REPORT

OF

THE BOARD OF INQUIRY

into the accident at

Toronto International Airport,

Malton, Ontario,

to Air Canada DC8-CF-TIW aircraft

on July 5, 1970

held before

The Honourable Mr. Justice Hugh F. Gibson,

Commissioner.

TABLE OF CONTENTS

Pages

APPENDIX "D"

I N T R O D U C T I O N

1. Preliminary

This is the Report of the Board of Inquiry established for the purpose of inquiring[1] into the circumstances of the aircraft accident which occurred on Sunday, July 5, 1970 at Toronto International Airport, Malton, Ontario.

The main body of this Report is divided into Parts A, B, C, D, E, F and G.

In Part A is detailed the procedure adopted in conducting the whole of the Board of Inquiry.

In Part B is related a short history of the whole of the flight of this aircraft on July 5, 1970.

In Part C are related the actions of the relevant personnel during the events which occurred during the last 10 minutes 16 seconds of this flight of this aircraft.

In Part D is related the whole of the evidence and the interpretation put on this evidence by the Board of Inquiry, and certain other matters such as the details of the ground spoiler system. It does not contain any critical comments or observations as to any matter.

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[1] The word "investigate" in section 5A of the *Aeronautics Act* (see Appendix) is used in that statute in the sense of "inquiring".

In Part E are related the comments and observations on the circumstances of this accident, which is a so-called "ground spoiler" accident, germane to the fact that the "ground spoilers" on this aircraft were inadvertently activated at an inopportune time with catastrophic consequences.

In Part F are recorded the conclusions which in turn are divided into two parts, namely: (1) the findings, and (2) the circumstances.

In Part G are related the recommendations.

2. Details of the Accident, Crew and Aircraft

Air Canada aircraft registration CF-TIW a DC8-63 aircraft, flight number 621, owned by Air Canada and operated under a valid air operator's licence crashed after a momentary touch down on runway 32 at Toronto International Airport, Malton, Ontario on Sunday, July 5, 1970 at 08 hours, 09 minutes and 34 seconds eastern daylight saving time when attempting an en-route stop on a scheduled flight from Montreal, Quebec to Los Angeles, California.

The three flight crew, six cabin crew and 100 passengers were all killed.

The flight air crew were Captain Peter C. Hamilton,

hereinafter referred to as the "Captain", First Officer Donald Rowland, hereinafter referred to as the "First Officer" and Second Officer H. Gordon Hill, hereinafter referred to as the "Second Officer".

Aircraft CF-TIW DC8 hereinafter will be referred to in this Report sometimes as either the "aircraft" or "621".

3. Establishment of the Board of Inquiry to Investigate under Section 5A of the *Aeronautics Act*

Pursuant to the power given him in section 5A of the *Aeronautics Act*, Revised Statutes of Canada 1952, chapter 2, as amended, the Minister of Transport, The Honourable Donald Campbell Jamieson established this Board of Inquiry and designated me as the member of the said Board for the purpose of investigating the circumstances of this accident (see Schedules 1 and 2 of Appendix "A").

4. Order in Council authorizing The Honourable H.F. Gibson to act as the Board of Inquiry

By Order in Council P.C. 1970-1766 dated October 6, 1970 His Excellency the Governor General in Council, on the recommendation of the Minister of Transport and the Treasury Board, with the consent of the Minister of Justice pursuant to subsection (1) of section 38 of the *Judges Act*,

authorized me to act as the Board of Inquiry established by the Minister of Transport. (See Schedule 3 of Appendix "A".)

5. Appointments made to the Board of Inquiry

By virtue of the appointment by the said Order of the Minister of Transport and the said Order in Council and pursuant to section 11 of the *Inquiries Act*, Revised Statutes of Canada 1952, chapter 99, I appointed Mr. R.D. Hiscocks, Vice-President (Scientific), National Research Council of Canada, Montreal Road, Ottawa, Ontario and Captain Cleland D. Lamb, Assistant Director of Flight Operations, Canadian Pacific Airlines, Vancouver International Airport, Vancouver, B.C., as technical advisers to aid and assist in the Inquiry; and Mr. B.J. MacKinnon, Q.C. and Mr. A.J. Stone as commission counsel; and Mr. Roy Ferdinand Fredericks as registrar[1].

6. *Caveat*

As was stated at the preliminary hearing stage of this public inquiry and again at the commencement of the hearing of the formal evidence, and also during such hearing,

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[1] During the formal hearing the Board was supplied with a daily transcript of the evidence. If a legal assistant had also been appointed for the purpose of summarizing the daily evidence for the Board and for other duties, he would have contributed to the efficiency of the task of the Board.

the purpose of this public hearing by this Board of Inquiry was "to investigate the circumstances of this accident".

It was not for the purpose of, nor was it in any way concerned with civil liability for loss of life or damage to property resulting from this accident.

Nor is this Report.

Different considerations may come into play in determining the legal liability, if any, of any person arising out of this accident, not only in the various Canadian but also in other jurisdictions.

Any language employed in this Report, therefore, which may be similar to or suggest language sometimes used by any Court in Canada or in any other jurisdiction to impute legal liability to anyone for loss of life or damage to property is not to be deemed and must not be deemed to be intended for such purpose and in any event and circumstances, was not intended to relate to such purposes and should not be so construed.

PART A

1. Explanation

In Part A is detailed the procedure adopted in conducting the whole of the Board of Inquiry.

2. Procedure adopted

As yet, there are no regulations prescribing rules of procedure for a Board of Inquiry such as this, or governing such matters as participation in it or the general method of conducting the Inquiry.

For this reason, the procedure followed in this case is set out in some detail.

Before doing so, it should be noted, firstly that the Aircraft Accident Investigation Division of the Ministry of Transport prior to the commencement of this Inquiry, had made an investigation into the cause of this crash and had prepared its report consisting of a number of group reports, which will be hereinafter referred to[1]; and secondly that the

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[1] Eight investigating groups were formed by the Ministry of Transport, Aircraft Accident Investigation Division employing a pre-planned system. Each was under the chairmanship of a specialist from the Government of Canada service and was staffed by experts in their respective appropriate fields. The whole was coordinated by a designated investigator in charge, an officer of the Aircraft.

purpose and scope of this public inquiry was not only separate and distinct from such investigation, but was much wider, namely, to quote the statutory words, to investigate the "circumstances of (this) . . . accident", which words Parliament intended should be given a very broad and liberal meaning.

In consequence thereof, a number of things were done and procedures adopted, the more important of which are now mentioned.

The Board of Inquiry was first of all provided with a copy of the said report of the Aircraft Accident Investigation Division of the Ministry of Transport.

Then it was decided to divide the public hearing into two parts; the first part to be a pre-hearing conference for the purpose of hearing representations from persons who might wish to submit that they were entitled to be represented by counsel and be recognized as parties or in the alternative, be recognized as observers at the public hearing when

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Accident Investigation Division of the Ministry of Transport. In the main, these groups made reports containing only factual information, but with some exceptions, where it was necessary to give opinions as for example, the human factors group, which of necessity incorporated the opinions of Aero-Medical Specialists.

evidence would be adduced; and the second part to be the actual public hearing when the evidence would be adduced.

Accordingly, public notice was then given that the pre-hearing conference part would be held (and it was held) at Toronto, Ontario on October 28, 1970 and that the public hearing part would be held also at Toronto, Ontario, commencing on November 23, 1970[1] and would continue until all the evidence was heard (which in fact was the case). This public notice was given by newspaper advertisements in the following newspapers on the dates mentioned, namely: (See Schedule 4 of Appendix "A".)

TORONTO, Ontario.

The Toronto Telegram, October 22, 1970.

The Globe and Mail, October 23, 1970.

The Toronto Star, October 22, 1970.

MONTREAL, Quebec.

Le Devoir, October 22, 1970.

La Presse, October 23, 1970.

The Montreal Gazette, October 23, 1970.

The Montreal Star, October 22, 1970.

LOS ANGELES, California.

The Los Angeles Times, October 23, 1970.

The Los Angeles Herald Examiner, October 23, 1970.

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[1] The days of the public hearing were November 23, 24, 25, 26, 27, 30 and December 1 and 2, 1970.

In addition, written notice of the time and place of the pre-hearing conference part and of the public hearing part was given by commission counsel to the following persons:

(a) Representatives of the air crew of the said aircraft, namely, the Captain, the First Officer and the Second Officer;

(b) McDonell Douglas Aircraft Corporation, Santa Monica, California;

(c) Ministry of Transport, Ottawa, Ontario; and

(d) Air Canada, Place Ville Marie, Montreal, Quebec.

At the commencement of the pre-hearing conference I informed those present that at the conclusion of the hearing an Order would be made recognizing certain persons as parties and others as observers only at the public hearing part of this Inquiry then to be held at Toronto, Ontario commencing November 23, 1970.

I informed that those persons who were recognized as parties would be entitled to appear by counsel at the said public hearing and such counsel would be permitted to cross-examine all witnesses called by commission counsel to give evidence. In addition, I informed them that if they considered it necessary and deemed it advisable they would be permitted to call witnesses of their own and have

such witnesses adduce their evidence.

I informed that those persons recognized as observers only at the public inquiry might if they wish appoint their own counsel, but that such counsel would not have the right to cross-examine any witnesses called by commission counsel or by counsel of any of the parties, but that they might request commission counsel to put to any witness any question that they might desire and that if commission counsel considered any such question relevant, counsel for the commission would put such question. In addition, I informed that counsel for persons recognized as observers only if they had any witnesses of their own they might request commission counsel to call these witnesses to have them give their evidence and if commission counsel considered that the evidence that such witnesses could give was relevant, commission counsel would call such witnesses and have their evidence adduced.

At the conclusion of this pre-hearing conference, after hearing and considering all submissions made, it was ordered that the following persons be and they were made parties at the public hearing and would be entitled to appear by counsel, that is to say, Air Canada, McDonell Douglas Aircraft Corporation, the representatives of the Estates of the air crew, namely, of Captain Peter C. Hamilton, First Officer Donald Rowland and Second Officer H. Gordon Hill, and the Ministry of Transport.

It was also ordered that the following be and they were given the status of observers only at the public inquiry namely, the representatives of the Estates of the various passengers and the Canadian Airline Pilots Association. This was so ordered because it was felt that none of these persons were in a position to contribute anything to the essential purpose of the Inquiry, which was, namely, as stated, to investigate the circumstances surrounding this accident. (See Schedule 5 of Appendix "A" for appearances by counsel.)

At the public hearing commission counsel led adducing evidence *viva voce* through various witnesses and by filing numerous documents. (See Schedule 6 of Appendix "A" for names of witnesses.)

Counsel for the parties cross-examined or declined to cross-examine, as the case may be, these witnesses, and following this commission counsel re-examined them in cases they considered advisable.

As some of these witnesses were experts, and chairmen of the various groups of the Aircraft Accident Investigation Division gave a group or a combined opinion of a number of other experts, I asked all counsel if they wished any of the other experts who had joined in such group opinion to be called as witnesses but all counsel declined and said they were satisfied.

P A R T B

1. Explanation

In Part B is related a short history of the whole of the flight of this aircraft on July 5, 1970.

2. History of Flight

Flight number 621 of Air Canada DC8-63 CF-TIW with one hundred passengers, six cabin air crew and three flight crew aboard on July 5, 1970 from departure at Montreal International Airport until its final crash at Toronto International Airport lasted slightly more than 52 minutes.

This aircraft took off at Montreal at 07 hours and 17 minutes EDT, initially touched down on runway 32 at Toronto International Airport at 08 hours 06 minutes and 36 seconds EDT and finally crashed at 08 hours 09 minutes 34 seconds EDT.

A synopsis of the history of this flight is now related, which synopsis breaks down this flight into four periods, that is to say:

(i) from take off at Montreal to "In-Range Check" at Toronto;

(ii) from the time of "In-Range Check" to the "Before-Landing Check";

(iii) from the time of "Before-Landing Check" to "touch down"; and

(iv) from the time of "touch down" to "final crash"[1].

(i) From take off at Montreal to "In-Range Check" at Toronto. The flight from Montreal to Toronto was routine.

(ii) From the "In-Range Check" to the "Before-Landing Check". The flight during this interval was also routine. The "In-Range Check" was made when the aircraft was about 10 miles from Toronto International Airport on a southerly heading.

(iii) From the "Before-Landing Check" to the "touch down". This is the period of the final approach of the aircraft to the runway.

The "Before-Landing Check" was made when the aircraft was about 8 miles from this Airport, and just commencing its turn onto final approach.

On this Before-Landing cockpit check, which includes the lowering of the undercarriage, the item "spoilers armed" was intentionally omitted.

During this period there occurred a conversation between the Captain and the First Officer as to whether the ground spoilers would be armed "on the flare" or "on the ground" and an agreement between them as to this was reached. The agreement was that the First Officer

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[1] See Schedule 1 of Appendix "B" for manner in which "In-Range" and "Before-Landing" checks should be completed on this aircraft (DC8 series 63) according to Air Canada operating manual.

would arm them "on the flare"[1], that is, immediately before the aircraft touched down on the runway.

Power was reduced then on the aircraft for the purpose of the flare and the Captain gave the order to the First Officer by saying "O.K."; and immediately thereafter the ground spoilers were deployed.

The spoilers were deployed when the aircraft was about 60 feet above the runway. As a result, the aircraft sank rapidly.

Practically immediately thereafter the Captain, with an exclamation, applied full throttle to all four engines and pulled back the control panel causing the nose of the aircraft to rotate upwards. During this sequence the First Officer apologized to the Captain for what he had done.

Notwithstanding the action taken by the Captain, he did not succeed in preventing the aircraft from touching down on the runway. Instead, the aircraft struck the runway very heavily. It remained on the runway only about ½ second and then rose back into the air at which time the ground spoilers commenced to retract and then did retract.

When the aircraft struck the runway, number 4 engine and pylon separated from the aircraft

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[1] See Schedule 1 of Appendix "C" for meaning of "on the flare".

and fell on the runway along with a piece of the lower wing plating (which allowed fuel to escape and subsequently ignite). Damage was also done at this time to the attachments relating to number 3 engine, but that engine after touch down continued to function.

(iv) From "touch down" to "final crash".

After this touch down, the aircraft climbed to an altitude of 3,100 feet above the ground.

During this climb, there were conversations between the First Officer and the aircraft airport control tower from which it is patent that the air crew considered that they would be able to cause their aircraft to circle for another landing attempt on runway 32. In fact, the air crew did not know, until only about 40 seconds prior to the final crash, that the happening of such final crash was irreversible.

During this climb, fire and smoke were seen trailing behind the aircraft intermittently.

About 2½ minutes after the initial touch down of this aircraft on the runway, the first explosion occurred in the right wing outboard of number 4 engine location causing parts of the outer wing structure to fall free to the ground.

Six seconds later, a second explosion occurred in the vicinity of number 3 engine and the engine with its pylon ripped free of the wing and fell to the ground in flames, trailing heavy black smoke.

Six and one half seconds later, a third explosion occurred which caused the loss of a large section of the right wing, including the wing tip.

The aircraft then went into a violent manoeuvre, and with the right wing still ablaze, lost height rapidly and at the same time more wing plating tore free following which the aircraft struck the ground at a high velocity, about 220 knots in the attitude with the left wing high and the nose low.

At final crash, all persons aboard this aircraft were killed.

P A R T C

ACTIONS OF PERSONNEL DURING THE FINAL SEQUENCE OF EVENTS

1. Explanation

What is related here are the actions of personnel during the events which occurred during the last 10 minutes 16 seconds of the flight of this aircraft, commencing at the time the Captain called for the "In-Range Check", which was followed by the "Before-Landing Check" on final approach to runway 32 at Toronto International Airport[1].

The reason for this is that this flight from Montreal, as stated, was routine until the time of the "Before-Landing Check".

Before relating such events, however, three matters are mentioned.

Firstly, on this cockpit check which includes the lowering of the undercarriage, the item "spoilers armed" was intentionally omitted in the "Before-Landing Check".

Secondly, this aircraft was equipped with a cockpit tape voice recorder which was found intact after the crash. On it was recorded the last 33 minutes of voices heard in its cockpit. (See Schedule 2 of Appendix "C".) What was said is significant in establishing the final sequence of events of this accident. The tape time beginning at 22

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[1] See Schedule 1 of Appendix "C" for Glossary.

minutes 23 seconds and up to the time of the crash, is especially significant, and relevant excerpts from it are set out hereunder.

Thirdly, additional information was obtained from the tape transcript of the whole flight from Montreal Air Traffic Control and some of the information related here is from it. (See Schedule 3 of Appendix "C".)

2. Recital of the Final Sequence of Events of this Accident

At 22 minutes 23 seconds the Captain called for the "In-Range Check".

At 22 minutes 51 seconds the "In-Range Check" was completed.

At 25 minutes 18 seconds the "Before-Landing Check" was called for.

At 27 minutes 46 seconds all items on the board of the "Before-Landing Check" had been checked and were completed except the "spoilers".

Prior to that time, (namely, commencing at 25 minutes 41 seconds) the Captain and the First Officer had had a discussion about whether the "ground spoilers" should be armed "on the flare" or "on the ground".

The Captain agreed with the First Officer that the

spoilers this time would be armed by the First Officer "on the flare", and so ordered.

(These two techniques (i.e., arming the ground spoilers (1) "on the ground" or (2) "on the flare" are different than (3) the technique called for in the Air Canada operating manual. The latter in effect called for arming the spoilers when the aircraft was approximately 1,000 feet or more above the ground.

The technique for deploying the spoilers that heretofore had been agreed to between the Captain and the First Officer and employed by them apparently when they flew on flights previous to this one, alternated between (1) and (2)[1].

Specifically, the said agreement reached between them was that when the Captain was flying the aircraft, the First Officer would cause the spoilers to be extended "on the ground", and when the First Officer was flying, the Captain would arm the spoilers "on the flare".)

At 27 minutes 46 seconds the Second Officer called out, "Spoilers to go and the boards clear".

At 29 minutes 37 seconds the Captain called "O.K.", which means that he called for the First Officer to arm the ground spoilers "on the flare" as they had agreed to in their said discussion commencing at 25 minutes 41 seconds.

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[1] This flight on July 5, 1970 was their first flight together in a month.

Immediately thereafter the First Officer instead of arming the ground spoilers by lifting up the knob of the spoiler actuating lever, pulled the lever aft to the aft extend position, which caused the ground spoilers to be deployed immediately thereafter. As a result, the aircraft lost lift immediately and developed an acceleration of approximately (-) $\frac{1}{2}$g.

This error was immediately noticed by the Captain because at 29 minutes 38$\frac{1}{2}$ seconds he called "No - No - No!!". And this error by the First Officer was recognized by the First Officer earlier than 29 minutes 29 seconds because at that time he said "Sorry - Oh ! ! Sorry Pete."

The aircraft, at the time that the First Officer pulled the spoiler actuator aft to the aft extend position, was passing approximately over the threshold of runway 32 at Toronto International Airport, Malton, and was about 60 feet above the ground. As a result of the deployment of the ground spoilers, the aircraft descended rapidly and attained a maximum rate of descent of about 24 feet per second until the Captain, by applying full power to all four engines and rotating upward the nose of the aircraft, checked the rate of descent of the aircraft so that at impact its rate of descent was about 18 feet per second.

The reaction of the Captain in his attempt to avoid

the consequences of this action taken by the First Officer, contrary to the Captain's order, was almost instantaneous with his observation of what the First Officer had done[1].

Notwithstanding what the Captain did, the aircraft struck the runway very hard.

As a result of this striking of the runway, number 4 engine and pylon, the horizontal attachment angles and the wing plating failed and the engine and pylon and section of the wing plating adjacent to number 4 pylon, were torn off, and a large hole was left in the bottom of the wing plate of number 4 alternate fuel tank. In addition, number 3 engine pylon to the wing vertical attachment plate bolts was sheared completely.

This loss of the wing plating at number 4 engine pylon (which also constituted the floor of the number 4 alternate fuel tank) resulted in fuel escaping.

Then after touch down, the aircraft climbed from the runway to a height of about 3,100 feet.

During this climb, fuel escaped from the hole in the lower wing plate at number 4 engine position. Smoke and flames were seen trailing back from the wing.

From the initial contact on this runway until some time after the aircraft reached a height of about 3,100 feet,

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[1] Among other ways to cause the ground spoilers to retract is to apply full power to number 4 engine.

none of the air crew knew that the aircraft had lost its number 4 engine or that fuel was escaping. In radio contact with the airport aircraft control tower it was obvious that they were of the view that they could make another circuit and re-land.

The tower offered them another alternative, *viz*, to turn left and come in on number 05 runway, which they declined. The tower at the time also did not know the extent of the damage to the aircraft.

Thereafter there were three explosions on the aircraft and finally the aircraft crashed to the ground, with the said catastrophic results.

3. Possibilities of Whether or not any Remedial Action After Initial touch down Could have been Taken which Would have Resulted in Survival

Following the pulling aft of the ground spoiler lever by the First Officer and prior to the touch down of this aircraft on runway 32, the Captain initiated corrective action in the manner already stated.

The Captain, by doing what he did, in effect initiated overshoot procedure.

A pilot's training for a hard landing is to do one of two things, *viz*, either take action for overshoot or recover from the bounce and continue the landing.

In this case, having initiated overshoot procedure, the other alternative for a hard landing procedure was no longer open to the Captain.

(As to this, it should be noted that there was filed as Exhibit 85 a document, containing certain compilations, entitled "Landing Distance if Pilot Elected to Abort Take Off". The calculations on this document are completely irrelevant to the situation that existed at this stage. Having initiated overshoot procedure and following the hard landing, to suggest that the Captain should have kept his aircraft on the ground at that time is unrealistic. At touch down, the aircraft was in configuration for overshoot procedure in that take off power was on all four engines and the aircraft had been rotated to a take off altitude. In short, therefore, this document analyzes a course of action which would have been exceedingly difficult to execute and would have been contrary to all the Captain's training and experience.

In relation to this matter, it should also be observed that the logical course of action for the Captain to take in the absence of any knowledge as to what would result from a touch down on this runway was to decide to overshoot. The Captain's training would dictate this course of action in preference to the other course of action, i.e., to continue the landing procedure.

It should also be observed that if the Captain instead had not elected to check the rate of descent of this aircraft, in the final analysis the rate of descent would have exceeded 24 feet per second and the touch down on runway 32 would have been very substantially heavier and substantially in excess of the structural stress limits of this aircraft.)

After touch down, as stated, none of the crew visually or from their instruments had any meaningful indication of the damage which had resulted to the aircraft. The force of the impact was in essence their main means of inferring the quality of the damage. This was a very unreliable indicator at the cockpit station, the cockpit station being about 73 feet from the point of impact and the damaged area. In addition, none of the crew had any experience to guide them as to what might be the probable consequences of a hard landing of this character.

On take off thereafter, as the tape recorder clearly indicates from the words used and the tones of their voices, the Captain and the First Officer were of the opinion that no substantial damage had been done to this aircraft and that they would be able to make another circuit and land safely.

In fact, 21 seconds after the aircraft struck the runway, the Captain said: "Oh, we'll go around - I think

we're alright.". And three seconds later, the First Officer told the tower, "Oh, Roger, we'll go all the way around - Thank you.". By this, obviously the Captain meant that he would go all around the airport and come in again on runway 32. He thought he could do that at that juncture, so he did not accept the option offered to him by the control tower of turning left and landing on runway number 05 right.

At or just prior to that time, the flight air crew were aware that they had a power loss on the right side but this presented no major problems to them. It was only about 40 seconds before the actual final crash that the crew had any indication that there was serious damage to the aircraft. Just prior to that 40 second period, of course, the Captain and also the First Officer and the Second Officer knew they had lost power in number 4 engine but again, repeating, it was not a matter of concern to them because they knew they could safely complete the circuit with three engines, or with two, for that matter. Thereafter, during that 40 second period, they heard or realized that there were three explosions, culminating in the final uncontrolled descent and final impact.

In sum, the air crew did not know that there was catastrophic damage to this aircraft and did not know (until just immediately before the final impact) that there was no action that they could have taken which would have reversed the eventual sequence of events; and there was no means by

which they could have had such knowledge.

Other than the air crew of this aircraft, the only person who was in a position to take some action during the final sequence of events was Andras Vasarins. He was the air traffic controller in the aircraft control tower at Toronto International Airport, Malton during the relevant time. He gave evidence of what he saw and did at such time.

(Complimentary to his evidence was the air traffic control tape transcript of the whole flight of this aircraft. (See Schedule 2 of Appendix "C".))

According to Mr. Vasarins, the touch down of this aircraft on runway 32 was at 08 hours 06 minutes 36 seconds eastern daylight saving time. Fifteen seconds later, Mr. Vasarins, according to the tape, stated to the aircraft, "Air Canada six twenty one checks you on the overshoot and you can contact departure on one nineteen nine or do you wish to come in for an immediate (on) five right?". As to this, Mr. Vasarins said that at that juncture he could not tell what damage had been caused to the plane by this touch down on runway 32.

He said that he was standing in the upper part of the control tower about one mile away, as the crow flies, from where the aircraft struck runway 32. He said that he

saw what he described as debris and dust. He said he assumed, although he knows differently now, that in the cockpit of DC8 flight 621 (and in all DC8s) that there would be all kinds of signals and bells which would have given to the crew information as to precisely what had happened to their aircraft as a result of this touch down on the runway.

Four seconds later, according to the tape, the Captain of the aircraft replied to Mr. Vasarins saying, "Oh, we'll go around - I think we're alright.".

Three seconds after the First Officer replied, "Oh, Roger, we'll go all the way around - Thank you.", to which Mr. Vasarins replied, "O.K. contact departure", and this was acknowledged by the First Officer a few seconds afterwards with these words: "Roger one nineteen nine".

