapsed. Fire broke out and the aircraft was destroyed; 31 passengers and 2 crew lost their lives.

Investigation and Evidence

Apart from certain cloud which was avoided by climbing, Able Mike's flight from Djakarta to Singapore met with no weather conditions presenting any difficulty. The flight was carried out at 10 500 feet - Visual Flight Rules - and at 0707 hours the aircraft called Air Traffic Control, Singapore, on 119.7 megacycles and gave its position as 100 miles out at 0706 hours. It requested and received permission to start a VFR descent - the expected time of arrival being 0735 hours. Radiotelephony procedure seems to have been normal and at 0720 hours the aircraft reported that it was 50 miles out, at 7 500 feet, descending VFR. The altimeter setting was given as 1 009.7 millibars and the aircraft was cleared into the Singapore Control Zone VFR.

When 10-15 miles out Able Mike changed to Tower frequency and passed a Malayan Airways Dakota which was also bound for Kallang. Two messages in the same terms were passed from the Tower to Able Mike - one that the wind velocity was 100 degrees/20 knots, that Runway 06 was to be used, that Able Mike should land ahead of the Dakota and that if it could not stop before the intersection of the North-East taxiway and the runway it should expedite its roll to the end of the runway and wait there in the turning circle or pan. This last instruction was new to the captain who said, indeed, that he had never previously received a similar one. Its purpose, however, was presumably to allow the Dakota to land as soon as possible after Able Mike had turned in the pan, back-tracked to the North-East taxiway and cleared the runway. The captain found nothing abnormal in it - nor, he says, did it affect his decision as to his landing.

A straight-in approach from a right hand base leg was made. The gear was put down across wind and by the time Able Mike was over or abeam the spire of St. Andrew's Cathedral (some 2 670 yards on a bearing of 245° from the centre of the threshold) it was 650 to 700 feet high, in a steady rate of descent with 80 per cent flap, 20" MP., a speed of 120-125 knots, and a rate of descent of approximately 1 000 feet per minute. At this stage, or soon after, it was on the North side (downwind side) of the centre line, tracking directly for the end of Runway 06. This is a method of cross-wind approach, though it is not clear from the evidence that the captain was using it as such. The approach was steady and constant from the Cathedral spire until a point about 900 yards from touch down. At this stage 100 per cent flap was taken, probably to reduce speed. As the schooners' anchorage was passed the nose was eased down to prepare for a short landing. The track probably passed close to the South end of the schooners' anchorage and at approximately 550 yards, 25" MP was called for and the flatter approach was begun. The speed was then reduced nearly to 100 knots, and the captain banked slightly to starboard in order to regain the centre line before the runway threshold. The rate of descent continued at something like 400 feet per minute until about 250 yards out when the aircraft was

probably about 15 feet higher than the sea wall and flaring out. A second later the captain called for "My Throttles" and as he eased the power up to 30" he must have been swinging the nose down the runway with left rudder and keeping the wings level or slightly right wing down. The aircraft continued to sink gently and as the sea wall came up the nose was lifted for a landing just over the threshold marking. Such a landing, however, was not achieved as the aircraft was too low and passed the sea wall at an estimated height of three or four inches, assuming that it was flying level at that time.

Able Mike first touched the ground with the right wheel of the starboard main gear, 3-1/2 inches above the height of the sea wall, about 13 feet from its edge and 10 feet short of the white threshold line. The left wheel of the starboard gear touched 2 feet later, the gear being virtually in line with the runway centre line. The initial scuff marks indicated a light touch-down, but the marks became deeper as the wheels met the resistance of the up-sloping grass until the actual earth was being broken and the tyres were making definite grooves in the grass. Some 5-1/2 feet after the initial brushing of the grass the starboard main gear came into contact with the ridge (described later) between the end of the perforated steel plating and the grass slope. The impact caused the undercarriage to receive a horizontal shock beyond its designed maximum which must have disrupted No. 3 integral fuel tank causing a leakage of fuel which streamed behind the right side of the aircraft like a white vapour. The right wheels rolled over the threshold line. Although the tyres were completely compressed, so that the wheel rims bit into the tarred ridge (leaving their own distinct grooves within the impressions caused by the tyres), they did not burst and were later found inflated and partly scorched. After the first impact the aircraft became airborne, touching again some 80 yards further up the runway when the starboard gear collapsed, moving rearwards, the wing went down and the starboard propellers struck the runway. The aircraft turned to the right and continued roughly in a straight line till the edge of the runway. There the angle of tilt increased as the aircraft turned sharply to starboard rolling at the same time until it came to rest facing the South-West (i.e. the direction from which it had come), on its back and leaning a little on its starboard side, roughly 350 yards from the South-West threshold. As it overturned the starboard wing broke at its root and the tail plane snapped near the rear pressure bulkhead. The starboard propellers had struck the ground while their engines were developing a high degree of power; the port outer propeller struck the ground while its engine was developing some degree of power, and there was no forward motion of the aircraft. As the starboard wing root came into contact with the ground it is probable that fire broke out on the starboard side. The broken-off starboard wing came to rest parallel to the runway on the runway's edge and the fuselage about 15 yards to the south of it.

While the ridge at the sea wall end of Runway 06 was untidy, and perhaps undesirable from the perfectionist view-point, it was considered that it was not the cause of the accident. If the ridge had been "faired off" to a slope running from the end of the runway to the inner edge of the sea wall and stressed to take the initial touch of a heavy aircraft, the accident admittedly might never have happened. Again, if the sea wall and grass slope had been a continuation on a level plane of the runway it is equally possible that the aircraft would either have struck the sea wall, or just made that portion of the runway delimited for landing purposes. But why should either of these steps have been taken? No aircraft could conceivably be expected to land where this aircraft in fact did i.e. off the runway and within a few feet of a clearly marked and most dangerous hazard. The cause of the accident was not the ridge but the fact that the captain touched down at a place where his aircraft had no right to be. The presence of the ridge no doubt contributed to the extent of the accident - but did not cause it. The ridge has now been "faired off" and marked as a hazard, but not strengthened to take a heavy aircraft; this is not considered to be necessary.

Down-draught was discounted as being a serious contributory factor and although the various lines of the runway, the ridge, the sea wall, the markers, the sea itself and the choppy conditions, the grass slope and the paint on the sea wall might all have blended to form a misleading picture of height, the captain must have been aware, by whatever processes a pilot's vision guides his judgment, that he was low, and that his intended point of touch-down was closing with the threshold marker with every second of the "flatter approach".

The captain testified that he was not fatigued, but told a doctor that he was tired, though no more so than usual. Fatigue as a cause of the accident in itself was ruled out, and it was not thought that tiredness led to the initial decision to land short; indeed, the captain was making a pattern of approach that roughly corresponded to his usual approach at Singapore. However, there was little doubt that tiredness played a part in the captain's ability to deal with the last fifteen seconds of the approach which, in view of the difficult position in which he found himself, called for a high degree of judgment.