What Mr. Vasarins did was done during a very short space of time, *viz*, something less than 40 seconds, the period from touch down until the First Officer made this last acknowledgement - *viz*, "Roger, one nineteen nine.".

Mr. Vasarins during this period, believing as he did that the air crew had more information as to the damage of the aircraft than he did, restrained from giving what information he had which he knew was not precise and accurate.

In sum, there was nothing that Mr. Vasarins could have done which would have assisted the air crew in any way in accomplishing remedial action after the initial touch down of this aircraft on runway 32.

PART D

RECITAL AND INTERPRETATION OF THE WHOLE OF THE EVIDENCE

1. Explanation

What is related in this part is the whole of the important evidence and where felt necessary, there is given an interpretation of it, but without criticism. All criticism is reserved until and contained in Part E *infra*. In addition, details are related of the ground spoiler system.

2. Source Data of the Evidence

On the very day of this accident, and almost immediately thereafter, investigation began into the causes of it. This was carried out by the Ministry of Transport Aircraft Accident Investigation Division, employing a pre-planned investigation procedure. A so-called group system was employed. Each group made their investigation within the sphere of their respective terms of reference and also, where relevant, coordinated their investigation with that of other groups. The investigation of all groups was coordinated by an Investigator-in-Charge who, in due course, received the reports of the various groups. (See Schedule 1 of Appendix "C" for Personnel.)

The groups were (a) flight recorder group; (b) operations group; (c) systems group; (d) structures

group; (e) powerplant group; (f) eye witness group; (g) records and documents group; and (h) human factors group.

The specific terms of reference of each of these groups were as follows:

(a) Flight Recorder Group

The Flight Recorder Group was responsible for:

(i) extracting the recorded information from the flight recorder system and providing this information in a suitable form to the other groups involved in the accident investigation;

(ii) making transcriptions of the relevant voice recordings and correlating the information with the measured sequence of events;

(iii) establishing the reliability of the measured data by correlating the various parameters from a knowledge of the systems involved, and by checking with other available sources of information, e.g., eye witnesses, evidence from the wreckage;

(iv) determining the accuracy of the data from prior calibrations and any other available means; and

(v) deriving and presenting in a suitable form the flight path and motions of the aircraft in the critical period.

(b) Operations Group

The Operations Group was responsible for:

(i) determining the flight crew list, the function of each cockpit flight crew member, and the qualifications and training of each;

(ii) obtaining details of the pre-flight circumstances related to flight planning, weather briefing, flight dispatch and aircraft loading;

(iii) determining the in-flight circumstances related to existing weather, air traffic control input, and crew actions; and

(iv) reviewing the flight procedures related to the use of the spoiler system by examination of the pertinent airplane operating manuals, training, and operating practices.

(c) Systems Group

The Systems Group was responsible for:

(i) locating and identifying all systems components and instruments;

(ii) determining the position, condition or reading at impact of systems components and instruments; and

(iii) arranging laboratory examination of components which failed before impact,

those for which the time of failure cannot be determined, or those from which useful information might be extracted.

(d) Structures Group

The Structures Group was responsible for:

(i) locating, identifying and plotting the wreckage;

(ii) determining the nature and sequence of structural break-up by examining the wreckage and other evidence; and

(iii) determining the condition of the airplane and its flying control surfaces prior to the initial impact.

(e) Powerplant Group

The Powerplant Group was responsible for examining the powerplants to establish their condition at the time of the accident.

(f) Eye Witness Group

The Eye Witness Group assisted in reconstructing the circumstances of the accident by:

(i) locating, interviewing and obtaining statements from all eye witnesses to the accident who might have pertinent

information; and

(ii) reconstructing the probable flight path as observed by the wintesses.

(g) Records and Documents Group

This Group was responsible for reviewing all maintenance records to ascertain the maintenance history of the aircraft in respect to adequacy of inspection, malfunctions that might be related to the occurrence, time on the aircraft, engines and components, and the time since overhaul. The function of this Group involved coordination with the operator involved, and was normally performed at the maintenance base headquarters of the operator.

(h) Human Factors Group

The Human Factors Group investigated the pre-accident human factors circumstances by:

(i) participating with the provincial authorities in the recovery, identification and examination of crew remains;

(ii) assisting in the determination of the direction and force of the final impact;

(iii) seeking evidence of pre-occurence fire, explosion, or other toxic contamination; and

(iv) examining the flight crew medical and personal histories and investigating their pre-flight activities with special reference to their fitness for the flight.

The Chairman of each of these groups gave evidence at this Inquiry and stated the findings of the members of his particular group, and also, where relevant (as for example in the case of the human factors group) gave the group opinion.

One of the more important of these groups was the flight recorder group. The evidence which they were able to obtain was used by most of the other groups to assist them in the findings of fact in many cases, and in most cases, in any event, was used by them to corroborate the findings of fact which they made from the data available to them within their respective terms of reference.

The importance of these facts is that in so many aircraft accidents in the past, when aircraft were not equipped with some kind of recording device, the data available for investigating the cause of the accidents to such aircraft has been confined to eye witness accounts and to the wreckage. From such data, the investigators have had to attempt to determine not only the cause, but the sequence of events leading up to the cause of such accidents. As a

result, in so many cases, the investigation of such accidents did not result in probable conclusions being made as to their causes[1].

In this aircraft accident, because of these recording devices, it has been possible to determine beyond a reasonable doubt not only how this accident happened, but also the sequence of events right up to the terminal break-up of the aircraft.

The flight recorder system on this aircraft was a type called FDRS 37/106 supplied by Leigh Instruments Limited.

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[1] It is of significance at this juncture to note that the DC8-F aircraft of Air Canada that crashed on November 29, 1963, at Ste Thérèse de Blainville in the Province of Quebec was not equipped with a flight recorder of any type. None was required at that time.

The Commission of Inquiry, which was held subsequently to inquire into and report upon the circumstances surrounding that crash, and more particularly to determine the cause or causes that occasioned or may have occasioned the crash, and which was unable to come to any definite conclusions, made the following recommendation, among others, namely:

(1) To provide a positive aircraft flight history, a flight data recorder should be installed as soon as possible at least in all transport category turbine powered aircraft engaged in commercial operations in Canada.

It is of significance also to note that in 1970 two Air Navigation Orders were passed requiring in the terms of such orders the installation of both tape recorders and also parameter recording systems in certain aircraft. (See Schedule 2 of Appendix "D".)

It was located in the tail of this aircraft and was found intact after the crash.

When it was dismantled by an experienced Air Canada technician under the supervision of the chairman of the flight recorder group and senior members of Air Canada maintenance engineering, and Leigh Instruments Limited, it was ascertained that it had been operating efficiently during all material times prior to the crash.

The parameters of this aircraft and also the voices in the aircraft and the radio transmissions heard in the cockpit were recorded.

The voice recording part of the system consists of three separate channels of audio information. The first one is from a small microphone known as the cockpit area microphone, which sits above the pilot on the flight deck and records all sounds which are heard on the flight deck. The second one is connected to the Captain, the signals being transmitted through the Captain's earphones, so this will include all the radio communications that the Captain hears, and also the Captain's microphone output which is also fed back through the earphones. The third channel is a similar system for the First Officer's earphones.

These three channels were recorded on $\frac{1}{4}$" magnetic tape formed into a continuous loop such that the previous 33 minutes of information were stored in any given time.

On the data side, this recorder has the capacity to measure up to 64 numbers every second with an accuracy of something less than one-half of one per cent. Alternatively, any one number can be replaced by eight on-off signals. The data are obtained from various systems in the aircraft, either directly, as from some of the pilot's instruments, or from special sources which are called transducers, and which have been fitted as part of the flight recorder system.

The signals from these transducers are given in a variety of forms of electrical signals which are initially fed into one unit where they are then conditioned into a standard format, and sampled at discrete intervals.

From this sampling process, the various signals are combined in sequence into one single electrical signal which is then converted into digital form for recording on magnetic tape in the tape recorder.

For the purpose of synchronizing voice and data information, the data signal is fed onto the fourth track of the quarter-inch tape which has voice recordings on it, so that in effect the data are in two places - although on the voice tape only the last 33 minutes of information are recorded, whereas the data tape on this aircraft contained 56 hours of information. (Schedule 3 of Appendix "D" contains a list of the 73 parameters which were being monitored at the time of the accident.)

In evidence a summary was given of the information obtained from this flight recorder system by the investigating flight data recording group, and the salient parts of it are used in relating what follows. (See Schedules 2 and 3 of Appendix "C".) In addition, in relating what follows, an interpretation is made of certain figures and other data which are set out in the following Schedules, that is to say:

Schedule 4 of Appendix "D" - Variation of critical parameters during spoiler deployment and touch down with synchronized voice information.

Schedule 5 of Appendix "D" - Determination of rate of descent at touch down.

Schedule 6 of Appendix "D" - Engine, roll and yaw data, during spoiler deployment and touch down.

Schedule 7 of Appendix "D" - Reconstruction of CF-TIW flight path and events from the flight recorder.

Schedule 8 of Appendix "D" - Reconstruction of CF-TIW motion in last 19 seconds before impact.

Schedule 9 of Appendix "D" - Drawing of the runways at Toronto International Airport, including Whiskey Beacon.

3. Flight Profile

The evidence provided by the cockpit voice tape, and the data output of the flight recorder, eye witnesses, and

accident investigators, provides the following summary of significant times and events.

The time of the initial touch down of this aircraft on runway 32 was 08 hours 06 minutes 36 seconds eastern daylight saving time[1].

7 mins. 18 secs. before touch down (B.T.)

The "In-Range Check" was requested by the Captain when the aircraft was descending to 3,000 feet above sea level.[2]

Apparently the "In-Range Check" was completed by the flight crew. However, from the transcript of the cockpit voice recorder tape it is not certain whether or not the check list was called and responded to as laid down in the Air Canada operating manual.

4 mins. 23 secs. B.T.

The "Before-Landing Check"[3] was requested by the Captain

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[1] It is proposed in this narrative to relate all events to the initial touch down time.

[2] All altitudes referred to in this Report are above sea level unless it is specifically stated to the contrary.

[3] As already noted, there are 5 items to be completed on the "Before-Landing Check". According to the Air Canada operating manual, these items are to be called out and responded to. In this case it is not known from the audio recording whether or not this drill was carried out in respect to all items. Certainly the last two items on this list were called out because the recorder clearly indicated these words from the Captain:

O.K., Brakes, 3 Green, 4 Pressures, Spoilers.

and later the words of the Second Officer were:

Spoilers to go and the boards clear.

when the aircraft was about three and one-half miles east of the Whiskey Beacon[1].

3 mins. 48 secs. B.T.

Just after the "Before-Landing Check" had been called for, the Captain and the First Officer had a discussion between them as to how the ground spoilers were to be deployed. According to the recording of the cockpit recorder tape, the specific words of this discussion were as follows:

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[1] See Schedule 9 of Appendix "D" - The drawing of the runways at Toronto International Airport.

N O T E:

It should be noted that information obtained from the cockpit voice recorder established unequivocally that the Captain was flying the aircraft and the First Officer was acting as co-pilot, in that, among other things, the recording indicates that the Captain issued all the orders and the First Officer carried them out. In addition, the First Officer did all the radio communicating with Tower Control. On the other hand, the evidence to the effect that small flakes of yellow paint were found on one of the hands of one of the flight crew is of no significance, and of absolutely no weight in proving or disproving who of the flight crew was actually flying the aircraft and who of the flight crew was acting as co-pilot (see also regarding this, page 73 and Schedule 19 of Appendix "D"), especially in view of the fact, as stated, that the aircraft in its descent to final crash went into a violent manoeuvre and then struck the ground at about 220 knots in the attitude with the left wing high and the nose low.

Captain: O.K. Brakes three green, four pressures, spoilers (on the flare).[1]

First Officer: (No OR or) on the ground.

Captain: All right, give them to me on the flare.

I've given up.

I'm tired of fighting it.

This is interpreted to mean that the Captain and the First Officer had agreed that the First Officer was to arm the ground spoilers when the aircraft was "on the flare" prior to touch down.

3 mins. 10 secs. B.T. The aircraft advised the Tower at Toronto International Airport that it was approaching Whiskey Beacon. The Control Tower informed the aircraft that it would be the first to land following the take off of two Boeing 727 aircraft. It was subsequently ascertained that these were, in fact, CPA flight Empress 60 and Eastern Airlines flight 337 which took off at 2 minutes 36 seconds and 1 minute 7 seconds, respectively, prior to the touch down of aircraft 621.

At about this juncture the Captain remarked that he thought his aircraft would experience a rough approach because of the turbulence in the wake of these two departing aircraft.

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[1] Some conversation was unintelligible due to background noise and low voice levels. Dubious words are enclosed in parentheses.

The flight data recorder provides no evidence that such was the case. In this connection, also, the evidence is that this Captain of Air Canada flight 254, a Viscount aircraft which was due to land on runway 32 following the landing of flight number 621, and who was on the approach to the runway approximately 2½ miles behind flight 621, stated:

> We watched the take-off of the 727 ahead of flight 621 and observed engine smoke drift to the east, so that by the time of his lift-off the runway was clear of smoke and visibility good from the threshold to approximately the Foxtrot Taxiway.[1]

Evidence was also given that the transmissometer, positioned 2,000 feet on a bearing of 100° magnetic from the threshold to runway 32, indicated visibility exceeded ten miles.

2 mins. 1 sec.B.T. The aircraft reported that it was at Whiskey Beacon.

Second Officer: Spoilers to go and the boards clear.

This would mean that the "In-Range Check" had been completed and also that the "Before-Landing Check" had been completed with the exception of the arming of the spoilers. (At this juncture, according to the evidence, the laid down procedure is that when these checks have been completed - and in this case also when there was only one item not completed -

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[1] The evidence shows that the distance from the threshold to Foxtrot was approximately 4,300 feet.

namely, the arming of the spoilers - the Second Officer would present the check board[1] to the Captain by exhibiting it within the Captain's range of vision.)

0.45 secs. B.T. The Control Tower cleared the aircraft to land.

0.6 secs. B.T. Engine power was reduced. Air speed was 136 knots, which was close to the recommended threshold speed of this aircraft of about 127 knots.

0.3½ secs. B.T. The Captain called "O.K.". This is interpreted to mean that the Captain gave the order to the First Officer to arm the spoilers in the manner that he and the First Officer had agreed upon at 3.48 minutes before touch down, i.e. when the aircraft was "on the flare" prior to touch down.

0.2½ secs. B.T. The inner spoilers started to extend and, almost simultaneously, the aircraft started to sink - indicative of a ground spoiler selection. At this point on the flight path the main wheels were approximately 50 feet above the runway.[2]

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[1] A mechanical check list containing all of the "In-Range" and "Before-Landing" items.

[2] An error made in the deployment of ground spoilers, if made when such an aircraft was at any height acceptable for carrying out the "Before-Landing Check" would not be catastrophic in that the consequences of such error could be remedied. While Air Canada does not prescribe the height above ground at which the "Before-Landing Check" must be made and executed, such depending upon local conditions at any given airport, the "Before-Landing Check" is usually carried out on a DC8 series aircraft, when such an aircraft is at a

Within approximately one-third of a second the accelerometer reading dropped from 1.0 to 0.5 g., indicating a substantial reduction in wing lift. Simultaneously the Captain called "No, No, No" in alarm, and at approximately the same time fuel flow to all four engines started to increase; the control column was pulled back through 70 per cent of its maximum rearward movement; the elevator trailing edge moved up through 32°; and the aircraft started to pitch nose up.

Commencing a fraction of a second after the spoilers began to extend, the First Officer stated:

Sorry - Oh ! ! Sorry Pete.

the last word being immediately followed by the noise of the impact on the runway.

From this it is deduced that the First Officer executed the order given by the Captain when the latter said "O.K.", by moving the ground spoiler cockpit handle towards the "aft extend" position, instead of lifting it to arm the spoilers as was the said agreement between them at 3.48 minutes before touch down.

The evidence indicates that the Captain recognized

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height above the ground of not less than 1,000 feet. Often the practice is to carry out the "Before-Landing Check" at much greater heights above the ground for other reasons, one of which is for noise abatement.

the First Officer's error coincidentally, and responded immediately by applying full power to all engines and raising the nose of the aircraft[1]. Coincident with the spoiler extension, the evidence established that the rate of descent of the aircraft increased from 11 feet per second to a maximum of 24 feet per second three-quarters of a second before touch down. The recovery action taken by the pilot reduced this rate of descent to 18 feet per second at touch down.

"Zero" time

The aircraft bounced heavily on the runway with the right wing slightly low. Number 4 engine and pylon separated from the aircraft[2].

As the aircraft was being rotated "nose up" the wheels made the initial contact on the runway, followed by a heavy impact at the tail bumper. The contact with the ground lasted approximately one-half second. The aircraft then climbed away. During this half-second interval the acceleration at the centre of gravity of the aircraft was in excess of 3.4g.[3 - 4]

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[1] It should be noted that a separate action would not be necessary to initiate spoiler retraction. The movement forward of the number 4 power lever would accomplish this. A detailed time history of the spoiler motion indicates that the spoilers extended in approximately 0.3 seconds, remained fully extended for roughly 0.2 seconds, and the retraction phase was underway when the impact on the runway occurred.

[2] This loss is not directly evident from the flight recorde

[3] It is not possible, from the evidence of the accelerometer in the flight recorder, to give a precise value of the

(In interpreting the data it is of significance to note that if the extension of the spoilers had occurred less than one-half second earlier in time, the corrective action taken by the Captain would have reduced the rate of descent to a value on contact with the ground within the capacity of the airframe. On the other hand, if the spoiler extension had occurred a fraction of a second later in time than when it did in fact happen, the structural damage on impact resulting from the high rate of descent would have eliminated any possibility of further flight.)

0.8 secs. after touch down (A.T.) The Captain made the statement:

We've lost our power.

The evidence was that the experts of the Aircraft Accident Investigating Division interpreted this to mean

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peak acceleration which was experienced on ground contact. This accelerometer is designed to measure flight loads only and incorporates a filter to suppress any signals produced by (relatively) high frequency vibrations in the airframe. The recorder, which samples the readings of the accelerometer at a rate of 5 times per second, may also "miss" rapid fluctuations in the signal. Unfortunately, for our record here, it is an impulse probably with a very short time base, and therefore beyond the capacity of the instrument, which is of primary interest in measuring the landing impact.

[4] "g" is the acceleration due to gravity. Here 3.4 g implies that external forces equal to 3.4 times the weight of the aircraft are applied to the airframe.

"an interruption of electrical power as there is no recognition of a specific engine power loss". That is not agreed to as correct[1].

0.15 secs. A.T. The aircraft had travelled a horizontal distance of about 3,200 feet and had gained an altitude of about 3,100 feet, during which the Control Tower advised the aircraft as follows:

> Air Canada six twenty one (I) checks you on the overshoot and you can contact departure on one nineteen nine or do you wish to come in for an immediate (on) five right?

Because of the short passage of time between the impact and the time the Control Tower verbally contacted the aircraft, it is interpreted that the Control Tower knew immediately that something serious had happened to the aircraft or otherwise the Control Tower would not have given that sort of instruction and option to the aircraft.

The reference in the advice of the Control Tower to "contact departure on one nineteen nine or do you wish to come in for an immediate (on) five right?", means that the Control Tower gave this aircraft the option to proceed to an immediate visual landing at runway 05 right or to do an instrumen overshoot, which involves radar vectors back to the runway in use.

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[1] See footnote number 2 at page 52.

0.25 secs. A.T. The Captain made his decision in response to this offer from Control Tower, and said:

Oh, we'll go round - I think we're alright.

The First Officer communicated this decision to the Control Tower three seconds later by stating:

Oh, Roger, we'll go all the way (around) - Thanks.

In the result, therefore, the Captain of this aircraft did not accept the option of making an immediate landing on runway 05 right. Instead, in causing the First Officer to inform the Control Tower "we'll go all the way (around)", he decided that he would follow the instrument overshoot procedure.

The Control Tower replied to this decision by saying to the aircraft:

O.K., contact departure.

This was acknowledged by the First Officer by these words, namely:

Roger one nineteen nine.

which meant that the First Officer would tune into that frequency which was the departure control frequency at that time at Toronto International Airport.

Having made this decision to go around, the Captain then called for the landing gear "up", and the First Officer caused this to be done. That this was done was confirmed

by the cockpit tape of the sound from the warning horn[1].

0.36 secs. A.T. The First Officer said:

What about the flap?

To this the Captain said:

Flap -- twenty five.

The warning horn then ceased. The evidence is that the significant setting on the 60 series of the DC8 is 23° of flap, but that on the earlier series, namely the 40 and the 50 series, it is 25°. This accounts for the Captain calling for flap 25 instead of 23. But this is immaterial because what the Captain was calling for would place the control lever in a slot which is the same in all DC8 series - namely, the slot that was appropriate to the "overshoot" flap setting.

0.51 secs. A.T. The First Officer indicated that number 4 generator was inoperative, and the Captain responded by saying:

O.K. Get the cross-feed off first (though).

1 min. 5 secs. A.T. The Captain said:

Will you give the approach a call?

(He really meant departure in this case.) At approximately this time the aircraft was passing over the middle marker of runway 14 which is .7 miles away from the threshold of runway 14. Runway 14 is the opposite end of runway 32.

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[1] This horn serves as a reminder to the pilot, prior to a landing, to lower the landing gear when the "landing" flap setting is selected. In an "overshoot" manoeuvre, it also serves to remind the pilot, when he retracts the landing gear, to use the "overshoot" flap setting.

1 min. 9 secs. A.T. The First Officer contacted the Control Tower and advised that the aircraft was overshooting on runway 32.

1 min. 20 secs. A.T. The Control Tower asked:

> Air Canada Six twenty one confirm on the overshoot.

To this the First Officer replied two seconds later:

> Affirmative.

1 min. 23 secs. A.T. The Control Tower asked the aircraft's intention, and four seconds later the First Officer replied that they:

> . . . would like to circle back for another attempt on thirty two.

From this it is interpreted that they wanted to turn back and circle all the way around the airport and make an approach on the same runway.

The Control Tower then advised the aircraft that runway 32 was closed down due to debris and that runway 23 left was now in use.

1 min. 31 secs. A.T. The aircraft was given a vector 070 at 3,000 feet which means that the aircraft was expected to climb to 3,000 feet, turn to a heading of 070 and receive further vectors from the Control Tower for the approach on runway 23.

1 min. 47 secs. A.T. The Captain stated:

> We've lost number four engine.

To this the First Officer replied:

> Have we?[1]

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[1] It should be noted that other evidence indicated that the master caution light was on at this

1 min. 59 secs. A.T. There were comments made by the Second Officer regarding fuel to which the Captain replied six seconds later by saying:

OK, cut number four.

It is interpreted that this discussion regarding fuel means that the Second Officer noticed that the fuel flow meter was at zero or low. He would not suspect that he had lost the whole tank of fuel by reason of the impact. Instead, he probably would have formed the judgment that number 4 engine was not getting its fuel. This was the way the Captain also probably understood it, which caused him to give the order "Ok, cut number four (engine)."[2].

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juncture. This would not indicate to the Captain or any of the crew at that time that number 4 engine had been lost because there are a multitude of causes, defects, or deficiencies which would result in this light going on. It would be beyond reasonable probability that any of the air crew would specifically identify the loss of number 4 engine as the cause of the master light going on under these conditions. In other words, neither the Captain nor any of the crew would immediately associate this indicator with the loss of an engine.

2 As noted above, at 8 seconds after impact the Captain had made the statement "We've lost our power". It was noted that the evidence was that this was interpreted "to mean an interruption of electrical power as there was no recognition of a specific engine power loss". It was then stated that this opinion in evidence was not interpreted correctly. The reason for saying this is as follows:

At 08 hours 07 minutes 30 or 55 seconds after touch down

Either the first or the Second Officer immediately

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the Second Officer announced "Number four generator's gone". At 08 hours 23 seconds or one minute 47 seconds after impact the Captain stated "We've lost number four engine". In evidence it was stated that "These statements indicate the possibility that the flight crew did not recognize the loss of power in number 4 engine". The evidence indicates the yaw induced when number 4 engine left the aircraft was corrected for immediately.

The opinion evidence also was that it had taken the crew 1 minute and 47 seconds to recognize the loss of engine power.

It is believed that the flight recorder group and the operations group have relied too heavily on the CVR to indicate all that was going on in the cockpit during these crucial few moments and do not seem to have joined these events into a logical sequence.

When the Captain announced "We've lost our power", it is interpreted that this meant electrical power as indicated to the Captain by various flight instrument failure flags flashing into view. The F.D.R. shows that during touch down phase A of the A.C. bus dropped from 114.6V to 110.5V and phase C from 115V to 112.7V probably due to number 4 generator leaving the aircraft. According to the manufacturer the minimum acceptable voltage on either phase is 107V. As the F.D.R. samples these voltages once every two seconds, there could have been larger voltage reductions of less than two second duration which could have caused the warning flags to be displayed for something less than two seconds.

As the Captain made this statement 8 seconds after impact at a time when the engines were up to full power and he was fully occupied with continuing the overshoot, it is highly unlikely he would be using any flight instrument except for a possible glance at the airspeed indicator which is not electrically powered and, therefore, has no warning flag. A momentary electrical interruption at this point would be of no consequence, and probably would have gone unnoticed.

It seems more likely at this point, or slightly before he made the statement, that the Captain recognized the loss of engine power. The loss of an engine is evident

thereafter queried whether this was really number 3, but

immediately at high engine powers due to large rudder inputs required to counteract the yaw. The evidence indicates the yaw, when number 4 engine left the aircraft, was immediately corrected for.

The engine instruments are grouped on the centre instrument panel. Each engine has five gauges mounted in a vertical row. There are, starting from the top, E.P.R., E.G.T., N_2, Fuel flow, & N_1. This layout gives a board containing 20 engine instruments with the four E.P.R. gauges indicated horizontally across the top. Due to their location and design, the E.P.R. gauges are most easily read at a glance. A loss of engine power is readily seen. The presentation of the other gauges makes them more difficult to read and due to the large number of gauges they have to be located in the group of 20 gauges.

When the Captain applied rudder to compensate for yaw, he recognized a loss of engine power, but at this point he would only afford a glance at the engine gauges. When number 4 engine left the aircraft E.P.R. would have remained as it was, showing full power - the other gauges would have run to zero. The Captain's glance at the E.P.R. would have confirmed all engines operating at full power which would have been confusing as he was then compensating for yaw.

With the loss of power on a jet engine, providing there is no fire, there is no hurry to shut the engine down, as is the case with a propeller driven aircraft. The act of shutting the engine down produces no decrease in drag in a jet engine. The crew had no indication of fire. It therefore, seems reasonable that the Captain elected to take no further action until he was certain which engine had failed and at this point he had more important things on his mind. He knew the power loss to be on the right side and had he shut down the operating engine he would have only compounded his troubles.

Forty-seven seconds after the Captain announced a power loss the Second Officer announced the loss of number 4 generator. This in itself is a minor problem. At this point the workload in the cockpit was reducing as 12 seconds after the loss of the generator the Captain

the First Officer finally agreed with the Captain that it was number 4 engine. He did this at two minutes 12 seconds after impact. The recorder which utilizes the same fuel flow transmitters as the cockpit indicators showed that number 3 engine fuel flow indications remained erratic and below normal after the touch down.

It is interpreted that there was difficulty experienced in operating one of the number 4 engine controls, either the power lever or the high pressure cock.

2 mins. 21 secs. A.T. The Captain stated:

Number three is jammed too.

This meant one of the number 3 engine controls. Eight seconds later the Captain stated that they were all jammed.

2 mins. 31 secs. A.T. At this time a crackling noise was heard on the cockpit area microphone which was a series of explosions. Number 3 engine fuel flow and r.p.m.'s first increased and then cropped

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requested the First Officer to call "Approach". This call would only have been initiated after important procedures were completed. However, the loss of the generator would guide the crew to identifying the engine problem. The reduction in cockpit workload would allow the Captain and the Second Officer to scan the engine instruments. They would then see number 4 E.G.T., N_2, F.F. & N_1 at zero, and conclude the engine power was lost due to lack of fuel flow. Fifty-six seconds after the Second Officer announced the loss of the generator the Captain was able to identify the engine when he announced "We've lost number four engine". Twelve seconds later the Second Officer called "fuel" indicating the probable reason for the power loss. At this point the Captain ordered number 4 engine shut down.

This sequence of events is more in line with what would be expected of a seasoned, well-trained crew operating under emergency conditions.

to very low values; which would appear to be consistent with the separation of number 3 engine from the aircraft.

The aileron and rudder hydraulic pressures both dropped to zero putting the associated control into manual rather than the normal powered operation.

The left wing flap showed a decrease of one and a half degrees and the right one an increase of three degrees.

There was an indication of right flight spoilers coming fully out for two seconds, a small change in flap settings, and a main undercarriage unsafe signal. However, it is quite probable that these signals were, in fact, erroneous as a result of the damage which had occurred to the aircraft. The crew probably associated these incidents to the power loss from number 4 engine.

2 mins. 38 secs. A.T. There was a sudden temporary dip in the vertical acceleration of approximately 0.1 g, and the aircraft started to pitch slowly nose down. The First Officer said:

Pete! Sorry!

2 mins. 43 secs. A.T. A louder explosion was heard, and three seconds later there was a sound which was like the noise of metal tearing.

2 mins. 58 secs. A.T. The final impact occurred 8½ miles beyond the threshold of runway 32, and approximately 2½ miles to the right of the extended centre line. (See Schedule 7 of Appendix "D".)

This concludes the detailing of the significant times and events from the summary of the information obtained from the flight recorder system, the investigating group and various witnesses.

The evidence which was given of the methods used to reconstruct the flight path (see Schedule 8 of Appendix "D") and the attitude of the aircraft from the parameters recorded during the terminal phase of the flight are not reproduced in this Report.

4. The Aircraft

This aircraft was a McDonell Douglas Aircraft Corporation DC8-63 serial number 46114 which was imported into Canada on April 29, 1970, on FAA Form 8130-4 with a Certificate of Airworthiness for Export number 98527. The Ministry of Transport issued a Certificate of Airworthiness and also a Certificate of Registration in respect to it, both on April 30, 1970, both numbered CF-TIW (46114).

Air Canada accepted the aircraft on April 30, 1970, and assigned to it serial number 878. Upon acceptance by Air Canada the aircraft had flown 7 hours. At that time Air Canada made various checks and modifications of a routine nature to the aircraft. Subsequent to this aircraft being put into service, Air Canada also corrected certain snags that had occurred to this aircraft. The details of all these are set out in Schedule 10 of Appendix "D".

The proper inference from this documentary evidence of the records is that (1) the McDonell Douglas Aircraft Corporation's DC8-63 aircraft number 878-CF-TIW was adequately maintained and certified in accordance with Air Canada's DC8 Maintenance Manual Inspection Schedules and Procedures, and (2) that an appraisal of the records of Air Canada disclosed no irregularities in the clearance of flight crew snags.

On July 5, 1970, the day of this accident, all the flight documentation was completed, including loading calculations which indicated on take off a gross weight of 220,993 pounds[1] with a centre of gravity of 25.33% M.A.C. (mean aerodynamic chord)[2], and a calculated landing weight at Toronto of 206,000[3] and calculated centre of gravity position 24.7 M.A.C. Subsequent calculations indicated that the actual landing weight was 208,000 pounds. This information was derived from the flight data recorder using the fuel flow parameter.

The total fuel load on departure from Montreal was 40,000 pounds. (This total fuel load consisted of

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1 Permissible gross weight at take off on this aircraft is 350,000 pounds.

2 The centre of gravity range on this series of aircraft is 14 to 31% M.A.C.

3 The maximum permissible landing weight of this aircraft is 245,000 pounds.

11,518 pounds of JP-4 fuel which was loaded at Montreal and added to whatever was the residual fuel then in the aircraft.)

5. Description of Spoilers and Comments on Specific Components of them used in DC8 Aircraft

The final mechanical operation which resulted in this crash was the deployment of the ground spoilers on this aircraft at an inappropriate time, *viz.*, when the aircraft was only about 60 feet above runway 32 at Toronto International Airport. For this reason a knowledge of the operating characteristics of spoilers is essential to explain the flight profile above referred to and other matters of the accident to aircraft CF-TIW.

A general description of the device, together with some comments on the specific components used in the DC8 aircraft therefore is now set out for the purposes of assisting in interpretating the whole of the evidence in any way relating thereto.

The spoiler, as its name implies, is an aerodynamic control device designed to spoil or disrupt the smooth flow of air around a streamlined body, such as an aircraft wing, with the object of increasing the drag, or reducing the lift, (or both).

In its most elementary role it has been in use for many years in aircraft as a drag control device. It usually

takes the form of a flat plate hinged to the wing's upper surface which may be projected into the airstream at the will of the pilot (see Schedule 11 of Appendix "D").

The drag force resulting from the extension of this spoiler will permit the aircraft to descend rapidly on a steep glide path without acquiring an excessive forward speed - a flight manoeuvre which is desirable, for example (1) to expose a community on the ground near an airport to a minimum of aircraft noise, or in the approach to a landing on an airfield located in a deep valley; (2) in descending through atmospheric turbulence; or (3) in a rapid descent following an emergency such as may occur due to the loss of cabin pressure at a high altitude.

A more complex type of spoiler (see Schedule 12 of Appendix "D") may be employed in a dual role to produce a reduction in the lift as well as an increase in the drag of the wing. This is accomplished by extending a spoiler plate, as before, and in addition by opening a slot in the wing to permit air to flow from a region of high pressure on the (lower) surface, to a region of low pressure on the (upper) surface of the wing. When the main flaps of the wing are extended for lowspeed flight, a powerful stream of air is ejected through the slot to augment the effect of the physical spoiler and produces a substantial reduction in wing lift. Spoilers of this type are

useful in two operating regimes - in flight at low airspeeds; as a supplement to the normal aircraft lateral controls (ailerons), and on the ground, to reduce wing lift at the beginning of the landing run.

Since spoilers cannot generate lift, their use as a lateral control device in the flight regime is limited to operating on one wing at a time - the wing on which it is required to reduce lift - and they are linked to the aileron lateral control circuit in a manner which provides for spoiler extension in conjunction with the "up" aileron only, on the "downgoing" wing. Thus if the pilot wishes to roll the aircraft to the left, the movement "up" of the aileron on the left wing will be accompanied by spoiler extension on the left wing; on the right wing the spoiler will remain stationary and flush with the wing surface. In many types of aircraft the spoilers are required to assist the ailerons at low airspeeds only, and it is common design practice to link the power source of the flight spoiler system to the actuator of main wing flaps or the actuator which extends the landing gear so that the spoilers cannot be used as a lateral control unless the aircraft is in a configuration appropriate to the take off or landing.

With respect to the second, or ground regime, the object of using spoilers to "dump" wing lift in the landing manoeuvre is to apply the full weight of the aircraft to the

main wheels of the landing gear immediately upon touch down. It is important that this be accomplished as rapidly as possible because the aircraft is travelling at a relatively high speed at touch down, there is an appreciable delay in developing reverse thrust from the engines, and, in the absence of a strong retarding force from the wheel brakes, a substantial length of runway is wasted. In this "ground" mode of operation, obviously it is essential that the reduction in lift be symmetrical across the span of the wings - i.e., that the spoilers be extended on both wings.

In discussing the use of spoilers it is necessary to distinguish between the various types and modes of operation, as described above. In summary, spoilers may be employed as:

(a) A drag device to control the flight path using a simple spoiler, extended on command by the pilot.

(b) A lift "dumping" device to:

(i) supplement the ailerons for lateral control in flight coupled to the pilot's control wheel in the cockpit and automatically "armed" for use at low airspeeds;

(ii) limit the ground run with the spoiler "armed" for use either at low airspeeds or on the ground, and extended symmetrically

on both wings, automatically on ground contact or on command by the pilot.

In the Douglas DC8 aircraft series, spoilers of the second, or lift "dumping", type are employed to provide lateral control in flight and control of the ground run following touch down. There are five spoilers in each wing. The two inboard spoilers ("ground" spoilers) on either side are for ground use only. The three outboard spoilers ("flight" spoilers) may be linked to the ailerons (the mode intended for use in flight) or linked to the "ground" spoilers (the mode intended to use on the ground). (See Schedule 13 of Appendix "D".)

In cruising flight, all spoilers are inoperative. At low airspeeds, the spoiler hydraulic system is automatically energized when the aircraft landing gear is extended, and unless the control lever in the cockpit is moved. the flight spoilers automatically respond to the movement of the pilot's control wheel to assist the ailerons in providing lateral control in flight.

When the pilot wishes to have all ten spoiler segments extend simultaneously, he can do so in two ways (see Schedule 14 of Appendix "D"):

(a) (Manual control for immediate extension) by grasping a lever which is located on

the control pedestal in the cockpit (see Schedule 15 of Appendix "D") and pulling it aft (toward the operator) into the "extend" position.

(b) (Automatic control)

by lifting the same lever to engage an electro-mechanical actuator[1].

In the first case (manual) the extension of the spoilers is practically instantaneous, whether the aircraft is in the air or on the ground, provided only that the landing gear is extended. In the second case (automatic) the spoilers will extend when a signal is provided by the aircraft landing gear following contact with the ground.

While many details of the operating mechanisms of the spoilers are of no interest here, it is necessary to describe the function of certain components in order to explain the gaps in information and the misunderstandings, which the evidence of this Inquiry disclosed, existed among instructors, pilots, and maintenance personnel. To begin with, there are important differences between the ground spoiler operating mechanisms of the earlier (40) and the

[1] The act of raising the lever to engage the automatic feature reveals a red (Warning) band on the lever, and the various manuals issued by both the aircraft manufacturer and operators of the aircraft describe this as "arming" the ground spoilers.

later (50, 60) DC8 aircraft series (see Schedule 16 of Appendix "D").

In the 40 series of aircraft, the force required at the knob of the cockpit control lever to fully extend the ground spoilers in the air was given in evidence at this Inquiry as 70 - 90 pounds. The corresponding force for the 60 series, according to tests made by the Ministry of Transport Aircraft Accident Investigation Division on a number of aircraft, varies considerably - with 85 per cent of the aircraft demonstrating a pull force requirement of 45 pounds or less, and one aircraft in the test set requiring less than 30 pounds. The same tests revealed that the distance in which the lever must travel to produce the forces discussed above, is relatively small (depending on the rigging 1 to 1.5 inches at the quadrant, increased by a factor of roughly 3 at the knob).

Since certain of the Air Canada pilots questioned the reliability of the system in the automatic control mode (armed), according to the evidence at this Inquiry, it is also necessary to say a few words about the mechanism used to deploy the DC8 spoilers when the landing gear makes contact with the ground.

In the earlier vintage 40 series aircraft, "arming" of the cockpit control lever by lifting it engages a mechanical system which extends the ground spoilers when the nose landing

gear is compressed by the weight of the aircraft. In the DC8-50 and 60 series, the 40 system is retained as a back-up unit to a primary system. This primary system incorporates a sensing device which responds to a signal generated in the main undercarriage wheels and an electrically controlled actuator in the spoiler circuit. When this system is "armed" by raising the control lever (as in the 40) in the cockpit, the rotation of certain combinations of the main wheels at a speed of approximately 700-800 r.p.m. will generate the electrical signal, trigger the actuator, and extend the ground spoilers.

6. The Aircraft Structure and Systems

The integrity of the aircraft structure and systems, prior to the rapid descent and touch down on the runway, is not in doubt according to the testimony. The sequence of significant events thereafter is as follows:

A heavy landing, with sufficient force to mark the runway at the point of contact of the wheels and tail bumper, caused number 4 engine pod, pylon and a portion of lower wing plating to break away from the aircraft (see Schedule 17 of Appendix "D"). There was fire on the ground, and fuel was observed streaming from the right wing in the climb segment of flight following the touch down. Fire and smoke were observed in the right wing during the climb. Approximately

two and a half minutes after contact with the ground, when the aircraft had reached an altitude of 3, 100 feet, and was flying level, three explosions occurred. The first blew out large sections of wing plating above and below number 4 (alternate) fuel tank, in an area immediately adjacent to the damage which occurred in the landing touch down. The number 3 engine and some small sections of wing plating were separated from the main structure at this time and the hydraulic pressure in the rudder and aileron control system dropped to zero. The second explosion, approximately 8 seconds later, blew off a substantial portion of the wing tip structure. This was followed in a few seconds by a third explosion which blew off a large panel from the top surface of the wing in the region of the number 4 (main) fuel tank.

With the loss of major portions of the right wing structure the aircraft rolled to the right and descended to the ground in an uncontrollable dive.

To consider the sequence of events in more detail, the first contact with the runway was made by the main wheels of the undercarriage on the right-hand side of the aircraft at a (vertical) velocity of approximately 18 feet per second. The oleo unit[1] on this side was damaged when the piston

[1] A shock absorber unit, incorporating a piston in a cylinder which contains oil and air under pressure. The piston works against the pressure to reduce vertical velocity and absorb the energy of the aircraft in landing.

"bottomed" at the end of the compression stroke.

Apart from this, the undercarriage appeared to have suffered little damage from the impact with the runway; it retracted normally in the subsequent overshoot manoeuvre, and an examination of the attachment brackets and trunnions in the wreckage of the aircraft did not reveal more extensive damage.

At touch down the (vertical) velocity and energy of the aircraft exceeded the design capacity of the undercarriage by approximately 60 and 100 per cent respectively. In these circumstances it is not surprising that the vertical force (reaction) applied to the airframe by the undercarriage struts substantially exceeded the permissible values for which the structure was designed. Due to the high rate of closures of the oleo leg, and subsequent "bottoming" of the piston, the time history of this force is not known; undoubtedly it would display the characteristics of an impact force with a high peak load spread over a very short time interval. As a result, the reading of the accelerometer located at the centre of gravity of the aircraft, as shown by the flight recorder, cannot be considered reliable because this instrument is designed to record flight manoeuvres and gusts in which accelerations build up more gradually with time. An expert witness testified that from the flight recorder traces one could

state only that the acceleration at the aircraft centre of gravity exceeded 3.4 g[1]. Data supplied by the manufacturer of the aircraft suggest that a vertical acceleration of 5 g at the centre of gravity is not inappropriate to a descent velocity of about 18 feet per second.

The forces which would occur throughout the airframe would vary considerably from the value at the aircraft centre of gravity due to elastic deformations which would occur in a large and relatively flexible structure under the conditions of the touch down. Data provided by the aircraft manufacturer indicate that an undercarriage force which would produce an acceleration of 5 g. at the aircraft centre of gravity would produce 6.5 and 7.0 g. at the centre of gravity of number 3 and number 4 engine pods, respectively.

These numbers are consistent with the evidence on the sequence of failures in the structure, and a statement by the manufacturer on the loads required to fracture the engine pylon-to-wing attachments, in that the attachments of number 4 pylon fractured completely and those of number 3 pylon

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[1] "g" is the acceleration due to gravity. 5 g, measured at the aircraft centre of gravity, implies a force equal to 5 times the weight of the aircraft. 7 g at an engine pod implies a force of 7 times the weight of the engine pod on the attachment brackets.

were severely damaged in the landing touch down.

The design philosophy of this aircraft included provisions for the separation of the engine pod and pylon from the aircraft structure when vertical loads of 7 g were experienced. This is accomplished by stressing the pylon-to-wing attachments so that the (shear) bracket at the front spar fails first, under vertical load, followed by a progressive failure of the bolts, front to rear, in the horizontal (thrust) attachment (see Schedule 18 of Appendix "D"). Unfortunately, in this accident the horizontal attachments did not perform in the manner prescribed. Some of the bolts at the rear did not fail, in sequence, and, as a result loads were transmitted to the wing which caused a portion of the wing plating - which is also the floor of the number 4 (alternate) fuel tank - to be carried away with the engine pod and pylon. From the evidence, it has been suggested that the number 4 pod did not fail directly downwards, a side component of the forces twisted the pylon to the right, and prevented the attachments from failing cleanly. As a result, a hole approximately four feet long and two feet wide forward, increasing to four feet at the rear, was left in the bottom of the wing plate of number 4 alternate fuel tank.

In this accident, the evidence showed a bundle of electrical wiring, which normally connected the number 4

engine with various services in the wing, was severed in the pylon when the latter separated from the wing in a manner which left a substantial length trailing in the region of the lower wing surface where the fuel escaped from the number 4 (alternate) tank. The insulation of this wire was found to be burned and the copper ends fused, indicating that the wires were sparking. It is quite possible that this was the source of ignition for the first[1] explosion which occurred when the fuel/air ratio of the fluid streaming from the wing fell within the critical range.

Evidence was given that the fuel used in the aircraft which crashed was specification JP-4. This is of concern because JP-4 (wide cut gasoline) fuel is more volatile than the more widely used specification JP-1 (kerosene). In evidence, it was the considered opinion of the experts of the relevant group that the difference in the flammability of JP-1 and JP-4 was not a factor in this accident because mists of JP-1 and JP-4 in the air are both flammable at the fuel temperature which existed at the time of the accident, and the turbulent air conditions which existed in the open tank would render an explosion equally probable with either fuel,

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[1] After the first explosion this bundle of wires was carried away by a portion of the structure which separated from the wing.

bearing in mind that a higher minimum energy is required to ignite a mist of JP-1 fuel[1].

The combination of escaping fuel and the shorting of the electrical circuits, resulting from the tearing out of part of the harness, may have been the primary source of the ignition. Alternatively, because the engine preceded the aircraft, after the initial touch down, and left a trail of burning fuel on the runway, ignition in the fuel escaping from the wing tank may have occurred when the plane passed over the flames in the wake of the engine. Alternatively also, there may have been other sources of this ignition but in any event a determination of the precise source is not possible. The fact is that there was ignition.

The structural and systems failures, including the separation of the number 3 engine pod[2], which followed the first explosion were also documented in the evidence.

No significance is attached to transients in the data received by the flight recorder in stages of the flight following

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[1] The specific conclusion of these experts was that:

> Because mists of JP-1 and JP-4 in air are both flammable at the fuel temperature considered and by virtue of the open tank, air flow would most likely create turbulent conditions within the tank; mist, and hence explosion could occur for either fuel.

[2] The evidence from the wreckage showed that the vertical shear attachments of this engine were seriously damaged in the first landing impact.

the first impact. These may be attributed to spurious electrical signals originating in the systems, and particularly in limit switches which were damaged.

7. The Air Crew

The air flight crew on this aircraft at the material times were as follows:

Captain Peter Cameron Hamilton

First Officer Donald Rowland

Second Officer Harry Gordon Hill.

All of the crew were in excellent physical health and during the previous 48 hours had led a normal life and were well rested and in full possession of their faculties. In addition, all of the crew were fully competent for the jobs that they were doing on this day by reason of their training and experience. (See Schedule 19 of Appendix "D".)

The Captain was occupying the left-hand seat prior to impact[1]. (See again Schedule 19 of Appendix "D".)

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[1] There was evidence from which such an inference could be and was made. Any other view would be based on conjecture or speculation, not on evidence. In *Caswell v. Powell Duffryn Associated Collieries Ltd.* (1939) 3 All E.R. 722, the House of Lords, through Lord Wright, at page 733 used words which are apt in relation to this subject matter, when he said:

> . . .The Court therefore is left to inference or circumstantial evidence. Inference must be carefully distinguished from conjecture or speculation.

8. Meteorological Information

It was established that the regular hourly weather observation taken at 080 hours E.D.T. at Toronto International Airport on July 5, 1970 was:

> Scattered cloud at 3,500 feet.
> Visibility 20 miles. Pressure tendencies
> 087. Temperature 64 degrees farenheit.
> Dew point 54 degrees farenheit. Wind
> 300 degrees true at 12 miles per hour.

In addition, the anomometer, a device for measuring wind velocity, records at 08:10 hours, that surface wind varied between 290 and 310 degrees true between 9 and 14 miles per hour.

There was and is no record of wind shear at Toronto International Airport. The nearest measurement at Buffalo, New York revealed that there was a 2 knot increase in wind speed at 1,000 feet and a 3 knot increase at 2,000 feet. This suggests that wind shear in the vicinity of Toronto International Airport was insignificant in so far as it might affect the operation of the aircraft.

No turbulence was reported in the vicinity of Toronto

There can be no inference unless there are objective facts from which to infer the other facts which it is sought to establish. In some cases the other facts can be inferred with as much practical certainty as if they had been actually observed. In other cases the inference does not go beyond reasonable probability. But if there are no positive proved facts from which the inference can be made, the method of inference fails and what is left is mere speculation or conjecture.

International Airport at the material time by anyone.

As already discussed, the evidence is clear that there was no turbulence of any significance at the material time and place from the two Boeing 727s that had taken off immediately prior to the touch down of this aircraft.

9. Air Traffic Control Tower

The Air Traffic Control Tower was strategically located in reference to runway 32. (See Schedule 9 of Appendix "D", the runways at Toronto International Airport.)

10. Other Incidents

The evidence disclosed that the Captain was aware of an incident involving involuntary deployment of ground spoilers and one other incident which he believed to be involuntary deployment of ground spoilers in DC8 series aircraft.

The first incident was one that happened to an S.A.S. DC8 aircraft in Bergen Norway. A McDonell Douglas Aircraft Corporation on a test flight with a series DC8-63 aircraft duplicated what apparently had happened in the S.A.S. incident. These took place prior to September, 1968.

In the S.A.S. incident and its duplication by McDonell Douglas Aircraft Corporation the ground spoilers became deployed in flight while armed without any action taken by any

of the crew. Apparently the cause was spurious electrical voltage.

After that, McDonell Douglas Aircraft Corporation made modifications to the electrical system of the ground spoiler system which is included in the anti-skid box. The evidence of the experts was that "from the information we have this modification would make it impossible for the type of defect which was experienced by S.A.S. to occur again".

Since then there has never been another recorded case of spoiler deployment of this nature.

The other incident concerned a Canadian Pacific Airlines Limited DC series aircraft in Tokyo on March 4, 1966. Captain Hamilton believed that the arming of the ground spoilers in flight was a factor in that accident. This belief held by him was in fact a mistaken belief.

The aircraft accident report inquiry into this incident made by the Accident Investigation Committee for Canadian Pacific Airlines Limited and British Overseas Airways Corporation reproduced by the Department of Transport with the permission of Professor Tomijiro Moriya, Chairman of the Accident Investigation Committee in Tokyo, Japan which was filed as an exhibit at this Inquiry expressly negatives the belief held by Captain Hamilton.

Interpreting this evidence and relating it to the evidence already mentioned that the First Officer did not arm the spoilers on this aircraft but instead pulled the

activating lever aft to the aft extend position, it is beyond doubt in this case (i.e., flight 621 on July 5, 1970) that no spurious electrical signal actuated the ground spoiler because the spoilers would have had to be armed in the first place to enable a spurious signal to have been the cause of the ground spoilers being deployed.

11. The Instructions Manuals

The basic document for the operation of the DC8-63 aircraft is the "DC8-63 FAA Approved Flight Manual" authorized by the U.S. Federal Aviation Agency. This is "the Aircraft Flight Manual . . ." document prepared by the aircraft manufacturer (McDonell Douglas Aircraft Corporation) and approved by . . . FAA.