The cause of the accident, i.e. the touch-down off the runway was attributed to the approach of the aircraft. While certain eye-witnesses describe the approach as normal, it was not normal relative to maintaining a steady glide path and rate of descent. The various rates of descent could be considered to be within normal bounds for a Constellation aircraft, but their general pattern was neither normal nor, having regard to the sea wall hazard, desirable. The extent to which the captain's original decision to land short on such a runway as 06 was an error can only be judged in relation to the wide range of expert pilot opinion as to what is a safe first point of touch-down. The fact that his first point of touch-down came back closer to the threshold markings than he originally intended can probably be attributed to a degree of tiredness of which he may or may not have been aware.

There was one inescapable fact, however, which could not be influenced by any factor that might have contributed to the error of judgment. The captain was low enough long enough and had been sufficiently warned of the wind conditions for him to have realized that his position, aircraft configuration and altitude did not conform to a desirable safe flight path consistent with a civil aircraft landing on Runway 06 at Kallang. The fact that he applied 30" MP unhurriedly so close to the threshold confirms that his last intention was to land on or inside the threshold markings, as was his own evidence when recalled. To attempt virtually to spot land a large civil aircraft in a light to moderate crosswind when off the centre line, so close in to such a runway and so close to a dangerous hazard, was something incompatible with civil aviation safety requirements. The aircraft touched where it did because the captain was unable to deal with the situation he found or put himself into during the last 10-15 seconds of the approach. He should not have been in such a situation. At a time when he wanted all the lift and speed effect his configuration would give him, the yawing of the aircraft and wing down attitude, together with the possible effect of a slight down-draught, were testing the fineness of his judgment. The movement of the sea against him possibly helped to confuse his correlation of distance and ground speed. In any event, when his estimated first point of touch-down moved towards the threshold markings and the hazard of the sea wall he did nothing to arrest that movement until the aircraft was virtually on the marking itself. It was then too late. The error of judgment was a fine one, though by that it does not mean that it was excusable; the error of decision depended upon what could be considered within the margin of a safe height over the sea wall, and by standards as disclosed in evidence, that margin is a wide one. The cause of the accident, thus, in the opinion of the court was an error of the pilot.

Fatigue. Much evidence has been heard on the subject of Fatigue - but the part it plays in aircraft accidents remains as elusive as ever. The Sydney - Singapore sector is the longest of the Corporation's scheduled sectors and allowing a minimum period of 1-1/2 hours for preflight preparations at Sydney, the captain was on duty for slightly over 21-1/2 hours ending with the crash at Kallang. These are undoubtedly long hours and the Assistant Director of Medical Services BOAC stated that it would be very desirable if everything could be planned to a 16 hour duty day. He added further that physiologically it is not a good thing for a crew to leave Sydney at 2130 hours (Australian time) as happened on this flight - i.e. at the end rather than at the beginning of the day. The difficulty which faced the Corporation here, however, was that both Darwin and Djakarta were unsuitable as night-stops and a morning departure from Sydney would result in Singapore being reached very late at night. The doctor gave as his opinion that for this particular crew a 24 hour day would not be unreasonable and several most experienced pilots confirmed this opinion. However, although the court could not deny this it was considered a very long period of duty.

Three considerations were given in the report as material to Fatigue:

a) The provision of a bunk on which officers temporarily off-duty can sleep. On long distance flights BOAC aircraft are not fitted with a bunk but a mattress is provided which some, though by no means all, crew members use for resting. The mattress is placed over the luggage carried in No. 3 Hold and it seems unlikely that it presents a very comfortable resting place. (A recommendation in this regard was given in the report).

b) The question whether there should be two or three pilots on long sectors. Qantas Empire Airways, under an Australian Air Navigation Order, invariably carry three pilots on long-distance aircraft on a flight of more than 12 hours and this permits of 30 hour sectors, though in fact there are none as long as this. If weather or other conditions present any difficulty, it was considered that the captain would wish to be at the controls himself and his co-pilot should readily be able to take over from him at all other times.

c) Whether, if only two pilots are carried, it is necessary that both should be extremely experienced. This was noted in the report as an important matter. The co-pilot was a young man and his total flying experience of 1 000 odd hours, relative to flying heavy four-engined civil transports, was considered as only just sufficient to qualify him for his crew duties, if indeed it did suffice. The minimum flying experience of a first officer in Qantas Empire Airways is some 2 000 - 2 500 hours and as the co-pilot fell very far short indeed of this standard, which is considered to be reasonable, there can be no doubt that his usefulness in giving his captain any appreciable rest during long duty hours was entirely inadequate. (A recommendation in this regard was included in the report).

In the words of the report:

"To sum up the position as regards this accident, the captain just prior to it had been on duty for many hours. The word "fatigue" I do not like, because I do not know its meaning - but undoubtedly the captain was tired when he brought Able Mike in to land and in view of the long hours and the inexperience of his co-pilot this was only to have been expected. Although it is perfectly possible for any man, including one of the experience of the captain, to make a mistake - I do not think that he would have made this error of judgment at the beginning of a day's flying and it is at least possible that he would not have done so even after 16 hours of duty."

Fire aspects of the accident

When the aircraft came to rest, it was completely inverted. Fires were burning in the broken-off starboard wing, the starboard wing root and the tail plane (empennage). Very soon afterwards, fire broke out in the port wing. Survivors reported there was darkness, dirt and noxious fumes in the aircraft within a few seconds. The door used by the crew for access to the cockpit would not open.

The flight engineer in the cockpit remembered that a clear vision panel was just wide enough (14 inches by 10 inches) to permit the passage of a human body and having opened one, he promptly climbed through it and lowered himself to the ground. In the seconds that followed, another flight engineer, the radio officer, the first officer and the captain followed suit. Several had minor injuries.

In the compartment immediately behind the cockpit were the flight stewardess, one of the two flight stewards, and, at his desk, the navigation officer. All three found themselves lying amidst brief cases, bundles and other articles packed in the No. 3 hold. The area was dark and a thick yellow-brown smoke rapidly filled the compartment which had a heavy choking effect. The navigation officer saw fire on his right-hand side and seeing a patch of light from a gash in the fuselage near the port crew rest chair, he eventually managed to struggle through it to freedom. The flight steward, his lungs bursting, found a slit in the fuselage on the starboard side through which he clambered to safety.

Thus, within a very few minutes, all the crew had escaped with the exception of the flight stewardess in the aft crew compartment and the second flight steward who was in the main passenger compartment.

One of the flight engineers ran around the aircraft trying to find a means of exit for the passengers. He tried but found that the main passenger door would not open. He discovered that when the tail plane had broken off, the hatch of the rear pressure bulkhead had become exposed.