From this manufacturer's flight manual each individual aircraft operator makes up its operating manual. In the case of Air Canada this is called "Manual 55, DC8 Operating". This manual according to the evidence, is "one associated with the Certificate of Airworthiness (Canada) and since this Certificate requires the operation of the aircraft in accordance with that flight manual, it in fact forms part of the Certificate of Airworthiness (Canada)".

Each individual aircraft operator's own manual is provided to each pilot and forms the text of his training

programme. Air Canada's Manual 55 DC8 Operating covers operating instructions for the "40", "50" and "60" series of the DC8 aircraft[1].

(In this connection, it should be observed that only certain of the manuals have to be approved by the Ministry of Transport. (See Schedule 20 of Appendix "D" for Ministry of Transport's circular as to this.))

Air Canada's Manual 55 DC8 Operating prescribed, in relation to the "Before-Landing Check" to be made on the aircraft's final approach in landing in order to configure it for such purpose, that five items on the DC8-60 series of aircraft be checked and completed, namely:

(i) landing gear control lever.....down

(ii) landing lights.....extend & check, as required

(iii) altimeters.....set

(iv) landing gear....."lever down, three green lights, four pressures check"

(v) spoilers....."armed".

In addition, the pilot flying the aircraft is required to check and call "lever, three green lights, four pressures, spoilers" which is done as a double check on items (iv) and (v) above noted.

[1] The Ministry of Transport does not compare the manuals filed with it of the various Canadian aircraft operators for the purpose of noting any differences in operating procedures.

In further addition, the Second Officer is instructed that "he will present the mechanical check list over the pedestal for the Captain's acknowledgement".

In relation to the operation of the ground spoiler system in DC8 series aircraft, the significant words employed in various manuals and other documents are set out in Schedule 21 of Appendix "D", being extracts from the following:

DC8-63 FAA Approved Airplane Flight Manual
(Section III, Page 32, June 15, 1967, all series),
(Section III, Page 33, June 15, 1957, 60 series).

DC8 Operation Manual Douglas Aircraft Co. Inc.
(2-152, Page 4, Code 1, May 1, 1963, 40 series).

Air Canada 55 DC8 Operating Manual
(Chapter 17, Page 39, January 1, 1968, 40 series).

DC8 Operations Manual Douglas Aircraft Co. Inc.
(2-152, Page 4, Code 8, August 1, 1969, 60 series).

Braniff International Operations Manual
(Page 16, May 10, 1968).

Air Canada 55 DC8 Operating Manual
(Chapter 17, Page 36, January 1, 1968, all series).

Air Canada 55 DC8 Operating Manual
(Transmittal 38, March 13, 1968).

and also:

Air Canada Lesson Plan No. 21, Page 10.

Air Canada "Spoiler Systems Training Aid - Questions for pilot supervisors", Page 2.

Air Canada DC8 Check Yourself Cockpit Levers 40/50/60, Pages 6-7, April 17, 1969.

Eastern Air Lines DC8-63 Flight Manual, October 1, 1969.

KLM DC8 Flight Manual 60 series.

PART E

COMMENTS AND OBSERVATIONS ON THE CIRCUMSTANCES OF THIS ACCIDENT

1. Explanation

As this was a so-called "ground spoiler" accident, what is related here in a critical fashion are the circumstances of this accident germane to the final fact that the "ground spoilers" on this aircraft were inadvertently activated at an inopportune time with catastrophic consequences.

These circumstances divide conveniently into the following four parts, namely: (1) the design of the aircraft; (2) the instruction manuals; (3) pilot training; and (4) maintenance of standardization operating procedures in the cockpit.

2. The Design of the Aircraft

(a) The spoiler actuating system

The spoiler actuating system of this aircraft was such that when the landing gear is extended a pulling of the actuating lever by a person in the cockpit a distance of (depending on the rigging) 1 to 1.5" at the quadrant, increased by a factor of 3 at the knob, causes the ground spoilers to be deployed.

When this manual mode is employed with the aircraft on the ground, it is necessary to raise the actuating lever after it is pulled in order to hold the ground spoilers in the extended position, otherwise the lever will return to the initial (null) setting and the ground spoilers will retract.

Alternatively, a raising, instead of a pulling, of the (same) actuating lever engages a mechanical device which causes the ground spoilers to automatically deploy when the landing gear contacts the ground. This act of raising the actuating lever to engage the automatic feature reveals a red[1] (warning) band on the lever.

These multiple motions with a single raising, pulling, pulling and raising, readily lend themselves to confusion and mistakes and are more appropriate to the operation of a secondary system, such as heating and ventilating, than to the primary lift force on the wings of an airplane. When the consequences of extending the ground spoilers in flight near the ground are catastrophic, as a minimum, one would expect a guard on the actuating lever of some kind, such as

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[1] The instruction manuals issued by both the manufacturer and the operator of the aircraft describe this as "arming".

a gate which would have to be removed by a separate and deliberate manual action. Safeguards of this kind are common practice in aircraft design; with wing flaps where a rapid retraction could produce an abrupt loss of lift, for example, the retraction mechanism is deliberately designed either to operate slowly and to "fail safe", or the actuating lever is "gated" so that flap retraction is accomplished in a series of steps, and to proceed from one step to the next requires a separate deliberate action by the pilot.

The absence of a safeguard of this kind is all the more remarkable when one considers differences between the 40 and the 50/60 series of DC8 aircraft in the force required to operate the actuator lever. While a "pulling" force requirement in the 40 series of 70 - 90 pounds may have been considered[1] to be a deterrent against an inadvertent movement of the lever the modifications to the system which reduced the required force by more than 50% in many 50/60 series aircraft most certainly made the operation of the lever too easy.

The evidence was to the effect that,

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1 This argument is rejected.

depending on the rigging of the controls, it was occasionally necessary to "jiggle" the actuator lever backwards and forwards in order to raise it to engage the automatic control. It is not beyond the bounds of possibility that experiences with the relatively stiff 40 series control mechanism would engender a false sense of security in handling the relatively soft 60 controls, particularly when the movement required for the abrupt deployment of ground spoilers was so small.

The wisdom of using a red warning sign and the terminology "arming" to indicate that the ground spoiler control actuating lever is engaged with the automatic portion of the system is debatable. A system is "armed", surely, when important and irreversible consequences flow promptly from a single manual operation, such as the pulling of a lever or the closing of a switch.

While in the foregoing it was suggested that a gate on the control lever would provide a minimum safeguard, a superior arrangement to a gated control would appear to be a control which is inoperative in all regimens of flight, and one wonders why this was not adopted for the DC8 50/60 aircraft series. In the 40 series, presumably, there were doubts about

the effectiveness of the automatic "ground shift" mechanism on the nose-wheel control in certain circumstances, and the manual control was intended to serve as a back-up device. In the 50/60 series the primary signal for the automatic system originates in the rotation of main wheels, with the nose-wheel "ground shift" device as a back-up, and it is difficult to understand the need for a manual "overriding" device or, if a need does exist, why it cannot be energized by wheel "spin up" so that the ground spoiler control cannot function in flight.

(b) Engine pod attachment structure

While the primary cause of the accident was the premature in-flight deployment of ground spoilers, there is the possibility that the consequences would have been less severe if a fuel tank had not ruptured. This possibility is strengthened by the evidence that the airframe and systems, apart from the number 4 alternate fuel tank, suffered no major damage on the first impact with the runway. Current design practice in aircraft structures is to provide adequate strength for a wide range of "probable" loads, with generous factors of safety as a precaution against the "improbable" case of a very severe load. Typically, the "most probable" loads

would be appropriate to descent rates of 2 to 3 feet per second, a very severe load, highly improbable and close to the capacity of the landing gear, would result from a vertical descent rate of 10[1] feet per second.

Above this range of descent speeds there is a gray area where it is generally impracticable to design an airframe which will sustain the resulting loads without some damage, but where "incidents" occur often enough to justify a requirement that the modes of failure should be predictable and afford the aircraft occupants with the maximum degree of protection which is practicable under the circumstances. This is consistent with the evidence that the design philosophy of the manufacturer of this aircraft was to make provision for a clean break-away of the powerplant in the event of a landing which produced loads in excess of normal design requirements.

From the evidence, there is little doubt that the loads experienced at the number 4 engine pod were in excess of normal design requirements, and the

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1 This vertical velocity would result from flying directly down the conventional glide path without any attempt to "roundout" or "flare" the aircraft prior to touch down.

separation of the pod and pylon from the wing structure was to be expected. Unfortunately the sequence of failures in the attachments, possibly due to unanticipated components of the load, was not according to plan, and some wing plating, which also served as the floor of a fuel tank, was torn out of the structure.

One cannot dismiss lightly the difficulties in designing an engine pod attachment structure which will have sufficient strength, with an adequate safety margin, to sustain the loads arising in all manoeuvres which are probable, including atmospheric gusts and landings on rough runways, yet at some moderately higher load, or combination of loads, will break free in a manner which will nct endanger the structure as a whole. While recognizing these difficulties, and the possibility that they require some elaboration, it is believed that it is within the capacity of the designer to develop an attachment structure which will fail under the conditions stated without involving the wing plating in the failure. It is considered that this requirement is mandatory in aircraft such as the DC8 series which use the wing plating to which a pylon is attached as the floor of a fuel tank.

(c) The electrical system

Similar considerations apply to the design of the electrical system. One recognizes that it is not possible to anticipate all modes of failure which may occur with major damage to the airframe. With minor damage, such as the separation of a powerplant, however, it is believed that it is entirely reasonable to require that precautions must be taken to ensure that any failure of any electrical cables which could provide a source of ignition shall take place in a region remote from the path of escaping fuel.

3. The Instructions Manuals

The wording of the various manuals and certain other documents have already been recorded in Part D (see Schedule 21 of Appendix "D" in particular).

Speaking generally, in respect to the extracts from these documents that have been recorded, certain of them contain misleading statements, certain of them incomplete statements, certain of them inaccurate statements and certain of them false statements, in relation to the operation of the ground spoiler system on series DC8 aircraft. The details of such are set out in Schedule 1 of Appendix "E".

From these facts, it appears clear that the various authors of the manuals and other documents referred to did not really understand the whole of the operating mechanism

of this ground spoiler system on the DC8 series aircraft or otherwise they would have been more explicit not only in describing the functions of it, but also they would have inserted in the manuals a most definite warning of what would happen in the event of some inadvertent or deliberate act done by any air crew personnel causing the ground spoilers to be deployed while any of such aircraft were in flight.

As already stated, Canadian aircraft operators, including Air Canada, in preparing their respective manuals, relied on the manufacturer's manuals. In doing so, it may have been natural for them to have presumed that the manufacturer's manuals would be explicit and correct in relation to these matters. Nevertheless, however, Air Canada and other Canadian aircraft operators should have taken independent steps to have corrected all deficiencies, errors and misleading statements.

As already stated also, the Ministry of Transport does not approve the aircraft operator's manuals but relies on the manufacturer's manual which in effect becomes part of the Ministry of Transport's airworthiness certificate. The Ministry of Transport therefore in fact relies on the accuracy and explicitness of the manufacturer's manuals. It would seem reasonable therefore, that the Ministry of Transport should not only have checked each individual Canadian aircraft operators' manual against the manufacturer's manual

for discrepancies, inaccuracies and differences, but for the same purpose also should have checked each Canadian aircraft operators' manual with every other Canadian aircraft operators' manual. If it had done so, it would have been possible for it to have alerted Air Canada as to the hazards of operating this ground spoiler system in this series DC8 aircraft and it would have been possible for it to have ordered that appropriate remedial action be taken by Air Canada in relation to the latter's manuals.

In addition, perhaps if all this had been done, the confusion among and the debate between Air Canada pilots as to the safest way to cause the ground spoilers on DC8 series aircraft to be deployed would have been resolved.

4. Pilot Training

From the evidence, it is patent that the Air Canada Ground Training School Staff, until July 5, 1970, did not know that the ground spoilers on the DC8s could be deployed in flight when the undercarriage was down by manually pulling aft the actuating lever in the cockpit whether or not the lever was armed. Why the operations staff or the engineering staff or both of Air Canada did not communicate this information to the Air Canada Ground Training School Staff long prior to July 5, 1970 is difficult to understand; especially when the whole matter of when and how these ground spoilers could be deployed in flight was the subject

of wide debate and discussion among Air Canada pilots and also among Air Canada check pilots' staff.

5. Maintenance of Standardized Operating Procedures in the Cockpit

Because of the deficiencies in the various manuals already discussed in relation to the matter of the possibility of the deployment of the ground spoilers on DC8 series aircraft when in flight, it is not surprising that a number of situations obtained which are now detailed.

A large percentage of Air Canada pilots did not know whether or not the ground spoilers could be deployed by such action. The Air Canada Ground School Instructors also, as stated, did not know that this could be done.

There was a general discussion and debate which was carried on for months prior to July 5, 1970 among various Air Canada pilots as to this and also as to other causes of deployment of the ground spoilers in DC8s while such aircraft were in flight. There was no resolution of this debate and discussion by operations or engineering personnel of Air Canada when they must have known that this discussion and debate was taking place.

The evidence disclosed that the Captain and the First Officer insofar as the item "spoilers" was concerned in the

"Before-Landing Check" laid down in Air Canada's operating manual, had made an agreement between themselves different from the procedure prescribed in such manual. The agreement, as stated, was that when Captain Hamilton was flying the aircraft with Rowland as First Officer, that in the "Before-Landing" procedure the item "spoilers" would be deleted and instead Rowland would manually cause the spoilers to be deployed by pulling the lever aft after the aircraft had touched the runway[1], that is "on the ground".

(It should be recalled that the agreement also was that when Rowland was flying the aircraft, that in the "Before-Landing" procedure Hamilton would arm the spoilers, again, not at the time and in the area prescribed in the Air Canada operating manual, but at a time when the aircraft was in the position referred to as "on the flare".)

This agreement between Hamilton and Rowland had been reached by them at some time prior to this particular flight 621. In fact, Rowland and Hamilton, prior to this flight, had not flown together for at least a month.

This agreement is what they were making reference to when they were discussing the matter of "Before-Landing"

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[1] The evidence establishing this was from numerous signed written statements made by various Air Canada air crew who had flown with Captain Hamilton and First Officer Rowland.

procedure as recorded from the cockpit voice recorder when they said:

ROWLAND: Check three green, four pressures, spoilers on the flare.

HAMILTON: OK. Brakes three green, four pressures, spoilers (on the flare).

ROWLAND: (No OR or) on the ground.

HAMILTON: All right, give them to me on the flare.

HAMILTON: I've given up.

HAMILTON: I'm tired of fighting it.

This evidence established that they had agreed at this particular time to adopt a procedure for landing that was contrary not only to that laid down in the Air Canada operating manual, but also contrary to the agreement that had been reached heretofore between them as to how and when the ground spoilers were to be deployed.

In the execution of this new variation of procedure, Rowland manually pulled the spoiler lever aft and did not arm it by lifting up its knob. He did this when the aircraft was about over the threshold of runway 32 and only about 60 feet above that runway.

In the result, therefore, the consequences which followed did not result because there were not proper

instructions in the Air Canada operating manual in relating the correct way to deploy the ground spoilers and also they did not result because the Captain and the First Officer did not know those instructions.

The evidence also established that Air Canada had no knowledge prior to July 5, 1970, of this agreement between the Captain and the First Officer. The only knowledge that Air Canada did have is that on an en-route flight check on April 17, 1968 (Exhibit 63), made by one J.W. Reid of Air Canada, apparently the Captain did not arm and cause the ground spoilers to be deployed in the manner laid down in Air Canada operating manual for "Before-Landing" procedure. The report reads that Mr. Reid, "Reviewed proper method of arming and using spoilers" with the Captain.

In response to a query as to what Mr. Reid meant in this en-route flight check, Exhibit 63, he stated that Captain Hamilton's "plans were to manually deploy the ground spoilers after landing. At that time I told him to arm the spoilers as laid down in the DC8 manual. And he did so."

Prior to July 5, 1970, however, the evidence was that it was common practice among certain of the Air Canada pilots to omit arming the spoilers during the "Before-Landing Check" and to cause them to be deployed by manually pulling the actuating lever aft after the aircraft touched down.

Among certain of the Air Canada pilots also prior to July 5, 1970, there was a debate as to whether on the DC8 series 63 the ground spoilers could be deployed while the aircraft was in flight with the landing gear down.

What this knowledge and common practice among Air Canada pilots in respect to these matters was, is cogently stated in the statement made by a Captain Wyman of Air Canada which was as follows:

> When I converted on to the DC-8, it was fairly common practice among DC-8 Captains, for reasons of safety, and in order to obtain smooth touchdowns, to omit the arming of the spoilers during the Before Landing Check and to apply them manually after touchdown. However this practice was discouraged. Most Check Pilots are reluctant to report a competent line pilot in such a manner as to incriminate him and, I suspect, some Check Pilots were in favour of the above so called malpractice in that it reduced the number of bad landings. I suggest this as a reason for the dearth of Check Flight Reports which made mention of this practice.
>
> Nevertheless, by the spring of 1969, I became aware that I was one of the last hangers-on to the manual spoiler procedure. No pilot can live happily in the complicated environment of a jet cockpit knowing that he is doing something, and asking his lieutenants to do something, which is different from the norm. I was acutely conscious of this, and I was aware that I was working a hardship on my First Officers. In discussions with fellow pilots, a compromise presented itself which answered the manufacturers requirements to activate the spoilers through spin-up and, at the same time, allowed a final approach without the spoilers being armed and alive. Why not arm the spoilers just before the main gear touched the runway?

On September 5, 1969, on a Route Check Report, my practice of having the spoilers armed just before the wheels touched was official reported, as far as I can discern, for the first time. The term "On The Flare" was used in this report and, unfortunately, I used the same term in correspondence with the Air Canada Director of Flight Standards shortly thereafter. Nevertheless, as I envisaged the procedure, the main wheels had, necessarily, to be within a few feet of the runway when I asked for the spoilers to be armed. I must emphasize also that this was a compromise procedure. It took away the smooth landings, but it also took away the long drive down Final Approach Path with the spoilers armed, which was considered unsafe.

Shortly after my Check Flight of September 1969, I was asked by my Chief Pilot to promise that I would abide by the Air Canada procedures and arm the spoilers during the Before Landing Check. A look at the AIDS tapes will reveal that I have done this absolutely.

It was generally believed by those pilots with whom I discussed the spoilers that they could not extend in flight. The Air Canada DC-8 Manual still states, quite flatly, that they do not extend in flight. A DC-8 Ground School refresher course sequence of January 1968 goes even further and states that the spoiler lever is locked in the retract position in flight. I repeat, that it was generally believed that the ground spoiler system could not be activated in flight.

Though I was already conscious of this belief, I was still thoroughly surprised when on February 25, 1969, while high over Kingston, Jamaica, the lever was moved back and, lo and behold, smoothly and symmetrically, the aircraft began to descend more rapidly for the five to ten seconds that the lever was back. I mention the above date because it was the only flight where all three pilots, who remembered the incident, were flying together. But we all remembered the incident differently and none of us could remember the other pilots in the cockpit correctly. Shortly after this

> trip I advised Air Canada Ground Training of the incident. I am probably remiss for not insuring that my knowledge about the possibility of extending the DC-8-50-60 spoilers in flight was not made more widely known. But I did pass it to the Air Canada Ground School. And I have to repeat; spoilers were not nearly so important to us before July 5, 1970 as they were after July 5, 1970.
>
> For the information of the investigators, I have flown very rarely with First Officer Rowland, and we never discussed spoiler procedure.
>
> Respectfully, Captain L.B. Wyman.

In addition, the evidence also was that Captain Wyman had carried on certain correspondence with various people about this ground spoiler system. The Captain (Hamilton) received copies of Captain Wyman's letters and also apparently of the replies made by certain of the addressees of Captain Wyman's letters.

Among these was a letter of reply to Captain Wyman from Mr. W.H. Benson, Director of Flight Standards, Air Canada, dated February 23, 1970. This letter as it turned out was prophetic. It reads in part as follows:

> This is in reference to our recent conversation and your letter of January 9th, 1970, in regard to the procedure over arming the spoilers on DC-8 aircraft.
>
> I have given further consideration to this matter and I do not feel that we could accept the change in procedure that you suggest; i.e. arming the spoilers when the aircraft is over the runway or just prior to flare.
>
> . . .

> As discussed inadvertent operation of the spoilers at a period as late in the approach as you suggest could cause even more disastrous resulted, and this would be possible on all approaches.

From this and the whole of the evidence relating thereto, it is difficult for one to understand why at some point some officer in authority at Air Canada did not resolve this debate and discussion and insist that laid down procedures be adhered to.

Perhaps the reason why no such order was issued was because there was inadequate communication within the Air Canada organization.

PART F

CONCLUSIONS

1. Explanation

In Part F are recorded the conclusions which in turn are divided into two parts, namely: (1) the findings, and (2) the circumstances.

2. Findings

(i) The air crew was properly licensed, qualified and medically fit at all material times.

(ii) The documentation of the aircraft was in order, and specifically the maintenance documents showed that the aircraft was fully airworthy; and that the weight and centre of gravity of the aircraft were within the approved limits at take off from Montreal and at all material times.

(iii) There was a design defect in this aircraft, in that it was possible, by a single movement of the actuating lever, to cause the ground spoilers of this aircraft to be deployed while it was in flight with its undercarriage down, thereby destroying a major portion of the lift on the wings.

(iv) The weather was not a factor in this accident.

(v) There were no structural or systems failures or malfunctions in this aircraft prior to its

initial touch down on runway 32.

(vi) Under the conditions which existed at the time after this aircraft initially touched down on runway 32, which conditions included the temperature then existing and the turbulence of the fuel vapour of the escaping fuel from the tanks and the energy of the ignition sources, JP-1 and JP-4 fuel would have been equally combustible. The use of JP-4 fuel instead of JP-1 fuel in this aircraft, therefore, was not a factor in this accident.

(vii) There was equivocation, inaccuracies and misinformation in the instructions in the manufacturer's aircraft flight manual, FAA approved, and in the manufacturer's aircraft operation manual and in the Air Canada aircraft operating manual as to when and how it was possible to cause the ground spoilers to be deployed. Specifically, among other things, in none of these manuals was there any warning that the ground spoilers of a DC8 aircraft could be deployed while such an aircraft was in flight with its undercarriage down; in addition and on the contrary, in two of these manuals, namely, the manufacturer's DC8 operation manual and the Air Canada DC8 operating manual it is erroneously stated that the lever is prevented from going to extend while in flight by a mechanical system.

(viii) Air Canada Ground School Instructors of student pilots did not know that the ground spoiler activating lever could be pulled back manually to cause the ground spoilers to be deployed in flight in the DC8 series aircraft.

(ix) Air Canada operations and engineering did not resolve the discussion and debate, which had been taking place for a long period of time prior to July 5, 1970, among Air Canada pilots as to the proper time and place of arming or manual deployment of the ground spoilers on DC8 series aircraft.

(x) There was no evidence that the Ministry of Transport Inspectors knew that the ground spoilers on the DC8 series aircraft could be deployed while any such aircraft were in flight with their undercarriage down. Notwithstanding this and in any event, such Inspectors did not check and as a result failed to ascertain that there were important differences in the instructions in respect to the operation of the ground spoilers systems of DC8 series aircraft contained in the Air Canada aircraft operating manual and the aircraft operating manuals of other Canadian licensed operators.

(xi) On the day of the accident, July 5, 1970, and at all prior times, both the Captain and the First Officer were aware of the procedure laid down in the Air Canada operating manual as to when the ground spoilers on the DC8 series aircraft were to be deployed. They knew the check list in respect to same set out in that manual.

(xii) The Captain had adopted a procedure at variance with the instructions contained in that manual. When he was flying any of the DC8 series aircraft, he instructed this First Officer not to arm the spoilers while the aircraft was in flight, but instead instructed him to cause the ground spoilers to be deployed when the aircraft was on the ground by manually pulling back the actuating lever.

(xiii) Prior to July 5, 1970, the Captain and the First Officer had flown together on a number of occasions. At some juncture during these prior occasions, the First Officer had objected to executing the Captain's orders as to the operation of the spoilers. Instead, the First Officer desired the ground spoilers to be operated in the manner prescribed in the Air Canada operating manual.

(xiv) This conflict of wishes was resolved between the Captain and the First Officer by them reaching a compromise. By this compromise, it was agreed that when the Captain was flying the aircraft with the First Officer, the ground spoilers would be deployed when the aircraft was "on the ground", but that when the First Officer was flying the aircraft with the Captain, the Captain would cause the ground spoilers to be armed "on the flare".

Implementing this compromise, the routine was that the Captain lifted the lever to arm the spoilers when the aircraft was "on the flare", whereas the First Officer pulled the lever back and lifted it to lock it when the aircraft was "on the ground".

(xv) On the day of this accident, July 5, 1970, with the Captain flying the aircraft, after discussion between himself and the First Officer, the Captain in ordering the First Officer to arm the ground spoilers while the aircraft was "on the flare", in fact ordered that a different routine be carried out by the First Officer in causing these ground spoilers to be deployed, that is a different routine from the one that the First Officer had been accustomed to carrying out, arising out of the said compromise.

(xiv) The First Officer in carrying out this order, through force of habit, did not follow the different routine, but on the contrary, he followed the routine he had become used to, that is, he pulled the actuating lever aft instead of merely lifting it. He did this when this aircraft was about 60 feet above runway 32 at Toronto International Airport.

(xvii) This aircraft struck runway 32 at a rate of descent beyond the design structural limits of this aircraft.

(xviii) Number 4 engine pod and pylon of this aircraft, after the initial touch down with runway 32, did not separate from the aircraft sequentially according to the manufacturer's philosophy. A fuel tank was ruptured and live electrical wiring was exposed followed by fire and explosions and subsequent disintegration of the right wing.

(xix) All persons aboard were killed when the aircraft finally crashed to the ground at a velocity of about 220 knots.