This hatch is normally used to permit access for engineers to work on the wiring and control cables inside the empennage. The hatch is situated at the aftermost extremity of the pressurized portion of the fuselage (in this particular aircraft, through the ladies' lounge). The hatch is circular, some 24 inches in diameter, and is normally opened by inserting a key (kept in the cockpit) which operates a four-armed plate on the rear of the hatch. To each of these arms is connected a rod which travels from the arms to the outside edge of the hatch and which, in turn, operates pawls (the actual locking mechanism for holding the hatch in place).

The flight engineer and at least one other crew member tried to move the operating rods from the exposed side by hand but unfortunately failed to do so. The flight engineer then seized an axe and hurried to the forward starboard side of the aircraft to join the other flight engineer who was attempting to make a hole near the place in the crew compartment where they could hear the cries of the flight stewardess. They were aided by two Qantas Empire Airways station personnel and a KLM ground engineer at Kallang, who had rushed to the scene from the Airport Terminal. Taking turns, their axes bit deep into the strutted fuselage and they were just about to extricate the stewardess when the nose of the aircraft under which they were working started to fall on them to the accompaniment of several exploding fuel tanks. With frantic effort and great heroism, the two Qantas Station employees finally succeeded in pulling the stewardess from the wreckage. Tragically, the stewardess subsequently died of injuries received.

Airport Activities

While all this was going on, many other things were happening at the airport.

The tower controller testified in the inquiry that he realized before the aircraft came to rest that a crash was imminent. He stated that he immediately instructed his companion in the tower to telephone the City Fire Brigade and he rang the fire alarm bell to call out the Airport Fire Service. Unfortunately, the inquiry could not verify accurately the time factors. The time of the accident was established at 3.03 p.m. Singapore time. If the call was made immediately it should have been received before the City Fire Brigade log indicated - 3.08 p.m. (All clocks meticulously kept accurate.) It appears that five minutes were "lost" between the time the aircraft first touched down and the call was made to the City. In the opinion of the investigators "this interim was critical" and "if outside assistance had arrived before the fire had reached an advanced stage in the center section of the aircraft, many lives might well have been saved".

The Airport Fire Service had one leading fireman, 6 firemen and 4 drivers on duty. Two vehicles (a foam "tender" and water "tender") were at the fire station and a rescue jeep was about three-fourths of the way down and just off the 6 000 foot runway. These three units constituted the mobile rescue and fire fighting force available at the airport and the foam tender was judged "a somewhat antiquated machine". The personnel to man this equipment were all native Malays, poorly trained and inexperienced.

Airport Fire Fighting Response

The leading fireman had watched the arrival of the aircraft and, gaining the impression an accident was likely, he proceeded to the scene before the aircraft came to rest. He guessed incorrectly that the aircraft would come to rest considerably further down the runway than it did and he committed himself and his vehicle to a route which took longer to travel than might otherwise have been the case. (Had he used the western rather than the eastern taxiway the

route would have been shorter. Crossing the grass area was hazardous as the area was soft in parts and the two-wheel drive tender was not constructed for cross-country service. Test runs later show that the travel time over the route selected was 2 minutes, 3 seconds.) The water tender followed the foam tender and the rescue jeep proceeded straight down the runway to the scene (travel time about 1-1/2 minutes).

The fire suppression efforts by the Airport Fire Service were described unanimously by witnesses having skilled fire protection backgrounds as being inefficient. No leadership was evident, the fire was attacked at the wrong place, the foam was of poor quality and no concerted attempt was made to rescue the trapped passengers. In a sentence, the deputy chief fire officer of the City Fire Brigade said that: "on 13 March the Airport Fire Service was inadequately equipped, organized and trained". The senior staff officer of the Fire Service Branch of the Ministry of Transport and Civil Aviation (London) investigated the facts and reported: "the attack made on this fire during its early stages by the Airport Fire Service was misapplied ... the manner in which the branches were placed and the manner in which foam was applied ... shows a grave lack of training in tactics".

Going through all the details of inefficient attack on the fire does not seem necessary but the following brief description of events is taken from the official report:

> "On arrival at the fire ground, 7 members of the crew were in the process of escaping from the aircraft. The foam tender took up a position about 30 feet on the upwind side of the fuselage and slightly to the rear of the tail plane. The water tender took up station in an adjacent position to transfer water to the foam tender. A considerable fire was burning in the detached starboard wing and the port wing was also alight. There is no precise evidence as to the exact state of this potentially dangerous port wing fire at this stage, but it is probable that at least the inner engine, and probably the outer also, was well alight. Fire was also present in the stub starboard wing and there are indications that it had begun to penetrate into the center section of the fuselage itself at this stage, or very shortly afterwards.
>
> The fire crew got to work at once with two foam jets, directing the first onto the starboard wing and running the other line of hose round a fin, which had broken off from the remainder of the tail unit, and up the upwind side of the fuselage at a point roughly abreast of the starboard wing root. The CO_2 available (total of 75 pounds) was also applied at this place, but due to the shedding of the discharge horn it is probable that the bulk of the very limited amount of gas available was discharged to waste. Subsequently, the foam from the branch on the upwind side was directed initially into the starboard wing root area and finally, at the suggestion of a civilian, over the top of the fuselage to the port wing root area. It was this fire (i.e. in the port wing), slowly gaining in intensity, which ultimately involved the whole fuselage since it was allowed to develop virtually unchecked. The evidence strongly suggests that this fire developed quite slowly for a petrol fire until the time of the collapse of the nose section at or about 3.16 p.m. (Singapore time) but thereafter very rapidly, probably as a result of increased flow of fuel to the fire resulting from the disturbance of the wreckage. This stage was the critical period of the fire which very soon penetrated the passenger cabin thus reducing further the chances of rescue. At or about this time the City Fire Brigade was in action."

Aside from the unsatisfactory efforts of the Airport Fire Crew, civilians in large numbers arrived at the scene. Some helped free the trapped stewardess as previously reported while others made frantic but undirected efforts with axes and other implements to break into the main fuselage. No serious attempt was made to break open with tools the hatch of the rear pressure bulkhead and it was not until sometime between 3.20 and 3.30 p.m. (Singapore time) that an entrance was made through there to the main cabin. Most of the time was spent to no avail in attempting to cut no less than seven holes through the starboard side of the fuselage with standard axes carried as part of the Airport Fire Service equipment. Detailed investigation showed that the axes used were not capable of cutting through the metal skin in what can be accepted as a reasonable time limit; from all the evidence, with two men, it took 8 to 10 minutes The difficulties were firstly in making an incision to favour cutting, and secondly, when the axe

blade had entered the skin, the metal impinged on the blade of the axe preventing easy withdrawal for a fresh strike. In every case, it was found impossible to enter any of the apertures which were made because of the high temperatures inside and the noxious fumes. Two passengers were extricated through them, one, who was still alive (but died later), from a position immediately aft of the starboard wing root and another, a woman, from the wardrobe in the after section in front of the ladies' cloak room. She was dead.

The City Fire Brigade sent two pumpers and an ambulance after receiving the call at 3·08 p.m. Singapore time. One additional pumper was despatched from Geylang. The Geylang pumper arrived first and was positioned at the sea wall at 3.15 and commenced to run a sea water supply relay to the fireground. The two other pumpers started to produce foam about 3.20. They worked efficiently and independently from the Airport crew and managed to effect reasonable control of the fire by 3. 30 by the mass application of foam on the advanced fire originating at the port wing. The rate of foam application by the City Brigade was 2 400 gallons of foam per minute.

Exits from the Aircraft

Apart from the rear pressure bulkhead discussed above which was not a normal means of access to the cabin, there were five methods of egress. One was through a door from the crew's compartment. It is safe to assume that this door was unapproachable early in the fire and there would have been no advantage in using it as we know of the predicament of the 3 crew members who were on the opposite side. Also, this door could not be opened from the crew side.

There were three emergency exits in the shape of removable windows, two on the port side and one on the starboard, which normally can be operated from either inside or outside. After the accident, the forward port window exit was found destroyed by fire and the rear port window exit was badly damaged. The starboard exit operated normally when tested after the wreckage had been moved, and it is not clear if it was overlooked by those inside and outside or whether it and the others were inaccessible either from within or outside owing to the inverted position. All three of these exits, furthermore, were situated over or very close to the wings and the commissioner investigating the accident issued the opinion that they were "entirely inadequate" and fell "grossly short of a proper standard of safety". He recommended that this model Constellation be modified to provide "at least two (and preferably four) more emergency exits, one (or two) on each side of the aircraft ... at the after end of the fuselage away from the point where fire is most likely to occur. This work should be put in hand as a matter of great urgency".

The main cabin door was the last of the standard methods of egress and this failed to function when badly needed. As reported above, one of the flight engineers tried to open the main cabin door from the outside within two or three minutes of the crash taking place but was unable to move the door locking handle more than an inch in either direction (the outside handle must be rotated clockwise 90 degrees to unlock). Some time later a further attempt was made to open the door but this time the handle was found to be in the unlocked position. Since the body of a first steward was found in a position consistent with his attempting to open the door it is probable that the handle was in fact unlocked by him. However, it proved to be impossible to open it by hand and nearly an hour after the crash it had to be broken open by forcing it outwards and sideways from the outside with crowbars, bolt cutters, and block and tackle. The commissioner's findings note that the door operating mechanism is complicated and that no matter whether the frame is distorted or not (and it probably was) it would be far easier to deal with the door from the outside if it opened outwards instead of inwards and then had to be slid aft.

Recommendations

(The following general recommendations were included in the report.)

"1. Fatigue

Fatigue and the part it plays in accidents appear to be a most complex matter far outside the scope of this report. Whilst it seems probable that chronic fatigue played no part in this

accident, it is by no means certain how much the captain's tiredness affected his judgment in the last stages of Able Mike's approach to Runway 06.

The learned commissioner in his report following an inquiry into the accident to a York aircraft G-AHFA in the North Atlantic on 2 February 1953, recommended that "the whole subject of crew fatigue should receive study at an impressive level". I would make a similar plea and would suggest that a study group, to include medical members not connected with civil aviation, be set up; that practical experiments be carried out to gather concrete information particularly on insidious fatigue; that such experiments be carried out, amongst others, under conditions prevailing in tropical latitudes, and include the effect of noise, vibration and recirculated air obtaining in some pressurized aircraft. The results of this study group could then be considered by a Commission set up to advise on any legislation which might be deemed necessary.

Until such time as the Commission's conclusions have been reached it is recommended:

i) That only most experienced co-pilots be considered for first officer duty on sectors where the duty hours are more than (say) sixteen. The co-pilot of Able Mike would be excluded under this recommendation as a co-pilot for some time.

ii) That rest facilities on board be discussed between management and representatives of all crew members flying long sectors, and that a bunk be provided for all sectors where the hours of duty exceed sixteen.

iii) That pilots be made aware of the meaning and possible effects of insidious fatigue, and be directed to take it into consideration when planning any operation or flight technique.

2. Training of air crew for "unpremeditated" crashes

This subject, it is appreciated, is not an easy one because the nature of every unpremeditated crash must necessarily be different. In this accident, however, lives were certainly lost because of the delay in opening the hatch of the rear pressure bulkhead. It has been said during this Inquiry that in aircraft crashes it is by no means uncommon for the tail plane to break off and crew members, it is felt, could easily be trained in the operation of the rear pressure bulkhead hatch. Short lectures might be given to them as to their responsibility for the passengers and every crew member should be made to operate emergency exits. One cannot help feeling that some sort of drill should be devised, as accidents do not occur only at airports where passengers can reasonably expect help from persons other than the crew.

3. Emergency exits

The positioning and number of emergency exits on Able Mike were quite inadequate. I have been told that a modern practice in aircraft design is to make an emergency exit of every window in the main cabin and this is obviously ideal. My Assessors advise me, however, that it would be an extremely expensive undertaking to modify Constellation aircraft in this fashion and there would also be practical difficulties. In these circumstances, I would urge that at least two (and preferably four) more emergency exits, one (or two) on each side of the aircraft, are forthwith constructed at the after end of the fuselage away from the point where fire is most likely to occur. This work should be put in hand as a matter of great urgency.

4. The cabin door

The cabin door is of complicated mechanism and is more than likely to jam in the event of an accident. I would recommend that consideration be given to the suggestion that during the final approach of an aircraft this door should be opened or at least unlocked before the first touch-down. There may be practical difficulties in this regard, but if they can be overcome, if only as a temporary measure pending the installation of more emergency exits, something may well be gained.

5. The rear pressure bulkhead

It is recommended that a key to the rear pressure bulkhead be attached to the wall of the ladies' lounge, preferably under a glass cover. I realize that the tail plane of an aircraft does not always break off in the event of an accident, but at times it does; in any event there is little to be gained in keeping the key in the forward part of the aircraft.

6. Break-in points

I recommend that break-in points should be clearly marked on the outside of fuselages to show where the skin is thinnest. When positioning such marks on the outside, consideration should, of course, be given to the configuration of the inside of the aircraft which varies considerably according to the requirements of the different operators. Some simple marking is suggested which would be easily recognizable in the various territories through which long range aircraft operate.

7. Scales of equipment for fire services

It is recommended that through ICAO, airline operators should urgently approach the Governments of all territories through which they operate with a view to introducing a standard scale of fire-fighting equipment. It may well be said that the ICAO suggestions and the Ministry of Transport and Civil Aviation scales are too expensive to be adopted in all such territories. However, it must be remembered that although the airlines wish, no doubt, to operate through those territories, considerable advantages also accrue to the territories themselves as a result of an airline affording them a regular air service, and the fact that landing fees may not compensate such a territory for the cost of maintaining its airport (including the Fire Service) is of little real relevance.