(xx) If the Captain, on the day of this accident, had ordered the First Officer to cause the ground spoilers to be armed in the manner laid down in the Air Canada operating manual, then this accident

would not have happened even if the First Officer had, through force of habit when flying with this Captain, not armed them but instead had pulled manually the actuating lever aft in the manner he did on the day of the accident, in that there would have been time to take effective corrective action and it probably would have been taken.

(xxi) There was nothing the Second Officer did which was in any way a contributing circumstance to this accident; nor was there anything he could have done that would have avoided it either before or after the initial touch down of this aircraft on runway 32.

(xxii) There was nothing that any personnel in the airport control tower at Toronto International Airport did which caused this catastrophic result, nor is there anything that any of them could have done either before or after the initial touch down of this aircraft to have avoided it.

3. Circumstances

Within the meaning of the word "circumstances" ("of any accident") in section 5A of the *Aeronautics Act*, Revised Statutes of Canada 1952, chapter 2 as amended, there were several contributing circumstances[1] to this accident. Without

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[1] See again *Caveat* at pages 4 and 5 of Introduction.

attempting to weight each or to list them in order of priority, they are set out hereunder, *viz*:

(i) The failure of the Captain to follow the procedures laid down in the "Before-Landing Check" in the Air Canada operating manual, in respect to arming the ground spoilers in this aircraft on this day.

(ii) The action taken by the First Officer, contrary to the order of the Captain on this day, in pulling the ground spoiler actuating lever aft manually to the "Extend" position when the aircraft was about 60 feet above runway 32 at Toronto International Airport.

(iii) The failure of the manufacturer of this aircraft to provide a gate or equivalent means to guard against such inappropriate manual operation of the ground spoiler lever in flight.

(iv) The acceptance and approval by the Ministry of Transport, of the design of the ground spoiler system in this aircraft.

(v) The acceptance and use by Air Canada of this aircraft with this defective design feature in its ground spoiler system.

(vi) The failure of the manufacturer and Air Canada in their respective manuals unequivocally to inform that the ground spoilers of this aircraft could be deployed when it was in flight by doing what the First Officer did in this case; and, also, to warn of the hazard of extending the ground spoilers when the aircraft is in flight and especially when it is close to the ground.

(vii) The failure of Air Canada to cause its Ground Training School personnel to instruct student pilots that the ground spoilers of this aircraft could be deployed in the way the First Officer did in this case or to warn that the ground spoilers could be deployed when this type of aircraft is in flight and especially when it is close to the ground.

(viii) The failure of the Ministry of Transport to detect the deficiencies and misinformation in the manufacturer's aircraft flight manual as to the operation of the ground spoiler systems on this type of aircraft; and the failure to require the manufacturer in such manual to warn of the danger of

inappropriate deployment of the ground spoilers on this type of aircraft when in flight and especially when it is close to the ground.

(ix) The failure of the Ministry of Transport (1) to have noted the differences in the manuals of Air Canada and other Canadian aircraft operators in relation to the hazards of operating this ground spoiler in this aircraft, (2) to have alerted Air Canada of this, and (3) to have taken appropriate remedial action so that Air Canada's manual in respect thereto was not deficient in respect thereto.

(x) Under the subject overload conditions, the failure of the manufacturer to design attachments of the engine pod to wing structure to provide for safe sequential separation, or failing which to otherwise ensure the integrity of the fuel and the electrical systems.

PART G

RECOMMENDATIONS

1. Explanation

What is related here are the recommendations of this Board of Inquiry after hearing and carefully considering the whole of the evidence adduced before it.

2. List of Recommendations

Eight recommendations are made and are listed again without attempting to weight each or to list in order of priority, that is to say:

(i) The ground spoilers of the type used in the DC8 series of aircraft should be designed and constructed so that it is not possible for them to be deployed while in flight.

(ii) In respect to the present series DC8 aircraft now in use, at the minimum, a gate, or an equivalent device, should be made part of the activating lever mechanism of the ground spoiler system to provide some safeguard against inadvertent or inappropriate deployment of the ground spoilers in flight.

(iii) The manufacturer should correct its manuals

in respect to the operation of the ground spoiler system in the series DC8 aircraft to eliminate all equivocation, mistatements and deficiencies set out in Schedule 1 of Appendix "E".

(iv) The manufacturer should review the design of the attachments of the engine pod to wing structure of this DC8 series aircraft to ensure that a safe sequential separation under the subject overload conditions will take place according to its philosophy; and specifically, consideration should be given to (1) the strengthening of the lower wing plating attachments, which constitute the floor of the number 4 alternate fuel tank, and (2) the development and incorporation of devices designed to enable the electrical connections to separate in a manner which will not allow live electrical cables to trail in the path of escaping fuel in the event of engine or pylon separation or partial separation.

(v) As the method of disseminating vital information was ineffective, a better communications system between Air Canada's operations and engineering personnel on one side and the pilots and the Ground School Instructors of student pilots on the other side, should be established to ensure that all flight safety information and instruction reaches all the pilots and Ground School

Instructors at all times; and specifically that action should be taken to ensure that all pilots and Ground School Instructors of student pilots be fully informed of all features of the operation of the spoiler systems and their limitations on DC8 series aircraft.

(vi) As the evidence indicated that some Air Canada check pilots did not insist that certain Air Canada pilots adhere strictly to the operating procedures prescribed in Air Canada's DC8 operating manual, that Air Canada take whatever steps are necessary to make certain that all its check pilots require that all pilots adhere strictly to the laid down operating procedures for this type of aircraft as prescribed in the said manual.

(vii) Consideration should be given by the Ministry of Transport to strengthen its capacity to approve the design of aircraft of the transport category imported for use into Canada. If this is not practical, then consideration should be given to the policy of issuing Certificates of Airworthiness.

(viii) Consideration should be given by the Ministry of Transport to strengthening its capability of monitoring flight procedures of Canadian air passengers carriers.

So much for the Recommendations.

With the Appendices attached, this completes this Report.

This Report, as is obvious from the technical complexity of many of the matters in issue, could not have been prepared and completed without the advice and assistance of the two technical advisors, Mr. R.D. Hiscocks and Captain Cleland D. Lamb, which is gratefully acknowledged.

The Honourable Mr. Justice Hugh F. Gibson,
Commissioner.

DATED this 29 day of January, 1971.

This is Schedule 1
of Appendix "A"

SECTION 5A OF THE *AERONAUTICS ACT* AND RELEVANT SECTIONS OF THE *INQUIRIES ACT*

Aeronautics Act

5A(1) The Minister may establish a board of inquiry to investigate the circumstances of any accident involving an aircraft or of any alleged breach of any regulation made under section 4 or of any incident involving an aircraft that, in the opinion of the Minister, endangered the safety of persons and may designate the persons that are to be members of that board.

(2) Every person designated by the Minister as a member of a board of inquiry has and may exercise all the powers of a person appointed as a commissioner under Part I of the *Inquiries Act*, including the powers that may be conferred on a commissioner under section II of that Act, and may administer such oaths and take and receive such affidavits, declarations and affirmations as are necessary for the purpose of the inquiry.

(3) Every witness who attends and gives evidence before a board of inquiry established pursuant to subsection (1) is entitled to be paid

(a) reasonable travelling and living expenses incurred by him in so attending and giving evidence; and

(b) the witness fees prescribed in the tariff of fees in use in the superior courts of the province in which his evidence is given.

(4) Each board of inquiry shall send a full report of the inquiry conducted by it to the Minister.

Schedule 1 of Appendix "A"

Inquiries Act

PART I.

PUBLIC INQUIRIES.

2. The Governor in Council may, whenever he deems it expedient, cause inquiry to be made into and concerning any matter connected with the good government of Canada or the conduct of any part of the public business thereof.

3. In case such inquiry is not regulated by any special law, the Governor in Council may, by a commission in the case, appoint persons as commissioners by whom the inquiry shall be conducted.

4. The commissioners have the power of summoning before them any witnesses, and of requiring them to give evidence on oath, or on solemn affirmation if they are persons entitled to affirm in civil matters, and orally or in writing, and to produce such documents and things as the commissioners deem requisite to the full investigation of the matters into which they are appointed to examine.

5. The commissioners have the same power to enforce the attendance of witnesses and to compel them to give evidence as is vested in any court of record in civil cases.

PART II.

DEPARTMENTAL INVESTIGATIONS.

6. The minister presiding over any department of the Civil Service of Canada may appoint at any time, under the authority of the Governor in Council, a commissioner or commissioners to investigate and report upon the state and management of the business, or any part of the business, of such department, either in the inside or outside service thereof, and the conduct of any person in such service, so far as the same relates to his official duties.

7. The commissioner or commissioners may, for the purposes of the investigation, enter into and remain within any public office or institution, and shall have access to every part thereof, and may examine all papers, documents, vouchers, records and books of every kind belonging thereto, and may summon before him or them any person and require him to give evidence on oath, orally or in writing, or on solemn affirmation if he is entitled to affirm in civil matters; and any such commissioner may administer such oath or affirmation.

8. (1) The commissioner or commissioners may, under his or their hand or hands, issue a subpoena or other request or summons, requiring and commanding any person therein named to appear at the time and place mentioned therein, and then and there to testify to all matters within his knowledge relative to the subject-matter of such investigation, and to bring with him and produce any document, book, or paper that he has in his possession or under his control relative to any such matter as aforesaid; and any such person may be summoned from any part of Canada by virtue of such subpoena, request or summons.

(2) Reasonable travelling expenses shall be paid to any person so summoned at the time of service of the subpoena, request or summons.

9. (1) If, by reason of the distance at which any person, whose evidence is desired, resides from the place where his attendance is required, or for any other cause, the commissioner or commissioners deem it advisable, he or they may issue a commission or other authority to any officer or person therein named, empowering him to take such evidence and report the same to him or them.

(2) Such officer or person shall, before entering on any investigation, be sworn before a justice of the peace faithfully to execute the duty entrusted to him by such commission, and, with regard to such evidence, has the same powers as the commissioner or commissioners would have had if such evidence had been taken before him or them, and may, in like manner, under his hand issue a subpoena or other request or summons for the purpose of compelling the attendance of any person, or the production of any document, book or paper.

10. (1) Every person who

(a) being required to attend in the manner in this Part provided, fails, without valid excuse, to attend accordingly;

(b) being commanded to produce any document, book or paper, in his possession or under his control, fails to produce the same;

(c) refuses to be sworn or to affirm, as the case may be; or

(d) refuses to answer any proper question put to him by a commissioner, or other person as aforesaid;

is liable, on summary conviction before any police or stipendiary magistrate, or judge of a superior or county court, having jurisdiction in the county or district in which such person resides, or in which the place is at which he was so required to attend, to a penalty not exceeding four hundred dollars.

(2) The judge of the superior or county court aforesaid shall, for the purposes of this Part, be a justice of the peace.

PART III.

GENERAL.

11. (1) The commissioners, whether appointed under Part I or under Part II, if thereunto authorized by the commission issued in the case, may engage the services of such accountants, engineers, technical advisers, or other experts, clerks, reporters and assistants as they deem necessary or advisable, and also the services of counsel to aid and assist the commissioners in the inquiry.

(2) The commissioners may authorize and depute any such accountants, engineers, technical advisers, or other experts, or any other qualified persons, to inquire into any matter within the scope of the commission as may be directed by the commissioners.

(3) The persons so deputed, when authorized by Order in Council, have the same powers that the commissioners have to take evidence, issue subpoenas, enforce the attendance of witnesses, compel them to give evidence, and otherwise conduct the inquiry.

(4) The persons so deputed shall report the evidence and their findings, if any, thereon to the commissioners.

12. The commissioners may allow any person whose conduct is being investigated under this Act, and shall allow any person against whom any charge is made in the course of such investigation to be represented by counsel.

13. No report shall be made against any person until reasonable notice has been given to him of the charge of misconduct alleged against him and he has been allowed full opportunity to be heard in person or by counsel.

Schedule 1 of Appendix "A"

PART IV.

INTERNATIONAL COMMISSIONS AND TRIBUNALS.

14. (1) The Governor in Council may, whenever he deems it expedient, confer upon an International Commission or Tribunal all or any of the powers conferred upon commissioners under the provisions of Part I.

(2) The powers, so conferred, may be exercised by such Commission or Tribunal in Canada, subject to such limitations and restrictions as the Governor in Council may impose, in respect to all matters that are within the jurisdiction of such Commission or Tribunal.

This is Schedule 2
of Appendix "A"

88015

IN THE MATTER OF AN ACCIDENT INVOLVING
A DC-8 AIRCRAFT OF AIR CANADA IN
THE VICINITY OF TORONTO, ONTARIO, ON
JULY 5, 1970.

Pursuant to section 5A of the Aeronautics Act Chapter 2, Revised Statutes of Canada, 1952, as amended, I, DON JAMIESON, Minister of Transport, do hereby establish a board of inquiry and do hereby designate The Honourable Mr. Justice H.F. Gibson, of the Exchequer Court of Canada as the member of the said board for the purpose of investigating the circumstances of an accident involving a Douglas DC-8 aircraft, registration CF-TIW of Air Canada in the vicinity of Toronto, Ontario, on July 5, 1970, with attendant loss of life.

DATED at Ottawa this 8th day of October, 1970.

(Sgd) (Don Jamieson)
Minister of Transport.

Schedule 2 of Appendix "A"

P.C. 1970-23/1809
21 October, 1970

CANADA
PRIVY COUNCIL

(T.B. Rec. 699850)

His Excellency the Governor in Council, on the recommendation of the Minister of Transport and the Treasury Board, is hereby pleased to authorize payment to the Honourable Mr. Justice Hugh F. Gibson who by Order in Council of October 6, 1970, P.C. 1970-1766, has been authorized to act as a Board of Inquiry to be established by the Minister of Transport pursuant to section 5A of the Aeronautics Act to investigate the circumstances of an accident involving a Douglas DC-8 aircraft, Canadian registration No. CF-TIW, of Air Canada which took place near Toronto, Ontario, on July 5, 1970, of actual transportation expenses plus all actual and reasonable expenses while away from Ottawa and engaged in the performance of his duties as Chairman of the said Board of Inquiry.

Certified to be a True Copy -
Copie Certifiée Conforme

(Sgd) (R.G. Robertson)

Clerk of the Privy Council -
Le Greffier du Conseil Privé

This is Schedule 3
of Appendix "A"

P.C. 1970-1766
6 October, 1970

CANADA
PRIVY COUNCIL - CONSEIL PRIVE

HIS EXCELLENCY THE GOVERNOR GENERAL IN COUNCIL, on the recommendation of the Minister of Transport and the Treasury Board, and with the consent of the Minister of Justice, pursuant to subsection (1) of section 38 of the Judges Act, is pleased to authorize the Honourable Mr. Justice Hugh F. Gibson, a judge of the Exchequer Court of Canada, to act as a Board of Inquiry to be established by the Minister of Transport pursuant to section 5A of the Aeronautics Act to investigate the circumstances of an accident involving a Douglas DC-8 aircraft, Canadian registration No. CF-TIW, of Air Canada which took place near Toronto, Ontario, on July 5, 1970.

Certified to be a True Copy -
Copie Certifiée Conforme

(Sgd) (R.G. Robertson)

Clerk of the Privy Council -
Le Greffier du Conseil Privé

This is Schedule 4
of Appendix "A"

A NOTICE OF PUBLIC HEARING

IN THE MATTER OF a Board of Inquiry into the accident at Toronto International Airport, Malton, Ontario, to Air Canada, DC-8-63, CF-TIW aircraft on July 5, 1970.

A Public Hearing will be convened on November 23, 1970, at Toronto, Ontario, for the purpose of inquiring into the above mentioned accident.

A Pre-hearing Conference will be held on October 28 at 10:30 a.m. in Court Room 19, New Court House, University Avenue, Toronto, Ontario, for the purpose of receiving representations from persons wishing to be recognized as parties to or observers at the Public Hearing.

Inquiries relating to the Public Hearing or the Pre-hearing Conference should be addressed to Commission Counsel, B.J. MacKinnon, Q.C., 365 Bay Street, Toronto 105, Ontario.

DATED at Ottawa this 15th day of October, 1970.

Hon. Mr. Justice Hugh Gibson
Commissioner.

This is Schedule 5
of Appendix "A"

COUNSEL LIST

Counsel		Person
François Mercier, Q.C. Alastair R. Paterson, Q.C. E.M. Lane	-	Air Canada
David C. Cathcart Lawrence J. Galardi (Los Angeles) (U.S. Counsel)	-	Estates of passengers Hermann, Witmer, Whybor, Sultans, Tournaviks
D.K. Laidlaw, Q.C. J.H. Francis René Bernard (U.S. Counsel)	-	McDonell Douglas Corporation
Roland H. Sperlich	-	Estates of passengers Maitz
B.J. MacKinnon, Q.C. A.J. Stone	-	Commission Counsel
John T. Keenan	-	Estates of P.C. Hamilton, and Canadian Airline Pilots Association
R.H. Evans	-	Ministry of Transport
W.A. Grant, Q.C.	-	Estates of D. Rowland and G. Hill

This is Schedule 6
of Appendix "A"

W I T N E S S E S

Mr. W. Howes	In charge of the Investigation; gave general background of accident.
Captain W. Benson	Described generally the duties of the cockpit crew, and the differences between the 40/50/60 series of DC8s.
Mr. A. Huneault	Chairman, Records and Documents Group.
Mr. L.A. Tapp	Chairman, Eye Witness Group.
Mr. H. Renken	Eye Witness.
Mr. Roy Goodbrand	Chairman Powerplants Group.
Mr. A. LeCheminant	Chairman, Structures Group.
Mr. T.W. Heaslip	Vice-Chairman, Structures Group.
Mr. J. Johnstone	Described the operation of spoiler system from model.
Mr. John Love	Chairman, Systems Group.
Mr. B. Caiger	Chairman, Flight Data Recorder Group.
Mr. A. Clark	Chairman, Operations Group.
Mr. A.J. Vasarins	Air Traffic Control Officer on day in question (eye witness).
Mr. T. Taylor	Air Traffic Control Supervisor (eye witness).
Mr. M.M. Fleming	Ministry of Transport.
Mr. H.H. Schoech	Supervising Flight Test Engineer, Flight Test Branch, Engineering Division, Western Region of the Federal Aviation Administration, Los Angeles, California.
Dr. F.O. Hemming	Chairman, Human Factors Group.

This is Schedule 1
of Appendix "B"

Extract from Inquiry Exhibit 57 (Air Canada "Manual 55, DC8 Operating", Chapter 2, Pages 38 and 39).

8 Initial Approach

. . .

.11 In Range Check: The pilot performing the In Range and Before Landing checks calls out each item as he completes it. The other pilot monitors and the Second Officer checks off each item as it is completed on the mechanical check list.

1 (63) Reverse Hydraulic Switch.....ON

2 Ordinance Light Switches (2).....ON

3 (DELETED)

4 (DELETED)

5 (63) Ignition Override Switch.....ALL ENGINES

6 Nos. 2 and 3 Cabin Compressor Shut-off Switches.....OFF

7 Recirculation Fan Switches(2/3).....AS REQ'I

8 (50/60) Airspeed Bugs (2).....SET

9 Altimeter Bugs (4).....CHECK

10 EPR Bugs (4).....SET

11 PTC Switch.....OVERRIDI

12 Flaps.....25°/23°

13 Fuel Panel.....SET

The Captain will check the Auxiliary Instrument and Fuel Control Panels.

Schedule 1 of Appendix "B"

9 Final Approach and Landing

.10 Before Landing Check:

1 Landing Gear Control Lever.....DOWN

2 Landing Lights.....EXTEND & CHECK, AS REQ'D

3 Altimeters.....SET

4 Landing Gear....."LEVER DOWN, THREE GREEN LIGHTS, FOUR PRESSURES CHECK"

5 Spoilers....."ARMED"

6 (DELETED)

7 Pilot flying checks and calls....."LEVER, THREE GREEN LIGHTS, FOUR PRESSURES, SPOILERS"

8 The Second Officer will present the mechanical check list over the pedestal for the Captain's acknowledgement.

The items deleted and marked "(DELETED)" refer to series of DC8 other than the subject aircraft, namely, a DC8 series 63 and are irrelevant for the purpose of this Report.

This is Schedule 1
of Appendix "C"

G L O S S A R Y

"In-Range Check"

The "In-Range Check", according to the Air Canada 55 DC8 Operating Manual, contains seven items (see Schedule 1 of Appendix "B" for details). These items are to be called out by the pilot performing the check as he completes each item. The other pilot monitors and the Second Officer checks off each item as it is completed on the mechanical check list.

"Before-Landing Check"

The "Before-Landing Check", according to the said Air Canada manual contains five items, and the same drill obtains in carrying out the same. (See Schedule 1 of Appendix "B" for details.)

"Arming the Spoilers"

The act of lifting the spoiler actuating lever radially outward to engage the automatic feature is commonly referred to as "Arming the Spoilers". This action reveals a red warning band at the base of the lever containing the word "ARM".

"On the Flare"

The "Flare" refers to the transition or change in the flight path of the aircraft from the approach path to a path horizontal to and over the runway surface.

"On the Ground"

"On the Ground" means the situation which obtains when the aircraft's wheels are in contact with the runway surface.

"Touch Down"

In this case the "Touch Down" refers to the contact of the aircraft with the surface of runway 32 at Toronto International Airport on July 5, 1970.

Impact

In this case "Impact" refers to the final destructive contact of the aircraft with the earth's surface at Toronto International Airport on July 5, 1970.

Centre of Gravity - C of G

The point on the aircraft where the sum of all the weight forces act.

Mean Aerodynamic Chord - M.A.C.

The area of the wing divided by the span (approximate).

Gravity - G

The acceleration due to gravity, i.e. 32.2 ft/sec^2. An aircraft in straight and level flight is operating at one G.

Cockpit Voice Recorder - CVR

The system of cockpit voice recording equipment used in this aircraft which had the approval of the Minister of Transport. A cockpit voice recorder normally records all cockpit conversations and radio transmissions.

Flight Data Recorder - FDR

Is described in Air Navigation Order Series II, No. 13, see Schedule 2 of Appendix "D".

Whiskey Beacon

Is a non-directional radio beacon (frequency 368 KHZ ident. "W") colocated with a fan marker to form the compass locator station on the back marker site located 4.2 nautical miles from the threshold of runway 32 at Toronto International Airport. The Whiskey Beacon forms part of the Back Course ILS serving runway 32.

Schedule 1 of Appendix "C"

VASI - Visual Approach Slope Indicator

Is a system of lights located near the approach end of a runway to provide the pilot with a visual indication of the correct approach path. The VASI approach path generally, but not always, will correspond to the ILS (Instrument Landing System) glide path if both are provided on the same runway. In the case of runway 32 at Toronto International on July 5, 1970, the ILS glide path would appear higher at a given location than the VASI approach path.

This is Schedule 2
of Appendix "C"

TRANSCRIPT OF THE COCKPIT VOICE RECORDER TAPE FROM CF-TIW

The following pages are a transcript of all the conversation extracted from the cockpit voice recorder tape. The conversation was obtained from three tracks of the tape which recorded audio information from a cockpit area microphone, the Captain's earphones, and the First Officer's earphones. The Captain's and First Officer's radio transmissions are included because their microphone outputs are amplified and fed back through their own earphones in addition to the incoming communications. Radio communications can also occasionally be heard on the cockpit area microphone from loudspeakers on the flight deck which the crew turn up and use in place of their earphones.

Radio communications between the ground and other aircraft on the same frequencies as CF-TIW are not included in this transcription although they could, of course, be overheard by the crew. These will be found in the transcript of the Air Traffic Control tapes which form part of the Operations Group Report.

Some conversation was unintelligible due to excessive background noise and low voice levels. These are denoted by (-------). Dubious words are also enclosed in parentheses.

The elapsed times quoted are based on the synchronization pulses of the digital data, which is also recorded on the tape, and are measured relative to the position of a piece of metal foil stuck to the beginning of the tape. The times quoted are consistent with those used for the measured data, and are given to an accuracy of ± 2 seconds for the voice transcriptions. From the timing track on the Toronto A.T.C. tapes, it is estimated that the foil position corresponds to a time of 07h:36m:55s EDT ± 5 seconds.

On this basis, the touchdown on runway 32 occurred at 08h:06m:36s EDT, and the final impact at 08h:09m:34s EDT.

Abbreviations

SOURCE

CAM	Cockpit Area Microphone
CH	Captain's Headset
FH	First Officer's Headset

VOICES

C	Captain
F	First Officer
S	Second Officer
CO	Company - Air Canada, Toronto
T	Toronto Tower
APP	Toronto Approach Control
DEP	Toronto Departure Control
CTR	Toronto Centre
STW	Stewardess
UN	Unidentified

Schedule 2 of Appendix "C"

ELAPSED TIME MINS:SECS	VOICE	SOURCE	
00:02	F	CH,FH	Toronto Centre Air Canada six two one level two seven zero.
00:08	CTR	CH,FH	Ah six two one, two seven - oh - squawk fourteen hundred and ident, the approach at Toronto the back course on thirty two.
00:14	F	CH,FH	- er - Checks OK.
00:18	CTR	CH,FH	Air Canada six twenty one radar contact.
00:20	F	CH,FH	Six twenty one.
00:42	C	CAM	(All right).
01:10	C	CAM	Last trip, - I figured since this is the same trip, - Monday afternoon, (---) I didn't wake up until half past one in the afternoon (--). - Took a long walk down around the city (----). I wound up in a pub that I haven't been in since nineteen forty four. I had forgotten all about it. It's a place called the - er - Black Friar, right at the end of Black Friars Bridge.
01:33	F	CAM	Yeah!
01:37	C	CAM	(----------)
01:38	F	CAM	Yeah - that's (----------) out of the way for me.
01:41	C	CAM	(----------) it's up by a point. It's on one of those crazy corners where people get together and form a sort of a choir.
01:47	F	CAM	Yeah!
01:50	C	CAM	It's right on a point. Like it is in Toronto.
01:51	F	CAM	(----------) got no problem that way. (------).
01:54	C	CAM	Oh yeah!
01:55	F	CAM	How do you like that?

Schedule 2 of Appendix "C"

ELAPSED TIME MINS:SECS	VOICE	SOURCE	
02:06	F	CAM	Hey mate (-------) more accurate (------).
02:13	C	CAM	We were about twenty minutes ahead last time.
	F	CAM	(----------).
02:24	CTR	CH,FH	Air Canada six two one you're cleared maintain eight thousand at your convenience, Toronto altimeter two niner seven five.
02:31	F	CH,FH	Six twenty one now is cleared maintain eight thousand at our convenience. Two nine seven five.
02:36	CTR	CH,FH	(Good: OR Roger.)
03:00	UN	CAM	WHISTLING
03:12	C	CAM	It sure looks like a nice ninety minus a hundred and ten or whatever the hell he gave us, Hey?
03:17	F	CAM	Yeah (----------).
03:26	F	CAM	Why do they bother? Why? Why, do they bother at all - Heh - Heh, Heh.
03:32	C	CAM	That guy's particular - he's got to be at work. Honest to God! (----------).
03:39	STW	CAM	Captain. (----). A passenger on - er - He works on the ramp. He says that - er - (-----) Montreal, someone forgot to close a panel - er - at the back - er - at the back there.
03:52	C	CAM	Oh! On which side?
03:53	STW	CAM	On that side.
03:54	C	CAM	Number one engine?
03:55	STW	CAM	Yeah.
03:57	C	CAM	OK - It's probably torn off by now.
03:58	STW	CAM	I don't know whether he (----------).

Schedule 2 of Appendix "C"

ELAPSED TIME MINS:SECS	VOICE	SOURCE	
03:59	F	CAM	Hey - (--------) We're going to get a new airplane when we get to Toronto.
04:02	STW	CAM	(----------)
04:04	C	CAM	(----------)
04:06	S	CAM	(----------)
04:08	C	CAM	(Do you) go to L.A.?
04:10	STW	CAM	(----------)
04:13	C	CAM	(--------) airplane didn't (--------) Anyway we're (--------)
04:16	STW	CAM	(----------).
04:19	C	CAM	O.K.
04:25	F	CAM	On the outside of the outboard engine?
04:28	C	CAM	Can't be, - er - 'cos he wouldn't see it on the outside. It's number one engine.
04:32	F	CAM	Oh.
04:48	UN	CAM	(----------).
	C	CAM	Eh?
04:50	UN	CAM	(-------close it).
04:52	C	CAM	No. The guy - er - says that they forgot to close it at Montreal (--------) open, tore it off.
05:15	F	CH,FH	Toronto, six twenty one.
05:28	CO	CH,FH	Six two one, (-----).
05:31	F	CH,FH	Six twenty one. I estimate over zero three. - Mm - It is reported that we have an open panel on engine number one. We have a mechanic who is travelling as a passenger reported this access door is either open or (-------) or is not closed. Require that checked.
06:07	CO	CH,FH	(----------) Your aircraft is

Schedule 2 of Appendix "C"

ELAPSED TIME MINS:SECS	VOICE	SOURCE	
06:23	F	CH,FH	Eight seven eight is planned through at forty one.
06:32	C	CAM	(Toodley - Toodledo.)
06:35	S	CAM	(----------) Twenty eight hundred broken seventy five hundred broken twenty miles, temperature (----------), dew point seven zero. Three ten degrees (----------) twenty nine seventy five. Runway thirty two. We'll contact the Approach.
06:48	C	CAM	O.K.
06:58	UN	CAM	(Have you heard about) the latest.
07:02	C	CAM	They have done a lot of work on the airport there.
07:04	F	CAM	Have they?
07:06	C	CAM	They're building a new taxi strip parallel to thirty two. Instead of going around the old ramp area, the old ramp area has been cleared.
07:12	UN	CAM	(---------) take - er - zero five left.
07:16	C	CAM	Yeah.
07:18	C	CAM	Zero five left. It gives you what, about seven thousand feet I guess hey?
07:25	UN	CAM	(----------) thirty three now.
07:28	C	CAM	Yeah. Hey?
07:30	S	CAM	I don't know what they're gonna extend it to. (----).
07:49	F	CAM	You know, I haven't been in Toronto for months.
07:52	C	CAM	Oh, I haven't been there since the last week (--------) started.
	S	CAM	(----------).
07:58	F	CAM	(----------).

Schedule 2 of Appendix "C"

ELAPSED TIME MINS:SECS	VOICE	SOURCE	
08:09	S	CAM	(----------) over towards twenty three right - left (----------).
08:14	F	CAM	(----------).
08:16	CTR	CH,FH	Air Canada six two one contact Toronto centre on one two seven decimal zero, squawk eleven hundred-out of twenty three thousand.
08:23	F	CH,FH	One twenty seven zero at eleven hundred out of twenty three thousand, six twenty one, good day.
08:28	CTR	CH,FH	Good day.
09:00	F	CH,FH	Toronto Centre Air Canada six twenty one leaving two seven zero for eight thousand.
09:06	CTR	CH,FH	Air Canada six twenty one radar contact, Toronto altimeter twenty nine seventy six.
09:11	F	CH,FH	Nine seven six.
09:12	C	CAM	I got the whiskey on number one.
09:16	C	CAM	Oh yeah! (-------) a glide slope on thirty two now.. A back course glide slope.
09:25	F	CAM	(Pete ----------).
09:28	C	CAM	Yeah. It's away above the vasis though (----------).
09:31	F	CAM	(----------).
09:42	F	CAM	(----------).
10:08	C	CAM	(----------).
10:20	F	CAM	(-- glide path angle ----------).
10:22	C	CAM	(----------) seems to be higher than the vasi (----------) a different location sort of thing.
10:42	F	CAM	You'd almost think (----------) where the old one was.

Schedule 2 of Appendix "C"

ELAPSED TIME MINS:SECS	VOICE	SOURCE	
10:47	C	CAM	(----------).
10:50	F	CAM	(----------).
10:51	C	CAM	Yeah.
12:55	UN	CAM	WHISTLING.
13:41	-	CH,FH	CRACKLING - MIKE NOISE
14:03	C	CAM	Better tell them we're through hey.
14:05	F	CAM	What?
14:06	C	CAM	Better tell them that this aircraft is through.
14:16	STW	CAM	Yes?
14:18	F	CAM	Oh. This airplane is planned through.
14:20	STW	CAM	It is?
14:22	F	CAM	Yeah.
14:46	UN	CAM	WHISTLING.
14:53	CTR	CH,FH	Air Canada six twenty one cleared to maintain six thousand.
14:57	F	CH,FH	Six two (twenty) one cleared to maintain six thousand leaving twelve.
15:01	CTR	CH,FH	Six two one Roger.
15:40	C	CAM	(-----for six).
16:13	S	CAM	Don, would you be going up into - uh - (--------). Not here, but in Montreal?
	F	CAM	Yeah.
	S	CAM	(----------).
16:20	F	CAM	I think so, - Yeah.
16:23	S	CAM	(----------).
16:27	F	CAM	(----------). Yeah.

Schedule 2 of Appendix "C"

ELAPSED TIME MINS:SECS	VOICE	SOURCE	
16:28	S	CAM	OK.
17:02	F	CAM	I wonder if that twelve dollars a day - that is - is er - regardless of how long, that twelve dollars a day doesn't seem (-----) broken down in any way, does it.
17:13	C	CAM	Oh, I imagine it would be. - Maybe it is just a flat twelve dollars a day for every day you work or something like that but, uh - (---------) over-coming this - er - income tax.
17:27	F	CAM	I hope that is.
17:29	C	CAM	That would be lovely.
17:31	C	CAM	(----------)
17:32	UN	CAM	LAUGHING - CHUCKLING.
17:35	F	CAM	Yeah - twenty four days a month (heh heh heh) or twenty three, or whatever it is.
17:40	C	CAM	Oh - I doubt if we get down to eighty hours in (---------).
17:43	F	CAM	Yeah! We get a credit for eighty hours?
17:46	C	CAM	By the end of the contract, but that doesn't come till the end of - uh - ; a year from now it is supposed to be eighty two and a half and then by the end of the contract it goes to eighty.
17:56	UN	CAM	That makes me feel a little more secure.
18:00	C	CAM	(----------).
18:02	UN	CAM	(----------).
18:03	UN	CAM	LAUGHING.
18:12	F	CAM	Yeah, that will help.
18:14	F	CAM	We got a little bit of supervisory flying. I'd like to see it all though (---------).
18:23	CTR	CH,FH,CAM	Six twenty one contact arrival now on

Schedule 2 of Appendix "C"

ELAPSED TIME MINS:SECS	VOICE	SOURCE	
18:27	F	CH,FH	Nineteen two. OK.
18:34	C	CAM	Get those compressors.
18:35	F	CH,FH	Toronto arrival Air Canada six twenty one is six thousand.
18:40	APP	CH,FH	Six twenty one at six thousand, I'll have vectors in about five miles, the altimeter two nine seven five.
18:46	F	CH,FH	Nine seven five.
19:13	UN	CAM	WHISTLING.
19:33	APP	CH,FH	Air Canada six two one left turn now to one eight zero.
19:37	F	CH,FH	Six twenty one left turn to one eight zero.
20:13	C	CAM	IRW identified and the whiskey on number one.
20:48	UN	CAM	WHISTLING.
21:29	UN	CAM	WHISTLING.
22:17	APP	CH,FH,CAM	Air Canada six two one you're cleared to three thousand.
22:20	-	CAM	APPARENT POWER REDUCTION.
22:21	F	CH,FH	Six twenty one cleared to three thousand, leaving six.
22:23	C	CAM	In range check.
22:34	UN	CAM	(-----).
22:37	UN	CAM	Yeah.
22:41	F	CAM	Flaps to go.
22:42	C	CAM	OK - eighteen flap.
22:51	S	CAM	We've been pumping for awhile, we have twenty eight hundred pounds in the main tanks.

Schedule 2 of Appendix "C"

ELAPSED TIME MINS:SECS	VOICE	SOURCE	
22:59	C	CAM	OK.
23:06	C	CAM	Twenty three.
23:08	-	CAM	CLICK.
23:09	F	CAM	One sixty four.
23:29	F	CAM	Nice day.
23:32	C	CAM	Beautiful.
23:40	F	CAM	That's where old (----) lives there, I guess, that - er - they - what do they call it, Hyde Park ---.
23:45	C	CAM	Oh.
23:45	F	CAM	- Apartments see them there.
23:46	C	CAM	Oh, the white ones there.
23:47	F	CAM	Yeah.
23:47	C	CAM	Oh yeah.
23:48	F	CAM	It looks over the ---. It's quite a good view out over the lake there.
23:56	S	CAM	The housing in Toronto is out of this world, expensive yeah.
24:01	F	CAM	Yeah - expensive alright.
24:08	F	CAM	Yeah, a lot of people must have made a lot of money.
24:12	C	CAM	Yeah, I'll say.
24:26	C	CAM	Four for three.
24:27	F	CAM	Four for three.
24:32		CAM	CLICK, CLICK, CLICK, CLICK.
24:35		CAM	APPARENT POWER INCREASE

Schedule 2 of Appendix "C"

ELAPSED TIME MINS:SECS	VOICE	SOURCE	
24:46	APP	CH,FH,CAM	Air Canada six two one is cleared for the vectored ILS back course thirty two and turn right to two three zero final in three miles.
24:55	F	CH,FH	Roger. Cleared back course ILS thirty two, turning right to three two zero.
25:00	APP	CH,FH	Two three zero.
25:02	F	CH,FH	Ah - Roger two three zero.
25:05	APP	CH,FH	You're currently three and a half east of the marker.
25:10	F	CH,FH	Six twenty one.
25:18	C	CAM	Before landing.
25:21		CAM	CLUNK - INCREASE IN BACKGROUND NOISE.
25:24	F	CAM	Twenty nine seven five.
25:35	APP	CH,FH,CAM	Six twenty one right turn now to heading two eight zero your three to the marker.
25:40	F	CH,FH	Air Canada two eight zero, six twenty one.
25:41	F	CAM	Check three green, four pressures, spoilers on the flare.
25:45	C	CAM	OK. Brakes three green, four pressures, spoilers (on the flare).
25:52	F	CAM	(No OR or) on the ground.
25:53	C	CAM	All right, give them to me on the flare.
	C	CAM	I've given up.
	F	CAM	LAUGHING.
	C	CAM	I'm tired of fighting it.
	F	CAM	LAUGHING.

Schedule 2 of Appendix "C"

ELAPSED TIME MINS:SECS	VOICE	SOURCE	
26:04	S	CAM	Fuel (panel) set.
26:06	C	CAM	Thank you.
26:07	C	CAM	Thirty five flap.
26:08	F	CAM	Thirty five.
26:09	F	CAM	One four two.
26:11	APP	CH,FH,CAM	Air Canada six two one right around to three ten to intercept the back course. Tower now one eighteen seven, good day.
26:16	F	CH,FH	(Maintain) three ten Roger, good day.
26:31	F	CH,FH	Toronto tower Air Canada six twenty one approaching the whiskey.
26:34	T	CH,FH,CAM	Six twenty one - number one, we'll depart two seven twenty sevens.
26:38	F	CH,FH	Roger.
27:02		CAM	APPARENT POWER INCREASE.
27:17	F	CAM	Yeh, it is pretty late.
27:18	C	CAM	Yeah.
27:19	F	CAM	Surprise uh (----------).
27:27	C	CAM	Landing flap.
27:30	F	CAM	One twenty nine.
27:31	C	CAM	One thirty four - five.
27:36	-	CAM	APPARENT POWER DECREASE.
27:40	F	CH,FH	Six twenty one is by the whiskey.
27:43	T	CH,FH	Six twenty one, Roger check (your) gear down.
27:45	F	CH,FH	Gear down.
27:46	S	CAM	Spoilers to go and the boards clear.
27:49	C	CAM	OK Thanks.

Schedule 2 of Appendix "C"

ELAPSED TIME MINS:SECS	VOICE	SOURCE	
27:51	-	CAM	APPARENT POWER INCREASE.
28:15	-	CAM	WHISTLING.
28:24	C	CAM	Ho! Ho - Ho.
28:28	C	CAM	Well that's right on the vasi, we are a little below the glide slope see.
28:32	F	CAM	Yeah, yeah you're right.
28:37	C	CAM	It's going to be rougher than a gut look at that stuff laying there on the runway.
28:42	-	CAM	APPARENT POWER DECREASE.
28:48	F	CAM	Get that thing off the ground. There you are. He's leaving a smokescreen for you just to make it a little more challenging.
28:56	T	CH,FH,CAM	(--) Six two one Toronto clear to land (on) Runway three two.
28:59	F	CH;FH	Six twenty one.
29:00	C	CAM	My IFR approach here.
	UN	CAM	Heh, Heh, Heh.
29:14	F	CAM	Here we have a green, the vasis appears to be a little bit high, yet you're low on the glide path.
29:21	C	CAM	Yeah - Oh this thing takes you away down the runway - terrible - it's a noise abatement - glide path.
29:29	F	CAM	Yeah.
29:32	F	CAM	Takes the whole air field that way (--).
29:33	C	CAM	Yeah.
29:37	C	CAM	OK.
29:38		CAM	APPARENT POWER REDUCTION.

Schedule 2 of Appendix "A"

ELAPSED TIME MINS:SECS	VOICE	SOURCE	
29:39	F	CAM	Sorry - Oh ! ! Sorry Pete.
29:40		CAM	APPARENT POWER INCREASE.
29:41		CAM	NOISE OF IMPACT.
29:43	F	CAM	Sorry Pete!
29:44	C	CAM	OK.
29:48	C	CAM	We've lost our power.
29:52	UN	CAM	Exclamation.
29:56	T	CH,FH,CAM	Air Canada six twenty one (I) checks you on the overshoot and you can contact departure on one nineteen nine or do you wish to come in for an immediate (on) five right?
30:02	C	CAM	Oh, we'll go around - I think we're alright.
30:05	F	CH,FH	Oh, Roger, we'll go all the way (around). Thanks.
	T	CH,FH	OK contact departure.
30:11	F	CH,FH	Roger one nineteen nine.
30:14	C	CAM	Get the gear up please, Don.
30:16		CAM	SOUND OF HORN.
30:17	F	CAM	What about the flap?
30:18	C	CAM	Flap - twenty-five.
30:20	F	CAM	Sorry, what was (--------).
30:27	F	CAM	(-----).
30:32	S	CAM	Number four generators gone.
30:34	C	CAM	OK. Get the cross-feed off first (though). Good. - (-----).
30:46	C	CAM	Will you give the approach a call.
30:40 to		CH,FH	SOUND OF MIDDLE MARKER SIGNAL.

Schedule 2 of Appendix "C"

ELAPSED TIME MINS:SECS	VOICE	SOURCE	
30:50	F	CH,FH	Toronto approach control Air Canada Six twenty one is overshooting on - ah - thirty two.
			END OF READABLE TRANSMISSIONS ON CAPTAIN'S HEADSET DUE TO INTERMITTENT SIGNAL.
31:01	DEP	FH,CAM	Air Canada Six twenty one confirm on the overshoot.
31:03	F	FH,CAM	Affirmative.
31:04	DEP	FH,CAM	OK Sir, your intentions please?
31:08	F	FH,CAM	Roger, we would like to circle back for another attempt on thirty two.
31:12	DEP	FH,CAM	K. Sir, the runway is closed. Debris on the runway. Your vector will be for a back course two three left. It is probably about the best. The surface wind is northwest at ten to fifteen. Turn right heading zero seven zero, three thousand feet.
31:25	F	FH,CAM	Right zero seven zero - Roger, three thousand.
31:27	DEP	FH	Roger six two one.
31:28	C	CAM	We've lost number four engine.
	F	CAM	Have we?
	C	CAM	(---------).
31:36	UN	CAM	(----------).
31:40	S	CAM	Fuel.
31:42	S	CAM	Fuel!
	C	CAM	Eh?
	S	CAM	Fuel.
31:44	C	CAM	Is it?
	F	CAM	Yeah.

Schedule 2 of Appendix "C"

ELAPSED TIME MINS:SECS	VOICE	SOURCE	
31:46	C	CAM	OK, cut number four.
	F or S	CAM	Number four engine?
	C	CAM	Yeah.
	F or S	CAM	Number three engine -
	C	CAM	Number four.
31:53	F	CAM	Number four, right!
32:02	C	CAM	Number three is jammed too.
32:04	F	CAM	Is it?
32:08	C	CAM	There it is.
32:10	C	CAM	The whole thing is jammed.
32:12		CAM	CRACKLING NOISE.
32:13	F	CAM	What was that?
32:16	F	CAM	What happened there Pete?
32:17	C	CAM	That's number -- that number four --- something's happened (------).
32:18	F	CAM	Oh look! We've got (a----a-----).
32:19		CAM	LOUD SOUND OF EXPLOSION.
32:23	F	CAM	Pete! Sorry!
32:24		CAM	SOUND OF EXPLOSION LOUDER THAN THE FIRST.
32:26	C	CAM	All right.
32:26	DEP	FH	Six two one the status of your aircraft please.
32:27		CAM	SOUND OF METAL TEARING.
32:28	C	CAM	We've got an explosion!
32:30	F	CAM	Oh look! We got (flame).
32:32	F	CAM	Oh gosh!

ELAPSED TIME MINS:SECS	VOICE	SOURCE	
32:35	UN	CAM	We've lost a wing.
32:39			END OF TAPE.

This is Schedule 3
of Appendix "C"

Slight differences between this transcription and C.V.R. due to indistinct words.

MONTREAL A.T.C. TRANSCRIPT

1. MONTREAL CLEARANCE DELIVERY 121.3 MHZ

TIME	FROM	TO	REMARKS
1059	AC621	C/D	Montreal Clearance Delivery AC621 standing by
	C/D	AC621	ATC clears AC621 to the Toronto Airport Centre stored flight plan to maintain flight level 270. Take off runway 28 on a Hawkesbury number 4 SID
	AC621	C/D	AC621 to the Toronto Centre stored flight plan maintain 270. Take off 28 Hawkesbury 4 SID
1100	C/D	AC621	AC621 clearance checks contact ground 121.9 prior to push back and check your splashing on both frequencies
	AC621	C/D	Roger 621

Schedule 3 of Appendix "C"

2. MONTREAL GROUND CONTROL 121.9 MHZ.

TIME	FROM	TO	REMARKS
1111	AC621	Grd.	Montreal Ground AC621 push back gate 40.
	Grd.	AC621	AC621 push back at your discretion no traffic behind you.
	AC621	Grd.	Roger thanks.
1112	Nil		
1113	AC621	Grd.	Montreal Ground AC621 taxi
	Grd.	AC621	AC621 Ground cleared to taxi to runway 28.
	AC621	Gd.	Roger
1114	Nil		
1115	Nil		
1116	Grd.	AC621	AC621 contact tower.

Schedule 3 of Appendix "C"

MONTREAL AIRPORT CONTROL 11.9 MHZ.

TIME	FROM	TO	REMARKS
1116	AC621	Twr.	Montreal Tower AC621 ready for take-off.
	Twr.	AC621	AC621 take position on 28 and hold.
	AC621	Twr.	Roger.
	Twr.	Dept.	AC621 ready for 28.
1117	Twr.	AC621	AC621 Montreal Tower your cleared for take-off 28 when airborne departure 120.1. Good morning
	AC621	Twr.	621 Good morning.

Schedule 3 of Appendix "C"

MONTREAL DEPARTURE CONTROL 120.1 MHZ.

TIME	FROM	TO	REMARKS
1118	AC621	Dept.	Montreal Departure AC621 2 thousand
	Dep.	AC621	AC621 Montreal Departure radar identified your SID is cancelled maintain flight lev 270 heading 310 to intercept Victor 316.
	AC621	Dep.	Roger SID cancelled cleared to climb to maintain 270 heading 310 to intercept Victor 316.
	Dept.	AC621	Roger
1119	Nil		
1120	Nil		
1121	Nil		
1122	Dep.	Ottawa Sector (UL Center)	18 north west 621
	Dep.	AC621	Squawk 1100 call Montreal center 133.4
	AC621	Dep.	133.4 Good day
1123	Dept.	AC621	Good day.

Schedule 3 of Appendix "C"

MONTREAL CENTRE - OTTAWA SECTOR 133.4 MHZ.

TIME	FROM	TO	REMARKS
1122	Dep.	Center	18 northwest 621
1123	AC621	Center	Montreal Center AC621 leaving 11 thousand 270.
	Centre	AC621	AC621 Montreal Centre radar identified proceed direct Ottawa when your able call Ottawa 270 squawk 2100.
	AC621	Centre	621 direct Ottawa We're able this time. We'll call you level 270.
	Centre	AC621	Roger
1124	Nil		
1130	Nil		
1131	AC621	Centre	Montreal Centre AC621 level 270.
	Centre	AC621	AC621 Center checks thanks.
1132	Nil		
1133	Nil		
1134	Nil		
1135	Centre	Toronto Centre	Higheast Montreal
1136	Montreal	Centre	West of Ottawa AC621 level 270 and I see
		Toronto Centre	992 if that's him about 40 west of Rideau.
	Toronto	Montreal	That's him.

Schedule 3 of Appendix "C"

TORONTO CENTRE EAST HIGH SECTOR 132.8 MHZ

INITIAL CONTACT WITH TORONTO ACC

TIME	FROM	TO	REMARKS
1137	AC621	Centre	Toronto Center AC621 level 270.
	Centre	AC621	621 at 270 squawk 1400 and ident the approach at Toronto the back course on 32
	AC621	Centre	er checks OK
	Centre	AC621	AC621 radar contact
	AC621	Centre	621
1138	Centre	Centre	That's AC621 at Conoto Lake now.
	Centre	AC621	AC621 you'recleared to maintain 8 thousan at your convenience Toronto altimeter two niner seven five.
	AC621	Centre	621 now cleared maintain 8 thousand our convenience two nine seven five.
	Centre	AC621	Rog
1139	Nil		
1140 - 1145			
1145	Centre	Centre	That's 621 at Coehill descending to 8.
	Centre	AC621	621 contact Toronto centre now on one two seven decimal zero squawk eleven hundred out of 23 thousand
1145	AC621	Centre	127.0 at 1100 out of 23,000 621 Good day
	Centre		Good day

Schedul3 of Appendix "C"

STERLING LOW SECTOR 127.0 MHZ.

TIME	FROM	TO	REMARKS
1145	East High Control- ler	Sterling Low Controller	621 at Coehill with a clearance to 8.
	AC621	Controller	Toronto Center AC621 leaving 270 for 8 thousand
	Control- ler	AC621	AC621 Radar Contact Toronto Altimeter twenty-nine seventy-six.
	AC621	Controller	Nine seven six.
1151	Control- ler	AC621	AC621 cleared to maintain six thousand.
	AC621	Controller	AC621 cleared to maintain six thousand were leaving 12.
1152		Centre	621 Roger
1155	Control- ler	AC621	AC621 contact arrival now one nineteen two.
	AC621	Controller	Nineteen two OK.
1156			

Schedule 3 of Appendix "C"

TORONTO ARRIVAL 119.2 MHZ.