8. Liaison of operators with airport fire services

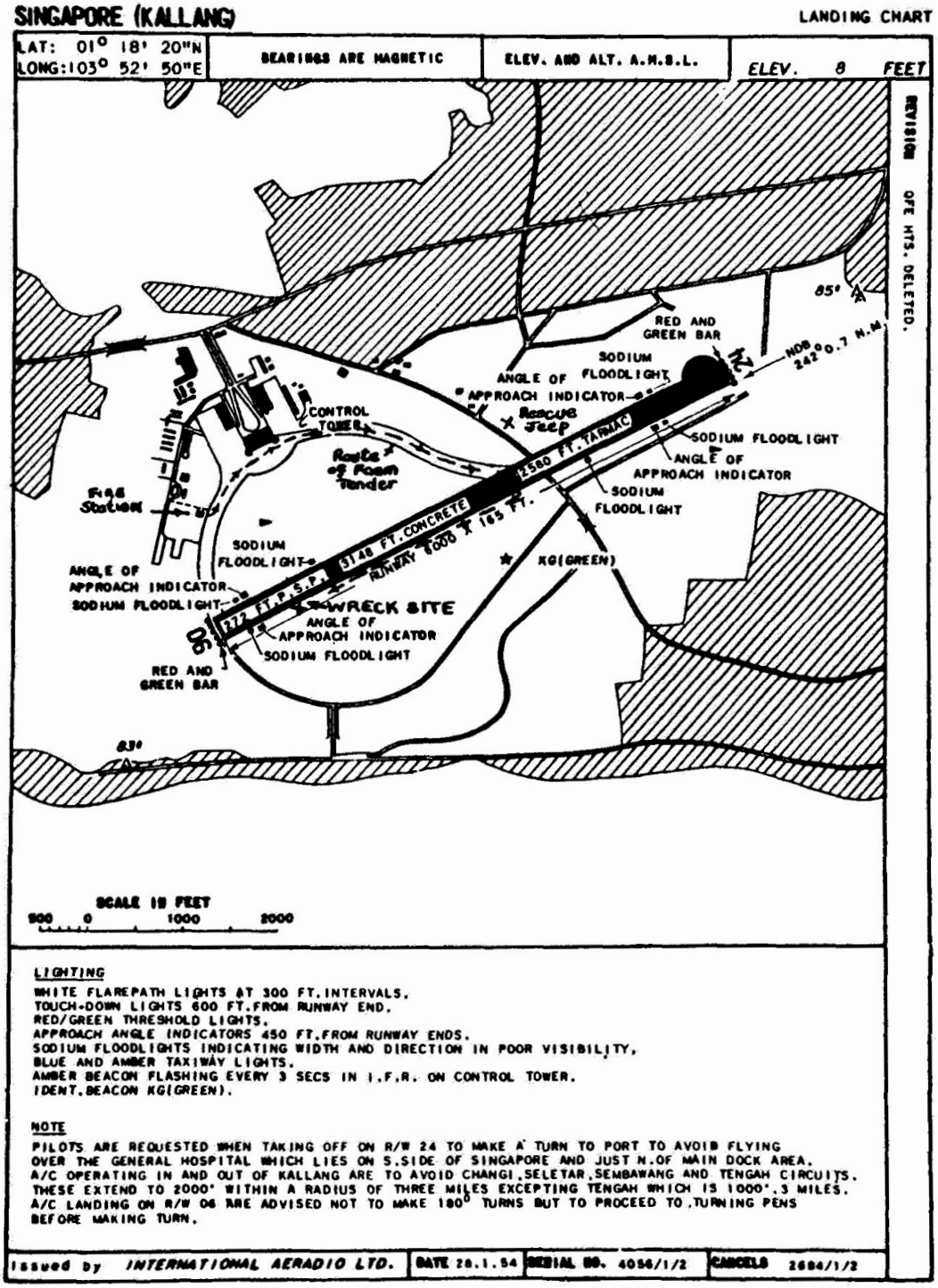
I suggest, for consideration by airline operators, that their representatives should work closely with the staffs of all airports through which they operate in matters of the fire service and that they should take an active interest in the fire-fighting facilities. I do not believe that any such interest is being shown at the present moment.

It is recommended that the Department of Civil Aviation should readily make available to representatives of airline operators any information they may require regarding the fire service Such representatives should be encouraged to witness fire drills and exercises of all kinds. In addition to this, I suggest that inspections of the various airport fire services along the route flown by the operators should be made by their own fire officers at regular intervals of perhaps six months and in the event of the operators not being satisfied with what they see and hear, they should consider the cessation of operations through the airport concerned.

9. Runway markings

It is recommended that where pre-threshold and approach conditions give rise to any concern, aviation authorities responsible for runways should actively consider the use of two thresholds, one for landing, and one for take-off."

ICAO Ref: AR/360


SINGAPORE (KALLANG)
LANDING CHART
LAT: 01° 18' 20"N
LONG: 103° 52' 50"E
BEARINGS ARE MAGNETIC
ELEV. AND ALT. A.M.S.L.
ELEV. 8 FEET
RED AND GREEN BAR
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ANGLE OF APPROACH INDICATOR
NDB 242 0.7 N.M.
CONTROL TOWER
Rescue Jeep
Route of Foam Tender
2580 FT. TARMAC
SODIUM FLOODLIGHT
ANGLE OF APPROACH INDICATOR
SODIUM FLOODLIGHT
FIRE Station
SODIUM FLOODLIGHT
5148 FT. CONCRETE RUNWAY 6000 X 165 FT.
KG(GREEN)
ANGLE OF APPROACH INDICATOR
SODIUM FLOODLIGHT
272 FT. P.S.P.
WRECK SITE
ANGLE OF APPROACH INDICATOR
SODIUM FLOODLIGHT
RED AND GREEN BAR
06
24
85°
83°
SCALE IN FEET
900 0 1000 2000
DELETED. OFF HTS.
LIGHTING
WHITE FLAREPATH LIGHTS AT 300 FT. INTERVALS.
TOUCH-DOWN LIGHTS 600 FT. FROM RUNWAY END.
RED/GREEN THRESHOLD LIGHTS.
APPROACH ANGLE INDICATORS 450 FT. FROM RUNWAY ENDS.
SODIUM FLOODLIGHTS INDICATING WIDTH AND DIRECTION IN POOR VISIBILITY.
BLUE AND AMBER TAXIWAY LIGHTS.
AMBER BEACON FLASHING EVERY 3 SECS IN I.F.R. ON CONTROL TOWER.
IDENT. BEACON KG(GREEN).
NOTE
PILOTS ARE REQUESTED WHEN TAKING OFF ON R/W 24 TO MAKE A TURN TO PORT TO AVOID FLYING OVER THE GENERAL HOSPITAL WHICH LIES ON S. SIDE OF SINGAPORE AND JUST N. OF MAIN DOCK AREA.
A/C OPERATING IN AND OUT OF KALLANG ARE TO AVOID CHANGI, SELETAR, SEMBAWANG AND TENGAH CIRCUITS. THESE EXTEND TO 2000' WITHIN A RADIUS OF THREE MILES EXCEPTING TENGAH WHICH IS 1000', 3 MILES.
A/C LANDING ON R/W 06 ARE ADVISED NOT TO MAKE 180° TURNS BUT TO PROCEED TO, TURNING PENS BEFORE MAKING TURN.
Issued by INTERNATIONAL AERADIO LTD.
DATE 28.1.54
SERIAL NO. 4056/1/2
CANCELS 2684/1/2