TIME	FROM	TO	REMARKS
1155	AC621	Arrival Controller	Toronto Arrival AC621 is at 6 thousand.
	Arrival Controller	AC621	621 at 6 thousand I'll have vectors in about 5 miles the altimeter two nine seven five.
	AC621	Arrival	Nine seven five.
1156	Arrival	AC621	AC621 left turn now to 180.
	AC621	Arrival	621 left turn 180.
1157	Arrival	AC260	260 cleared for the vectored back course to 32 final in 3½ miles and your altitude now please.
	AC260	Arrival	Roger 260 is leaving 6 thousand.
	Arrival	AC260	OK you have about 7 or 8 miles to the Outer Marker if that's enough room.
	AC260	Arrival	Yea, we'll be OK.
	Arrival	Tower	260's your next one 9 south on left base.
	Tower	Arrival	All right
1158	Nil		
1159	Arrival	AC621	AC621 you're cleared to 3 thousand.
	AC621	Arrival	621 cleared to 3 thousand leaving 6.
	AC254	Arrival	AC254 is descending from 7 to 2.5.
	Arrival	AC254	254.
1200	Nil		

Schedule 3 of Appendix "C"

TIME	FROM	TO	REMARKS
1201	Arrival	AC621	AC621 is cleared for the vectored .ILS back course to 32 and turn right to 230 final in 3 miles.
	AC621	Arrival	Roger cleared back course ILS 32 turning right 320.
1202	Arrival	AC621	230
	AC621	Arrival	AH roger 230.
	Arrival	AC621	You are currently 3½ east of the marker.
	AC621	Arrival	621
	AC254	Arrival	AC254 has the airport in sight request a visual.
	Arrival	AC254	I'll have that for you closer in 254 at the moment number 3 to land.
	AC254	Arrival	Roger 3.
	Arrival	Tower	621 is next 3 to the marker right base.
	Arrival	AC621	621 right turn now to heading 280 you're 3 to the marker.
	AC621	Arrival	AC two eight zero six twenty one.
1203	Arrival	AC621	AC621 right around to 310 to intercept the back course tower now one eighteen seven Good day
	AC621	Arrival	Three ten roger, good day.
	Arrival	AC254	AC254 the traffic your following is a DC8 going thru your 12 o'clock 6 miles. Let me know when you have him in sight.
	AC254	Arrival	OK we've got about an 8 across the shoreline.
	Arrival	AC254	Yea, He's just inside the shoreline.

Schedule 3 of Appendix "C"

TIME	FROM	TO	REMARKS
	AC254	Arrival	OK, we've got him.
	Arrival	AC254	OK, cleared for the visual approach 32 following that traffic.
1203	AC254	Arrival	Cleared for the visual approach following that traffic AC254.
1204	Arrival	Tower	Next is at 6 thousand a left base on a visual.
	Tower	Arrival	Who Dick
	Arrival	Tower	AC254
	Tower	Arrival	All right.

Schedule 3 of Appendix "C"

AIRPORT CONTROL 118.7 MHZ

TIME	FROM	TO	REMARKS
1203	Tower	AC260	AC260 right turn in Foxtrot contact ground one two one decimal nine clearing.
1203:20	AC621	Tower	Toronto tower AC621 approaching the Whiske
	Tower	AC621	AC621 number one we'll depart 2 727's.
12:03:30	AC621	Tower	Roger
	EA337	Tower	EA337 is ready.
	Tower	EA337	337 I'll position you as soon as the 727 rolls.
	EA337	Tower	337
	Tower	CP60	Empress 60 Toronto cleared take-off 32 contact departure one one niner decimal niner airborne the winds 310 at 15.
1204:00	CP 60	Tower	Empress 60 rolling.
	Tower	EA337	337 taxi to position 32.
	EA337	Tower	337
	Tower	Departure	Empress 60 Eastern on the pad.
	Departure	Tower	End of the runway.
	Tower	Departure	Thank you.
1204:35	AC621	Tower	621 is by the whisky.
	Tower	AC621	621 roger check the gear.
	AC621	Tower	Gear down.
1205			

Schedule 3 of Appendix "C"

TIME	FROM	TO	REMARKS
1205:05	Tower	EA337	EA337 Toronto cleared take-off runway 32 contact departure one one niner decimal niner airborne good day.
1205:25	EA337	Tower	EA337 cleared to go.
1205:29	Tower	EA337	That's affirmative one nineteen nine airborne you have been cleared.
1205:29	EA337	Tower	OK
	AC254	Tower	AC254 is a couple back from AH whisky.
	Tower	AC254	AC254 number 2 following the DC8.
	AC254	AC254	AC254
1205:42	Tower	AC621	AC621 Toronto cleared to land runway 32.
	AC621	Tower	621
1206:00	Tower	Departure	Eastern
1206:51	Tower	AC621	AC621 I check you on the overshoot and you can contact departure one nineteen nine or do you wish to come in on an immediate 5 right.
1207	AC621	Tower	Roger we'll do a right hand thanks.
	Tower	AC621	OK contact departure.
	AC621	Tower	Roger one nineteen nine
	Tower	Departure	621 is on the overshoot right wing is onto fire.
	AC (believe to be AC254)	Tower	His number 4 engine is on fire.

Schedule 3 of Appendix "C"

TIME	FROM	TO	REMARKS
	Tower	AC254	OK AC254 you can continue number one 32 prepare for a possible overshoot.
	AC254	Tower	254
	Departure	Tower	Is he coming here or staying with you.
	Tower	Departure	Check it OK runway 32 is closed.
	AC (believe to be AC254)	Tower	That 8 that overshot there is losing all sorts of fuel out the back end there.
	Tower	AC254	I check it OK 254 runway 32 is closed you can commence your overshoot contact departure one nineteen decimal nine and you can expect runway 23L.
	AC254	Tower	AC254 changing thank you.
1207	Tower	Departure	254 on the overshoot 32 closed you will have to vector 23L.
	EA337	Tower	EA337 with you departure control.
	Tower	EA337	One nineteen nine.
	Departure	Tower	Who is the overshoot?
	Tower	Departure	621 with the fire.
1208	Nil		
1209			
1209:44	Departure	Tower	Do you see him?
1209:46	Tower	Departure	He's gone Jerry.
1210:00	Tower	Departure	---garbled----seems to be north of Bramalea.

Schedule 3 of Appendix "C"

DEPARTURE CONTROL 119.9 MHZ

TIME	FROM	TO	REMARKS
	Tower	Departure	621's on the overshoot right wings onto fire.
	Departure	Tower	Is he coming here or staying with you.
	Tower	Departure	I check it OK 32 is closed.
	Departure	Tower	Did he lose pieces.
	Tower	Departure	254 on the overshoot 32 closed you'll have to vector him on 23L.
	AC621 (same time as above transmission)		AC621 overshooting on - ah - 32.
	Departure	Tower	Who's the overshoot please.
	Tower	Departure	621 with the fire.
	Departure	AC621	AC621 confirm on the overshoot.
	(AC621	Departure	Affirmative.
Same time	(Tower	Departure	OK 32 is notamed closed. Debris on the runway and you'll have to vector him for 23L
	(Departure	AC621	OK sir your intentions please.
	AC621	Departure	We would like to circle back for another attempt on 32.
	Departure	AC621	OK sir the runway is closed debris on the runway you vector will be for a back course 23L. It's probably about the best the surface wind is north west at 10 to 15 turn right heading 070° 3 thousand feet.
	AC621	Departure	Right 070 Roger 3 thousand.
	Departure	AC621	Roger 621.

Schedule 3 of Appendix "C"

TIME	FROM	TO	REMARKS
	EA337	Departure	Departure control, EA337 5 thousand
	Departure	EA337	EA337 climb to 7 steer heading 170 for on course report level.
	EA337	Departure	OK 7 thousand 170 heading we will check level.
	Departure	EA337	Rog
	AC254	Departure	Toronto departure AC254 on a missed approach.
	Departure	AC254	254 maintain your runway heading climb now to 3 thousand feet. We will be vectoring you for a back course runway 23L surface wind north west 10 to 15 now runway 32 is closed.
	AC254	Departure	AC254 understand runway heading and we're cleared up to 3 thousand we're 15 climbing.
	Departure	AC254	Thank you.
	Departure	CP60	CP 60 transponder 2000.
	CP60	Departure	CP60 2000.
	(believe to be AC254	Departure)	Where did the debris come from please.
	Departure	Unknown	Say again please.
	(Believe to be AC254	Departure)	The debris on the runway we're just curious.
	Departure	Unknown	Apparently Tower advises there is some type of debris on the runway for runway 32 and they are closing it till they investigate.
	Voice		OK

Schedule 3 of Appendix "C"

TIME	FROM	TO	REMARKS
	Departure	AC621	621 the status of your aircraft please.
	Departure	Tower	Do you see him.
	Tower	Departure	He's gone Jerry.
	Departure	AC254	AC254 do you see the traffic at 1 o'clock about 4½ miles.
	AC254	Departure	Yeh, 621 has ah crashed.
	Tower	Departure	The last contact seems to be north of Bramalea.
	AC254	Departure	He sure did he went down in flames.
	AC254	Departure	That is affirmative it crashed.
	Departure	AC254	OK fine 254 just hold your runway heading please.

Schedule 3 of Appendix "C"

GROUND CONTROL 121.9 MHZ

TIME	FROM	TO	REMARKS
1207:08	Ground vehicle	Ground control	Ground control Red 7.
	GC	GV	Red 7 Ground stand by 1 OK he's going to be landing on 23L ah Red 1. Red 7 check.
	Crash veh.	GC	Ah - Roger Red 7 what's the nature of the emergency over.
	GC	CV	OK that 8 just landed he - ah - knocked off an engine and his right wing may be on fire. Coming around for 23L Red 7.
	CV	GC	Roger Red 7.
	GC	CV	The -ah- off runway 32 on the about 1500 feet up is -a ah - engine off that DC8.
	CV	GC	Red 6 and Red 7 where do you want us to take us up
1209	CV	GC	Toronto GRD Red 6 where would you like me to take up position on this.
	GC	CV	For an emergency runway 23L.
	CV	GC	Red 6.
1209:22	GC	CV	He just lost another engine.
	GC	CV	Looks like it's going to crash land in Malton Village.
1209:28	CV	GC	Ground control this Red 7 with the duty officer we're heading out to airport road over.
1209:50	GC	CV	OK he's just crashed in Malton Village now the DC 8 - he's just crashed. - well north of Malton Village all the red vehicles check.

Schedul3 of Appendix "C"

TIME	FROM	TO	REMARKS
	CV	GC	Red 6 checks we'll go all the way up.
	GC	CV	OK.
1210	CV	GC	Toronto Grd Red 2 we're getting poor radio reception would you repeat the message please.
	GC	CV	OK the DC8 just crashed north of Malton Village he just went down in flame.
	CV	GC	Roger we're on the way
	GC	CV	OK.
	Voice	GC	Just playing games are you.
	GC		Say again.
	Voice	GC	Just playing games
	GC		Negative.
	Voice	GC	Who's the airplane ground control.
	GC		Air Canada
	Voice	GC	Do you know the flight number?
	GC		I'm afraid we can't say.
	Voice	GC	OK
1211	GC	CV	Red 7 Grd.
	CV	GC	Grd control Red 7 on the Airport road over
	GC	CV	Well you guys can do what you like do you want to head up there and leave a vehicle here in case of emergencies. I don't know what else to tell you.
	CV	GC	Toronto Grd Red 2's on the way now so he might as well keep going.
	GC	CV	OK it's quite a ways north of here looks like about 5 miles north of the airport. Looks like pretty well up the airport road.

Schedule 3 of Appendix "C"

TIME	FROM	TO	REMARKS
	CV	CV	Red 7 to Red Vehicles Red 2 and Red 4 return to the Fire Hall.
	GC	CV	Red 2 and Red 4 check return to the Fire Hall.
1212			

This is Schedule 1 of Appendix "D"

PERSONNEL OF VARIOUS GROUPS

		Specialty
Flight Recorder Group		
Chairman	Mr. B. Caiger, Flight Research, National Aeronautical Establishment, National Research Council	
Member	Mr. C. de Lavison, Air Canada Maintenance Engineering	Flight data recorder system
Member	Mr. R. Farren, Air Canada Maintenance Engineering	Data playback
Member	Mr. W. Gadzos, Flight Test Section, Aeronautical Engineering Division, Ministry of Transport	Cockpit voice transcript
Member	Dr. D.G. Gould, Flight Research, National Aeronautical Establishment, National Research Council	Data analysis
Adviser	Mr. S. Grossmith, Avionics Design, Aeronautical Engineering Division, Ministry of Transport	Flight data recorder system
Adviser	Mr. A.J. Hamblin, Leigh Instruments Limited, Engineering Department	Data playback system
Adviser	Mr. J.I. MacPherson, Flight Research, National Aeronautical Establishment, National Research Council	Flightpath reconstruction
Adviser	Captain E.T. Marriott, DC8 Check Pilot, Air Canada	Cockpit voice transcript and operational procedures
Adviser	Mr. W.D. Wells, Leigh Instruments Limited, Engineering Department	Aircraft flight recorder system

Schedule 1 of Appendix "D"

		Specialty
Operations Group		
Chairman	Mr. A.J. Clark, Aircraft Accident Investigation Division, Ministry of Transport	
Member	Captain J. Smith, Air Canada, Toronto	Chief Pilot, DC8
Member	Captain R.J. Smallman, Air Canada, Toronto	Pilot, DC8
Member	Mr. J. Blair, Air Canada, Montreal	Flight Safety
Member	Mr. T. Taylor, Ministry of Transport, Toronto	Air Traffic Control
Systems Group		
Chairman	Mr. John A. Love, Ministry of Transport	
Member	Mr. Keith Rhodes, Air Canada	Sr. Systems Engineer, hydro-mechanical
Adviser	Mr. Fred Stewart, Air Canada	Quality technician
Adviser	Mr. Ray Duffy, Air Canada	Engineering technician
Structures Group		
Chairman	Mr. A.N. Le Cheminant, Ministry of Transport, Accident Investigation Engineering Laboratory	
Dep Chairman	Mr. T.W. Heaslip, Ministry of Transport, Accident Investigation Engineering Laboratory	Metallurgical Engineer
Member	Mr. R.M. Logan, Ministry of Transport, Accident Investigation Engineering Laboratory	Wreckage Analyst

Schedule 1 of Appendix "D"

		Specialty
Member	Mr. K. Lopez, Ministry of Transport, Toronto	Construction Engineer
Member	Mr. E. Hand, Air Canada	Sr. Technician, Airframes
Adviser	Mr. A.J.W. Melson, Ministry of Transport, Accident Investigation Engineering Laboratory	Aeronautical Engineer
Adviser	Mr. P. Labor, Douglas Aircraft Corporation	Structures Engineer
Adviser	Mr. P. Thompson, Ministry of Transport, Toronto	Construction Engineer
Adviser	Mr. C.M. Munsen, Air Canada, Program Manager	DC8 Specialist

Powerplant Group

Chairman	Mr. R.D. Goodbrand, Aircraft Accident Investigation Division, Ministry of Transport
Member	Mr. C. Gross, Senior Systems Engineer, Air Canada
Member	Mr. R. Desjardins, Service Representative, United Aircraft of Canada Limited
Adviser	Mr. T. McCabe, United Aircraft of Canada Limited

Eye Witness Group

Chairman	Mr. L.A. Tapp, Ministry of Transport, Aircraft Accident Investigation Division
Member	Mr. M. Fellows, Air Canada

(Assistance was provided by Constable B. Shipley and other members of the Ontario Provincial Police.)

Schedule 1 of Appendix "D"

		Specialty
Records and Documents Group		
Chairman	Mr. A. Huneault, Ministry of Transport	Airworthiness
Member	Mr. John Berth-Jones, Air Canada	Maintenance
Human Factors Group		
Chairman	Dr. F.O. Hemming, Department of National Health & Welfare	
Dep Chairman	Dr. A.R. Kempton, Regional Medical Officer, Department of National Health & Welfare, Toronto	
Member	Lt-Col. I.H. Anderson, Canadian Forces Institute of Environmental Medicine (CFIEM), Toronto	
Adviser	Col. W.R. Franks, CFIEM, Toronto	
Adviser	Lt-Col. W.J. Stevenson, CFIEM, Toronto	
Adviser	Major C.A. Burden, CFIEM, Toronto	
Adviser	Major L.N. Howlett, CFIEM, Toronto	

This is Schedule 2
of Appendix "D"

AERONAUTICS ACT

Flight Data Recorder Order

AIR NAVIGATION ORDER, SERIES II, NO. 13

The Minister of Transport, pursuant to the *Aeronautics Act* and the Air Regulations, is pleased hereby to revoke the Flight Data Recorder Order (Air Navigation Order, Series II, No. 13) made July 4, 1968 and to make the annexed Flight Data Recorder Order (Air Navigation Order, Series II, No. 13) in substitution therefor.

Dated at Ottawa, this 24th day of April, 1969.

PAUL T. HELLYER,
Minister of Transport.

AIR NAVIGATION ORDER, SERIES II, NO. 13

Flight Data Recorder Order

1. This Order may be cited as the *Flight Data Recorder Order*.

2. In this Order,

(a) "cockpit voice recorder" means a system of cockpit voice recording equipment that has been approved by the Minister; and

(b) "flight data recorder" means a system of flight data recording equipment that complies with the requirements set forth in the Schedule.

3. Subject to sections 6 and 7, no person shall operate a turbine-engine powered pressurized aeroplane that

(a) has a maximum certificated take-off weight of more than 12,500 pounds, and

(b) is registered as a commercial aircraft under Part II of the *Air Regulations*,

unless that aeroplane is equipped with a serviceable and functioning flight data recorder.

4. The installation, accuracy, systems correlation, survivability and retention of recorded intelligence and calibration check results of a flight data recorder shall be in accordance with requirements set forth in the *Engineering and Inspection Manual* published under the authority of the Minister.

5. If the operator of an aeroplane becomes aware of a hazard or potential hazard to flight safety resulting from improper operation or functioning of the aeroplane, near collision or abnormal meteorological conditions, the operator shall submit to the Director, Civil Aviation such information as has been recorded by the flight data recorder relating to the hazard or potential hazard and a report from the pilot-in-command relating to the circumstances of the hazard or potential hazard.

6. Where a flight data recorder becomes inoperative but the cockpit voice recorder is serviceable and functioning, an aeroplane may be flown on such flights as are necessary to complete a planned itinerary to a maintenance base.

7. (1) An aeroplane in which both the flight data recorder and cockpit voice recorder are inoperative shall not commence a flight unless authorized to do so by the Minister.

(2) Where a flight is authorized under subsection (1), the operator of the aeroplane shall make and retain a report of the circumstances relating to the authorization for a period of six months from the date of the authorization.

8. This Order applies to

(a) turbo-jet powered pressurized aeroplanes commencing May 1, 1969; and

(b) turbo-prop powered pressurized aeroplanes commencing January 1, 1970.

SCHEDULE

1. Each flight data recorder shall record at least the following parameters:

(a) time;

(b) pressure altitude;

(c) indicated airspeed;

(d) vertical acceleration; and

(e) magnetic heading.

2. Where an aeroplane is designated by an air carrier for the carriage of passengers, its flight data recorder, in addition to recording the parameters set forth in item 1, shall record:

(a) force applied to control column or control column position;

(b) force applied to rudder pedals or rudder pedal position;

(c) force applied to control wheel or control wheel position;

(d) position of horizontal stabilizer;

(e) out-of-trim condition;

(f) auto-pilot "on" - "off" selection;

(g) engine power including

(i) engine torque,

(ii) engine RPM, and

(iii) fuel flow;

(h) ambient air temperature; and

(i) pitch attitude.

Schedule 2 of Appendix "D"

AERONAUTICS ACT

Cockpit Voice Recorder Order

AIR NAVIGATION ORDER, SERIES II, NO. 14

The Minister of Transport, pursuant to the *Aeronautics Act* and the Air Regulations, is pleased hereby to revoke the Cockpit Voice Recorder Order (Air Navigation Order, Series II, No. 14) made July 4, 1968, and to make the annexed Cockpit Voice Recorder Order (Air Navigation Order, Series II, No. 14) in substitution therefor.

Dated at Ottawa, this 24th day of April 1969.

PAUL T. HELLYER,
Minister of Transport.

AIR NAVIGATION ORDER, SERIES II, NO. 14

Cockpit Voice Recorder Order

1. This Order may be cited as the *Cockpit Voice Recorder Order*.

2. In this Order

(a) "cockpit voice recorder" means a system of cockpit voice recording equipment that has been approved by the Minister; and

(b) "flight data recorder" has the meaning assigned to it in the *Flight Data Recorder Order*.

3. Subject to sections 6 and 7, no person shall operate a turbine-engine powered pressurized aeroplane that

(a) has a maximum certificated take-off weight of more than 12,500 pounds, and

(b) is registered as a commercial aircraft under Part II of the *Air Regulations*,

unless that aeroplane is equipped with a serviceable and functioning cockpit voice recorder.

4. Except as may be necessary to comply with the requirements of section 5 in respect of the preservation of recorded data, a cockpit voice recorder shall be operated continuously from the start of the use of the checklist before starting the engines of the aeroplane for the purpose of a flight to completion of the final checklist at the termination of the flight.

5. If the operator of an aeroplane becomes aware of a hazard or potential hazard to flight safety resulting from improper operation or functioning of the aeroplane, near collisions or abnormal meteorological conditions, the operator shall investigate and submit to the Director, Civil Aviation such information as has been recorded by the cockpit voice recorder relating to the hazard or potential hazard and a report from the pilot-in-command relating to the circumstances of the hazard or potential hazard.

6. Where a cockpit voice recorder becomes inoperative but the flight data recorder is serviceable and functioning, an aeroplane may be flown on such flights as are necessary to complete a planned itinerary to a maintenance base.

7. (1) An aeroplane in which both the cockpit voice recorder and flight data recorder are inoperative shall not commence a flight unless authorized to do so by the Minister.

(2) Where a flight is authorized under subsection (1) the operator of the aeroplane shall make and retain a report of the circumstances relating to the authorization for a period of six months from the date of the authorization.

8. This Order applies to

(a) turbo-jet powered pressurized aeroplanes commencing May 1, 1969; and

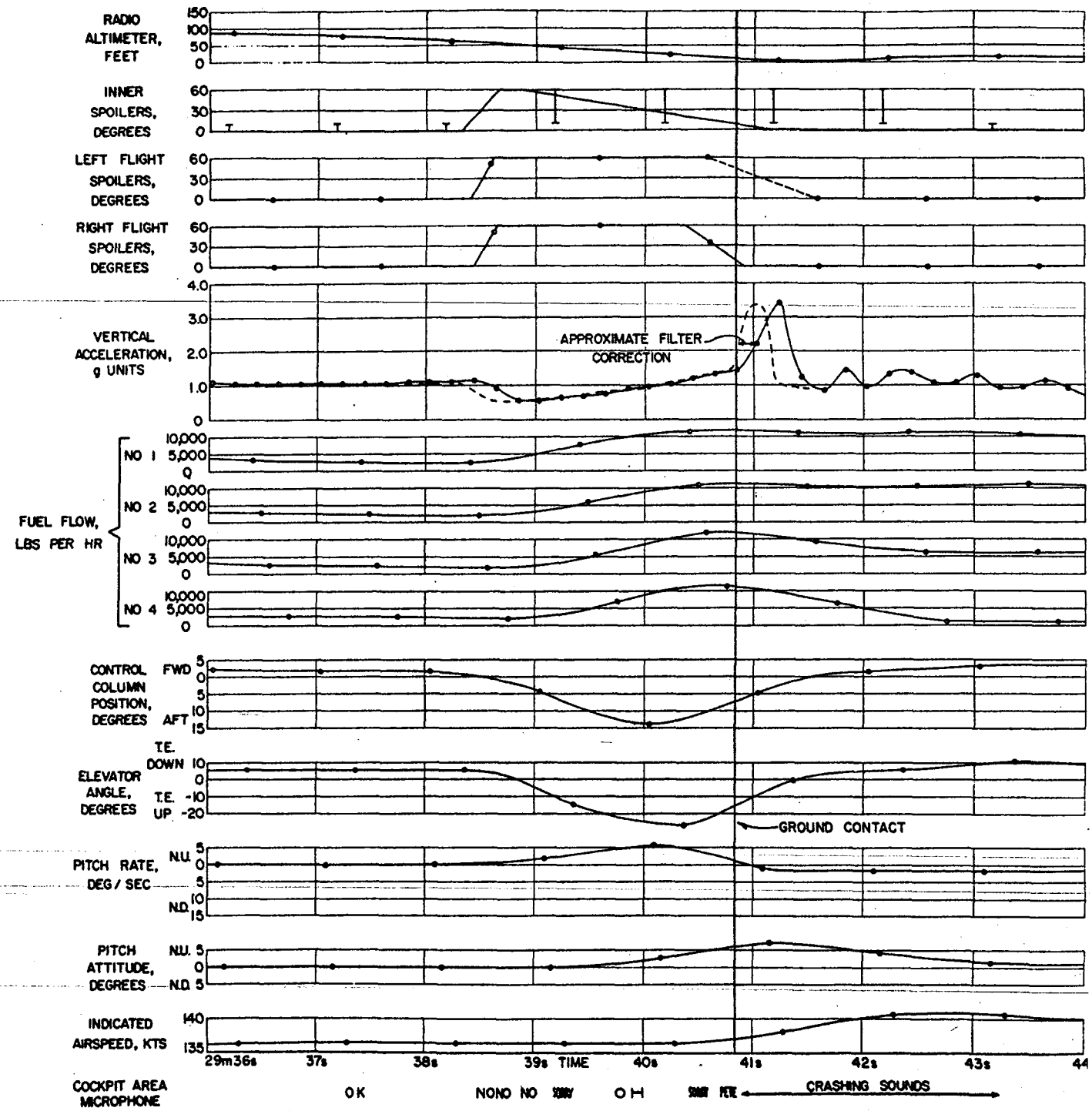
(b) turbo-prop powered pressurized aeroplanes commencing January 1, 1970.