Figure 18

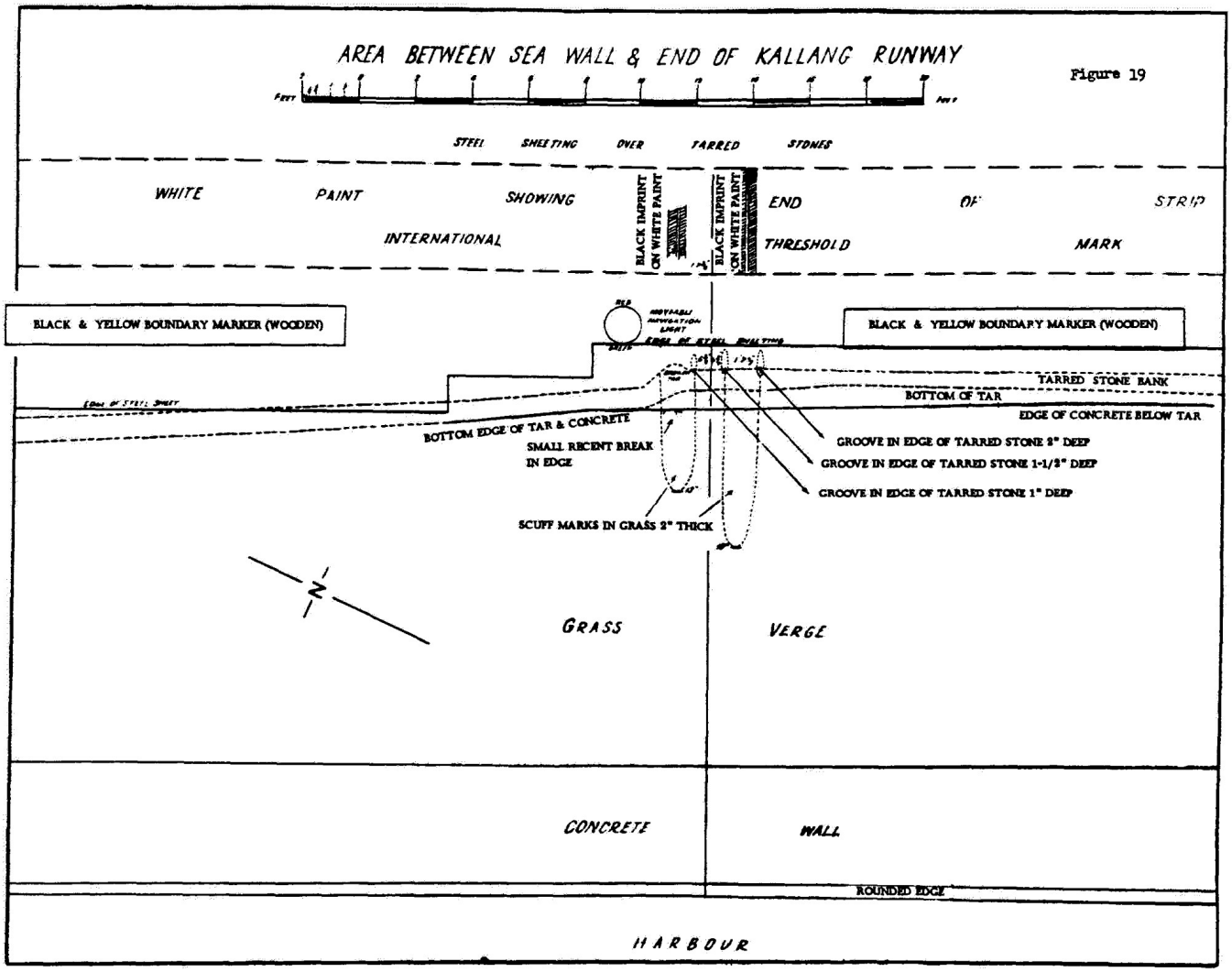
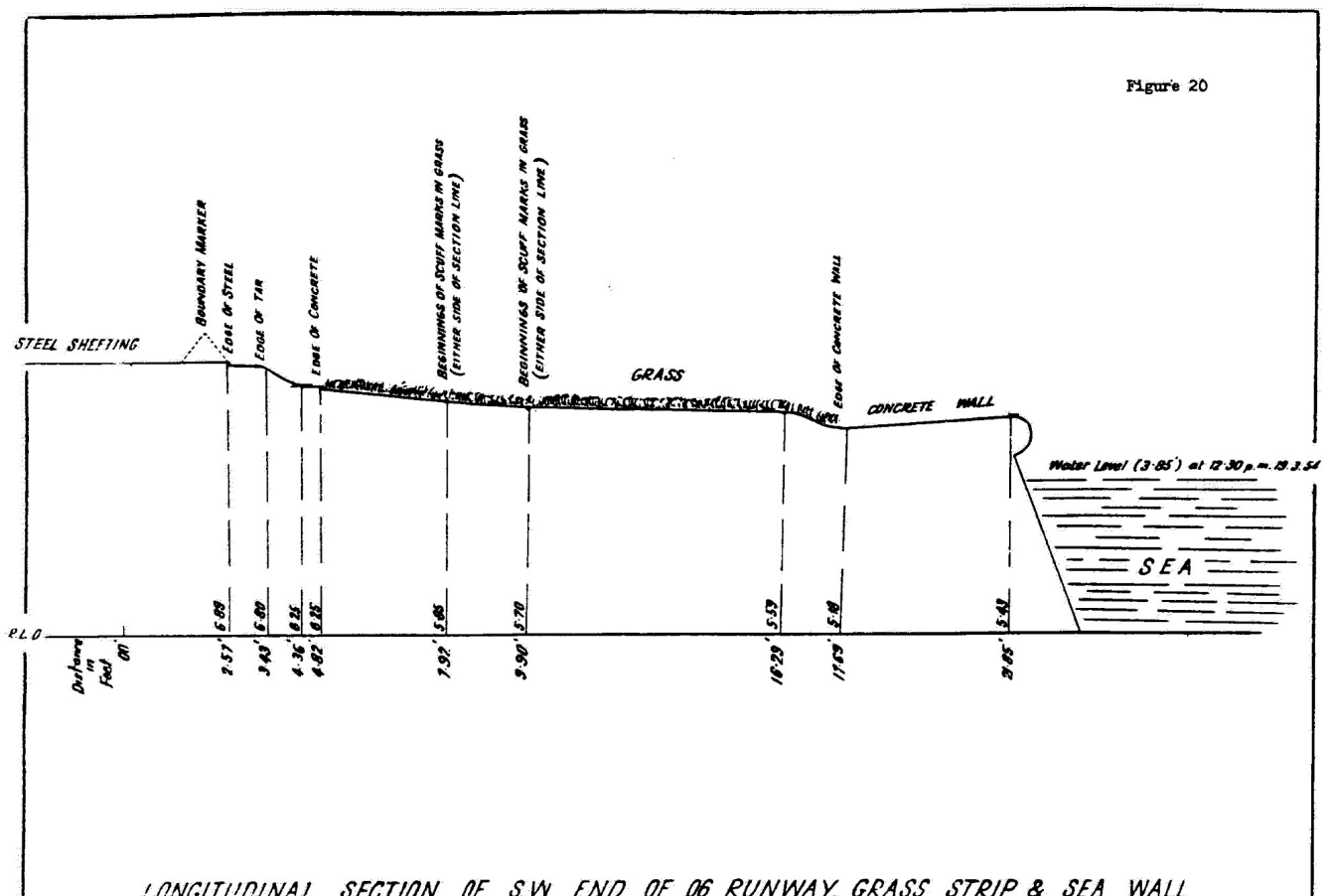

AREA BETWEEN SEA WALL & END OF KALLANG RUNWAY
Figure 19
FEET
STEEL SHEETING OVER TARRED STONES
WHITE PAINT SHOWING INTERNATIONAL
BLACK IMPRINT ON WHITE PAINT
BLACK IMPRINT ON WHITE PAINT
END OF STRIP THRESHOLD MARK
BLACK & YELLOW BOUNDARY MARKER (WOODEN)
BLACK & YELLOW BOUNDARY MARKER (WOODEN)
TARRED STONE BANK
BOTTOM OF TAR
EDGE OF CONCRETE BELOW TAR
BOTTOM EDGE OF TAR & CONCRETE
SMALL RECENT BREAK IN EDGE
GROOVE IN EDGE OF TARRED STONE 2" DEEP
GROOVE IN EDGE OF TARRED STONE 1-1/2" DEEP
GROOVE IN EDGE OF TARRED STONE 1" DEEP
SCUFF MARKS IN GRASS 2" THICK
GRASS
VERGE
CONCRETE
WALL
ROUNDED EDGE
HARBOUR

Figure 20



LONGITUDINAL SECTION OF S.W. END OF 06 RUNWAY, GRASS STRIP & SEA WALL

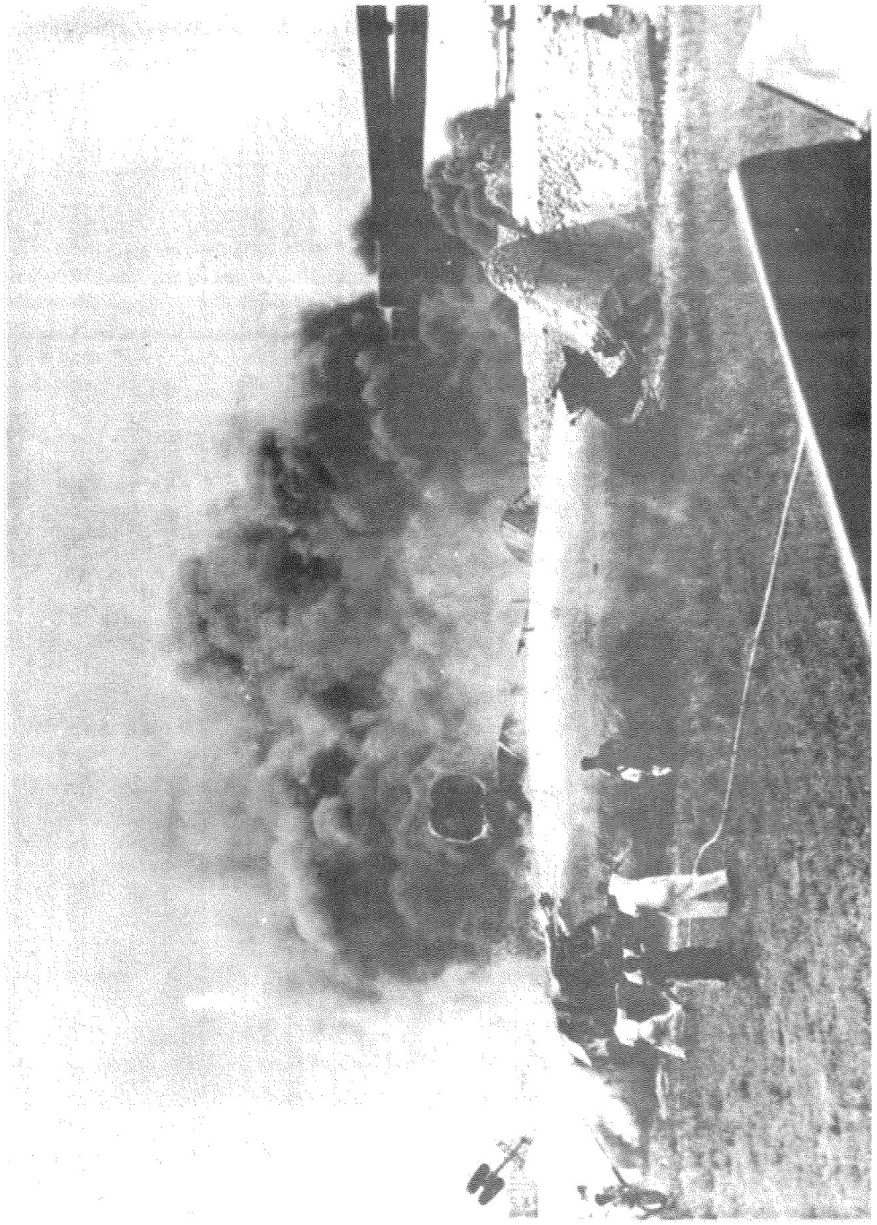


Figure 21

Figure 22

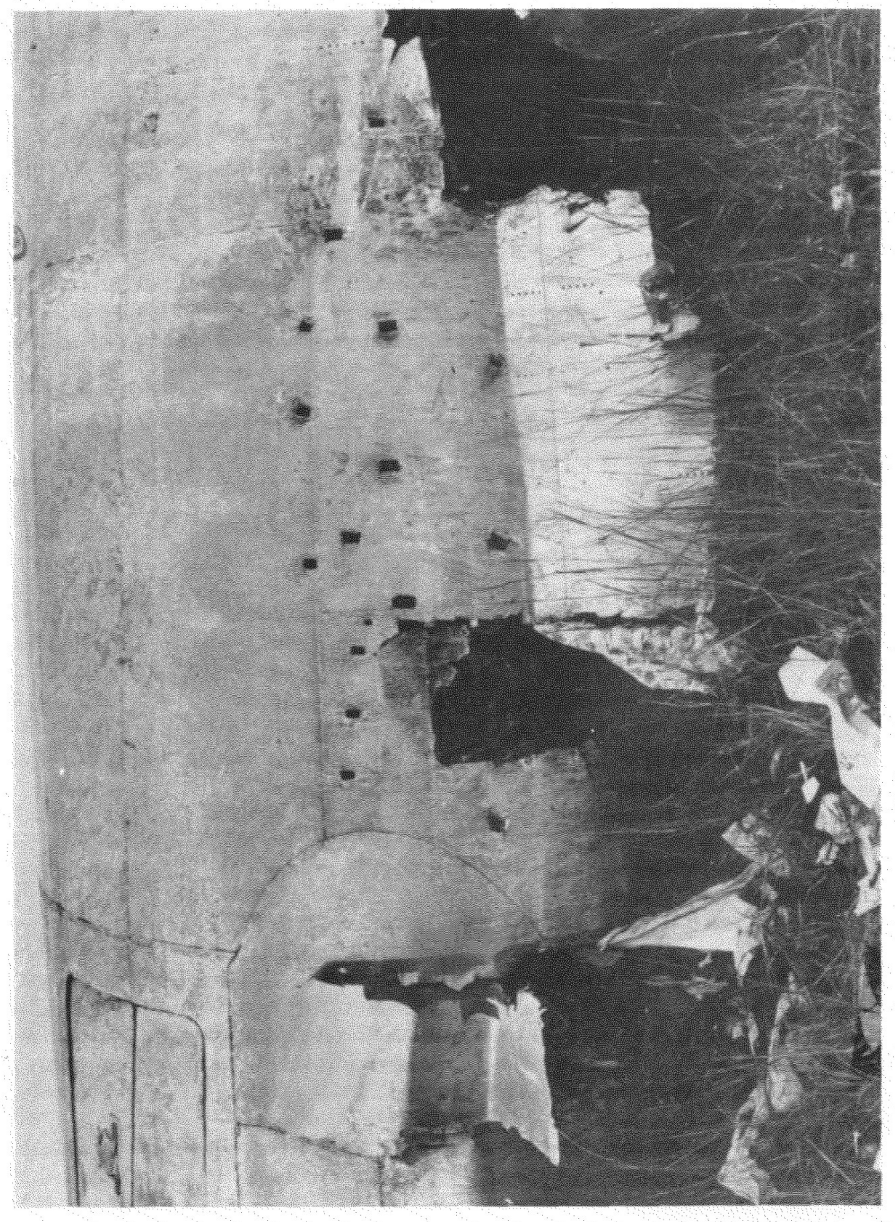


Figure 23

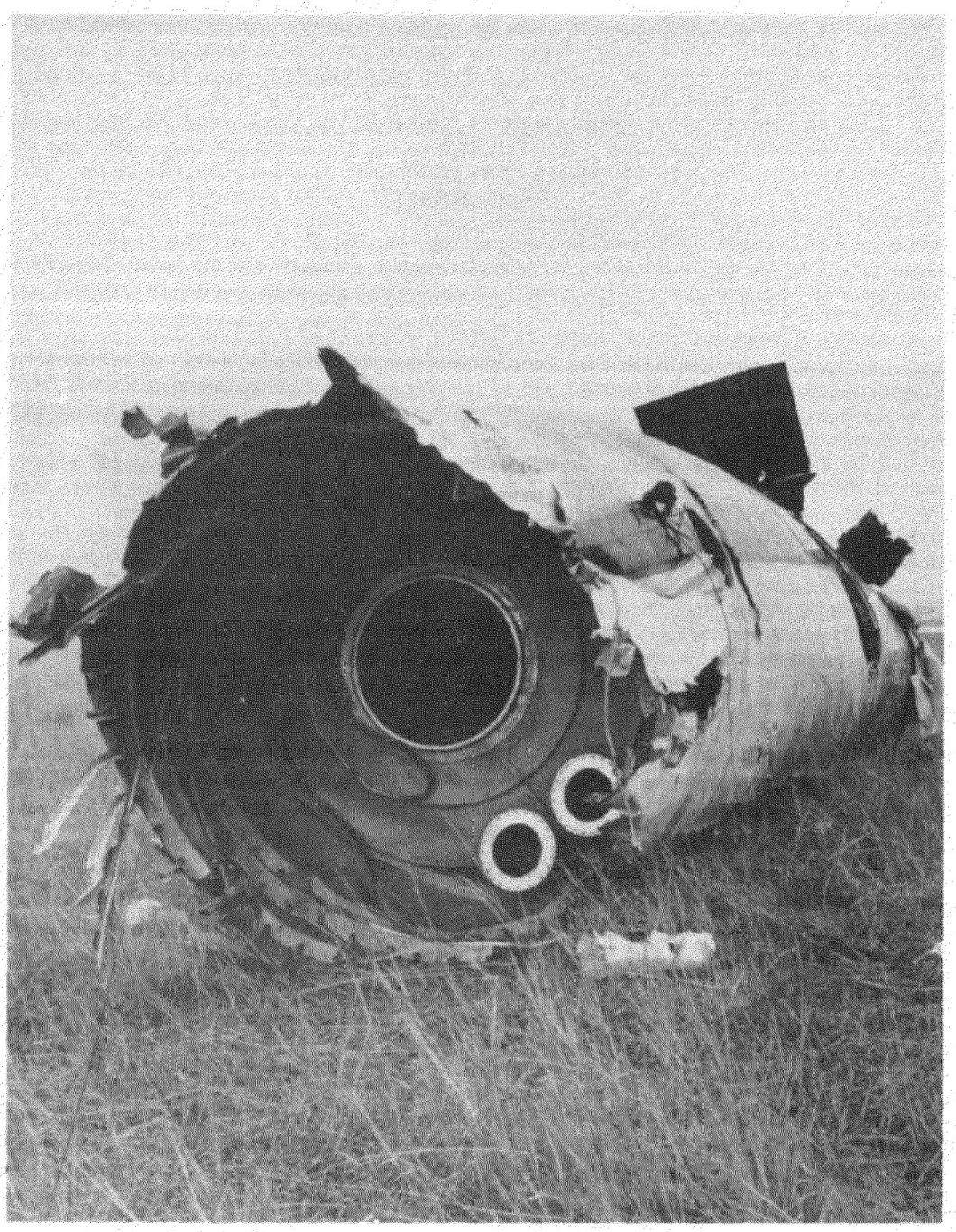


Figure 24