PARAMETERS BEING MONITORED ON DCS-63, CF-TIW, FLIGHT RECORDER

	Number of Parameters	Mean Time Between Samples, Sec.
Measured Parameters		
Time	1	-
Pressure altitude, coarse and fine	2	1
Indicated airspeed, coarse and fine	2	1
Magnetic heading, coarse and fine	2	1
Vertical acceleration	1	0.2
Pitch and roll attitudes	2	1
Pitch, roll, yaw rates	3	1
Engine low pressure spool RPM, N_1	4	2
Engine high pressure spool RPM, N_2	4	2
Engine fuel flow	4	1
Control column position	1	1
Elevator angle, coarse and fine	2	1
Radio altimeter	1	1
ILS glideslope and localizer deviations	2	1
Left and right wing flap positions	2	2
Left and right flight spoiler positions	2	1
Ram air temperature	1	1
Aileron and rudder system hydraulic pressures	2	2
Brake hydraulic pressure	1	2
Cabin pressure	1	1
A.C. Bus voltage - A and C phases	2	2
D.C. Bus voltage	1	2
Left and right instrument transformer volts	2	1
TOTAL	49	
ON-OFF Parameters		
Reverse thrust selection	4	0.33
Engine fire warning	4	1
Engine fire action	4	1
Undercarriage safe-down, left, right, nose	3	1
Main undercarriage unsafe	1	1
Ground spoiler	1	1
Autopilot mode	1	1
Yaw damper actuator	1	1
Pitch trim compensator actuator extension	1	1
Engine anti-ice, inboard and outboard	2	1
Scoop and radome anti-ice	1	1
Heading mode. Magnetic or free gyro	1	1
TOTAL	24	

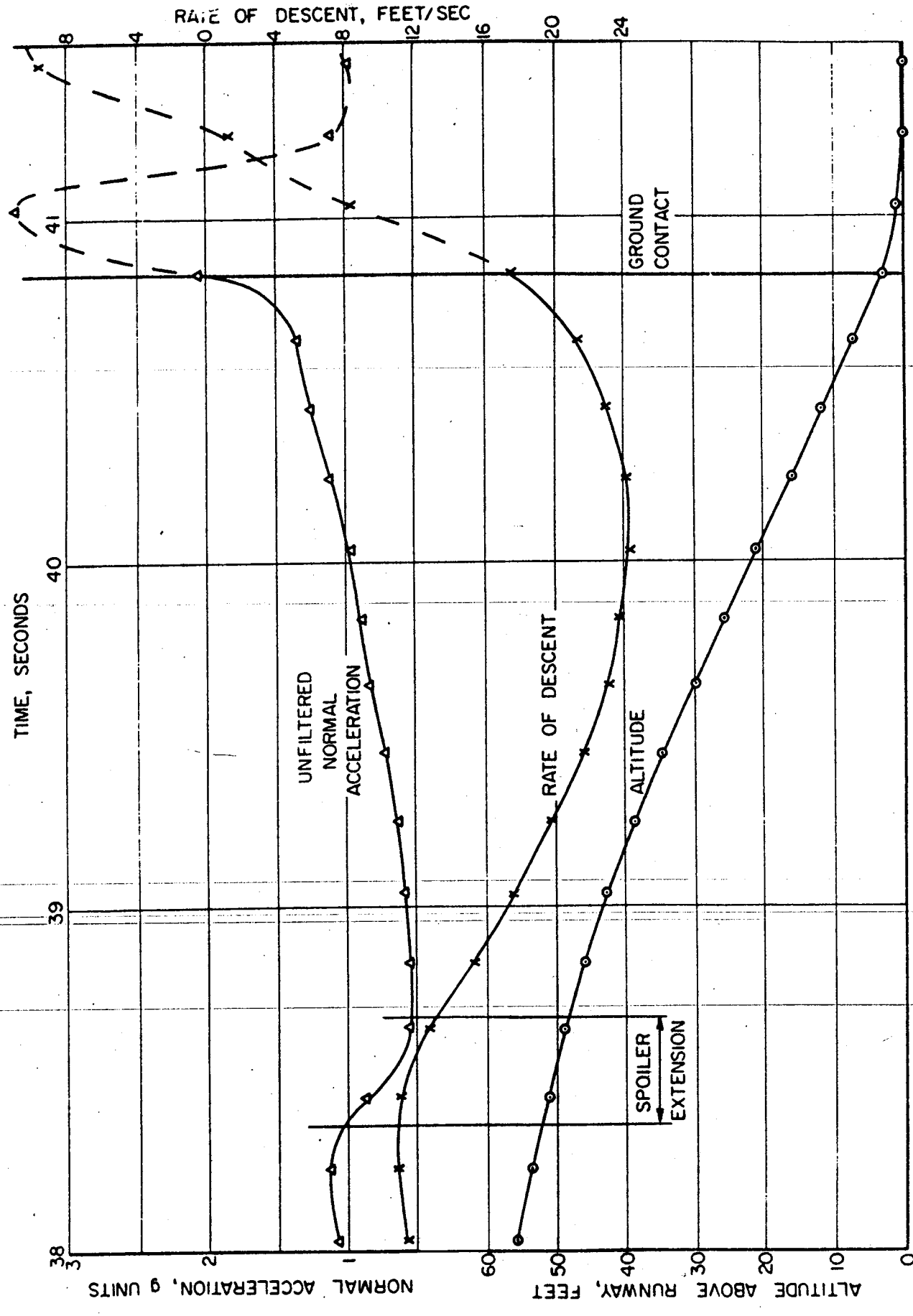
NOTE: Control wheel, rudder pedal, and horizontal stabilizer position parameters were not operative on CF-TIW at the time of the accident. However, these do not appear to be critical parameters in this particular accident.

SCHEDULE 4 OF APPENDIX D



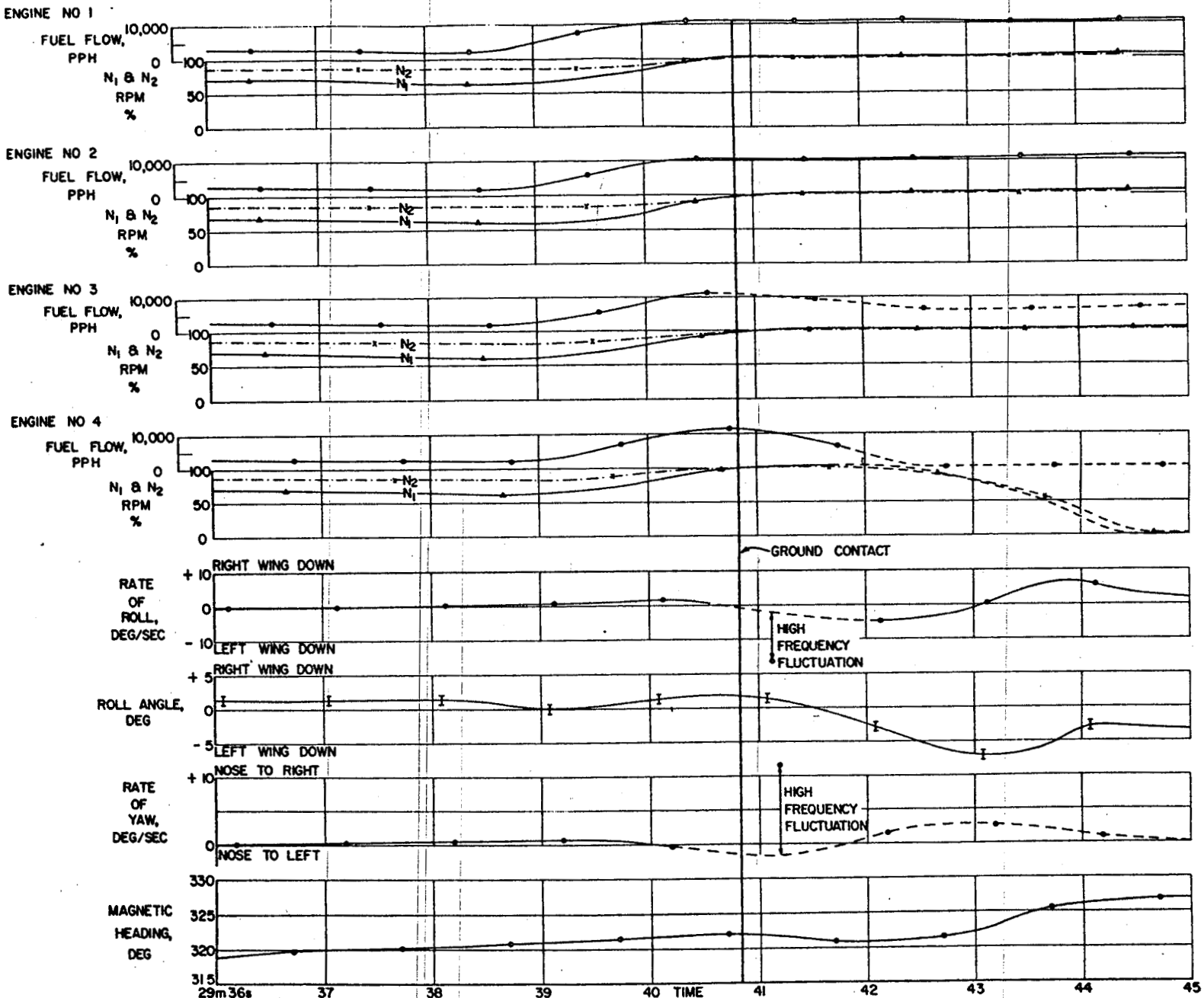
VARIATION OF CRITICAL PARAMETERS DURING SPOILER DEPLOYMENT AND TOUCHDOWN WITH SYNCHRONIZED VOICE INFORMATION

SCHEDULE 5 OF APPENDIX D



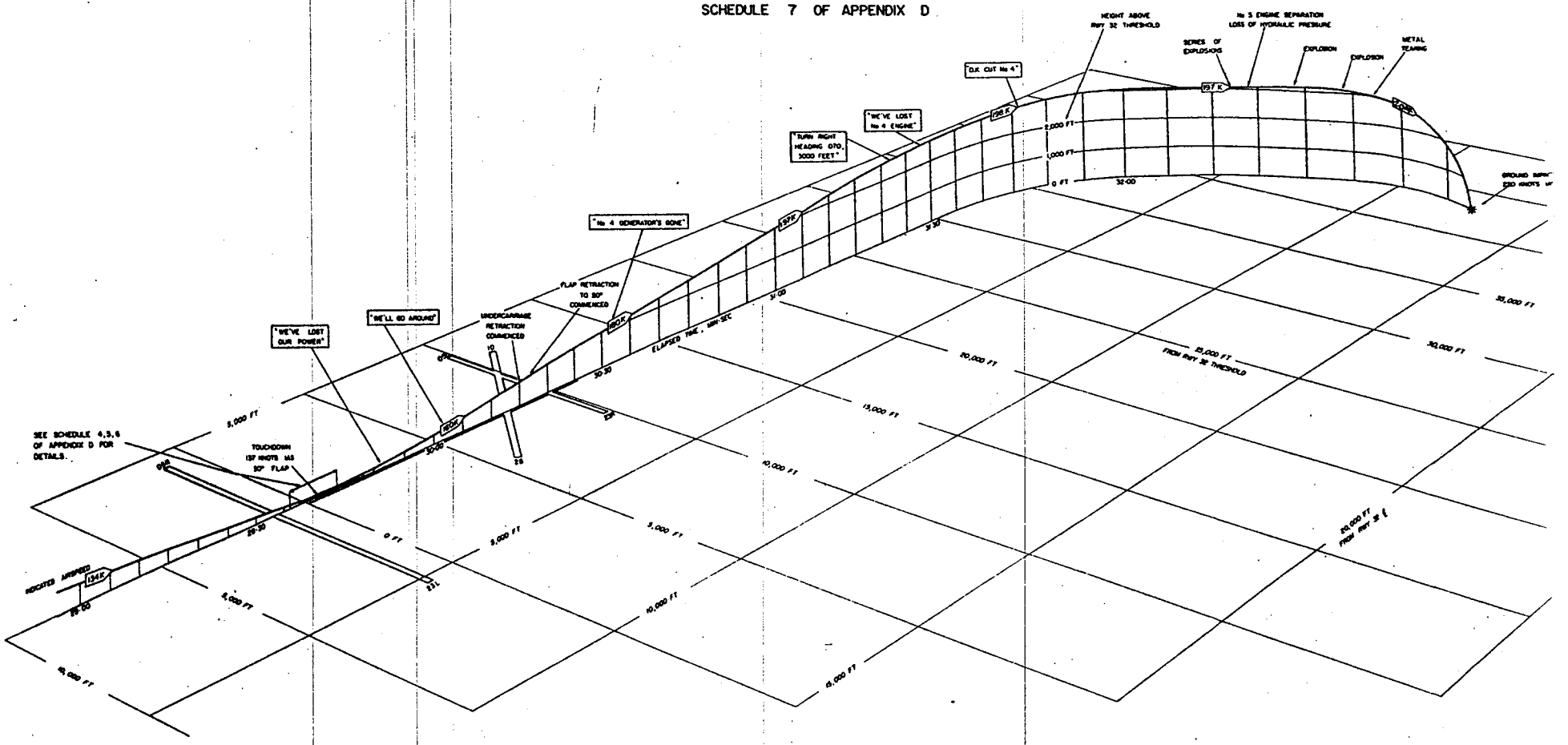
DETERMINATION OF RATE OF DESCENT AT TOUCHDOWN

SCHEDULE 6 OF APPENDIX D



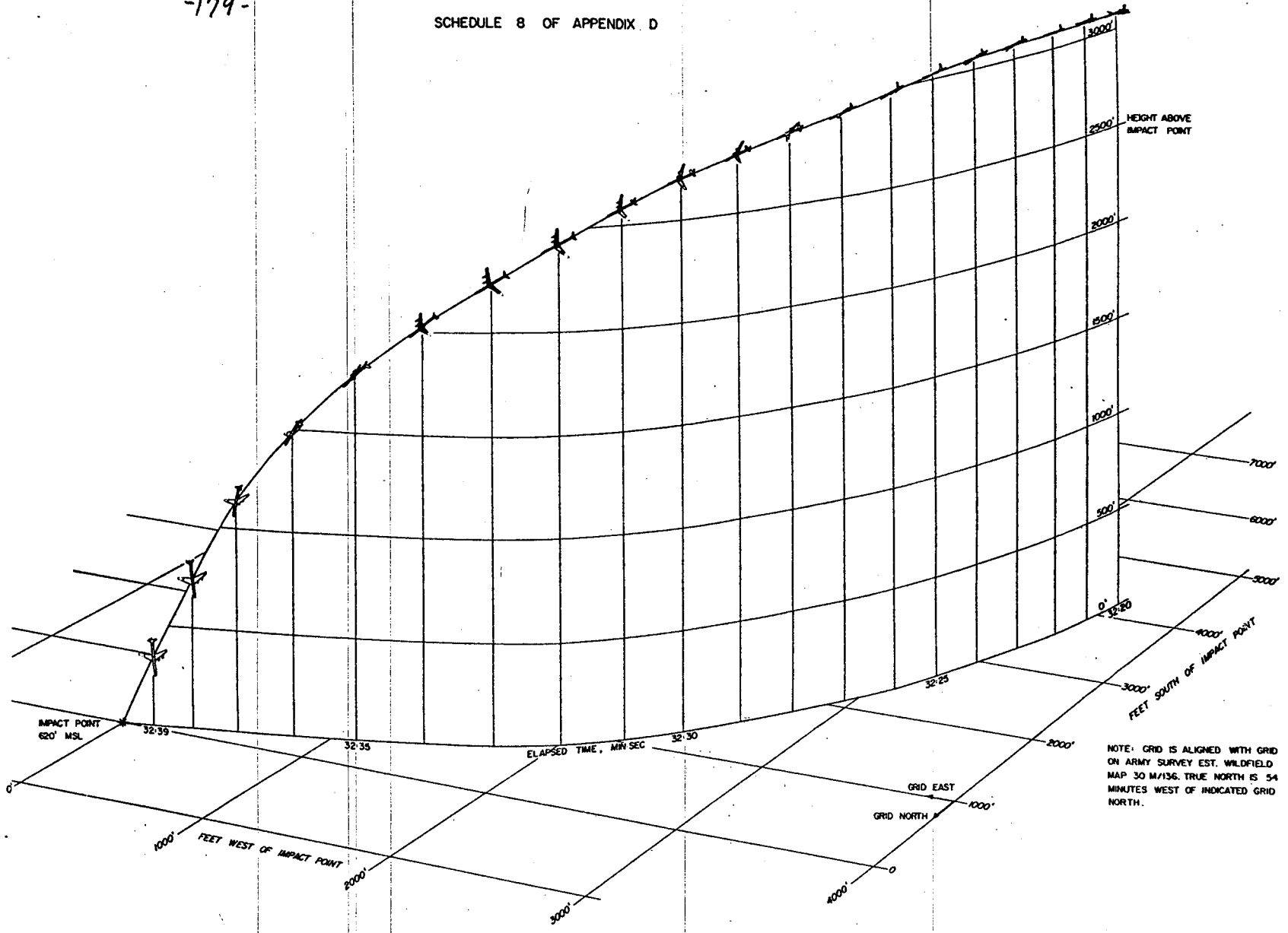
ENGINE, ROLL, AND YAW DATA DURING SPOILER DEPLOYMENT AND TOUCHDOWN

SCHEDULE 7 OF APPENDIX D



RECONSTRUCTION OF CF-TIW FLIGHT PATH AND EVENTS FROM THE FLIGHT RECORDER

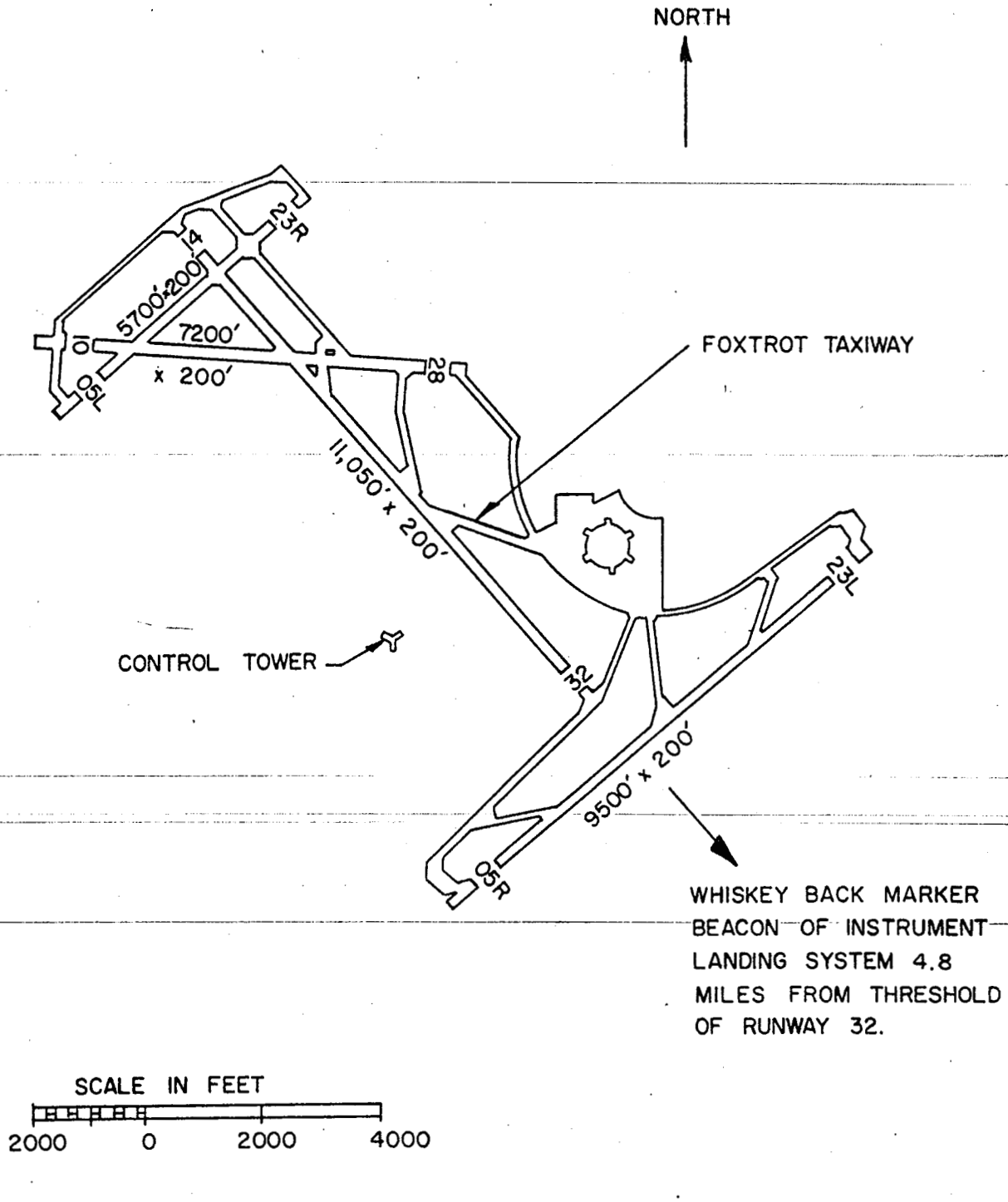
SCHEDULE 8 OF APPENDIX D



RECONSTRUCTION OF CF-TIW MOTION IN THE LAST 19 SECONDS BEFORE IMPACT

SCHEDULE 9 OF APPENDIX D

DRAWING OF THE RUNWAYS AT TORONTO INTERNATIONAL AIRPORT INCLUDING THE WHISKEY BEACON



This is Schedule 10
of Appendix "D"

AIR CANADA DATA

Air Canada accepted the aircraft on April 30, 1970, with a total time on receipt of 7:00 hours.

Line check #1 (11:37 hours) was carried out and completed on May 19, 1970 for the acceptance check. The acceptance check, Air Canada pre-service modifications, FDVR system installation and line check #1, job tickets and check with additional work sheets were reviewed with no significant event of failure evident. The files containing job tickets, check and additional work sheets on the following subsequent line checks were screened thoroughly with no significant event or failure evident:

Line check #2 (136:30 hrs) dated June 3, 1970;
Line check #3 (250:05 hrs) dated June 14, 1970;
Line check #4 (370:05 hrs) dated June 27, 1970.

The flight time since the last line check was 83 hours (approx.); at the time of the accident, the total was 453:00 hours.

The modification status of the installed powerplants was established by reviewing the following documents for each powerplant:

(a) P. & W. final acceptance test log sheet;
(b) Douglas engine historical record card;
(c) Air Canada pre-service modifications list;
(d) Air Canada engine section inspection record sheets.

The modification status of McDonell Douglas DC8-63 #878, CF-TIW, aircraft was established by reviewing the following documents, with no sifnificant event of failure evident:

(a) Pre-service modifications;
(b) Flight data voice recorder system installation, E.O. 8-130 dated May 19, 1970, job tickets and additional work sheets;

(c) Listing of installed units as per Air Canada DC8 serial sheets numbering system.

There was no deviation from Air Canada DC8 Maintenance Manual approved schedules.

There were no deferred flight snags from the journey log sheets at the time of the accident. All flight snags were corrected and certified in accordance with Air Canada DC8 Maintenance Manual. The flight crew snags related to the spoiler system were:

Snag #32 - May 27, 1970. Spoiler extend light on continuously. Light was on before start-up - maintenance checked operation of spoilers and light went out when lever disarmed. Light came back on during flight. No wing heaviness observed.
Correction: Microswitch changed.

Snag #48 - May 31, 1970. Main gear spoiler inoperative light "ON" - worked OK on landing.
Correction: Anti-skid box changed.

Snag #74 - May 31, 1970. Spoiler extend light on at ramp with spoiler lever in retract position (light went out momentarily when spoiler lever placed in retract position - and came back on again).
Note: (YZ-UL - spoiler light on - spoiler operation normal during landing) light went on at the ramp when the spoilers retracted.
Correction: Spoiler operation normal indication only. Deferred, OK to proceed. Spoiler operation inspected. (Dual inspection) 20:45 YZ 8/6/70.
Correction - 9/6/70
R/H spoiler limit switch changed - operation OK. OK layover check completed.
Dual Inspection Stamp
Spoiler controls - dual inspection verified.

Schedule 10 of Appendix "D"

The P. & W. JT3D-7 engines on the aircraft on July 5, 1970, are the same model and serial numbers and positions as shown on the Certificate of Airworthiness for Export #E98527 dated April 29, 1970:

Engines Installed as of 5/7/70

Pos	Manufacturer's Number	Total Time
1	P671408DSLG	453:
2	P671410DSLG	453:
3	P671411DSLG	453:
4	P671412DSLG	453:

The files for each of the powerplants were reviewed as follows:

(a) P. & W. final acceptance test log sheet;

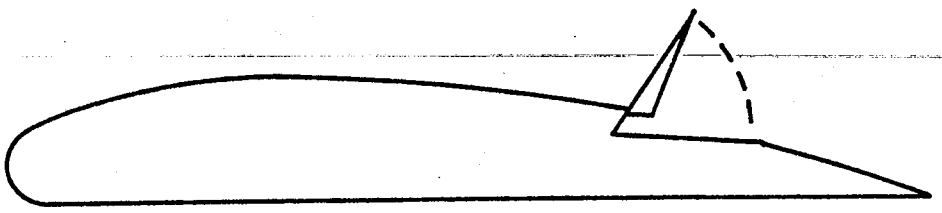
(b) Douglas engine history record card;

(c) Air Canada pre-service modification list;

(d) Air Canada engine section inspection report sheets. (Appendix "B" - Sheets 13 to 16 list the installed units as per Air Canada DC8 serial numbering system: four ancillary components only were exchanged with serviceable units).

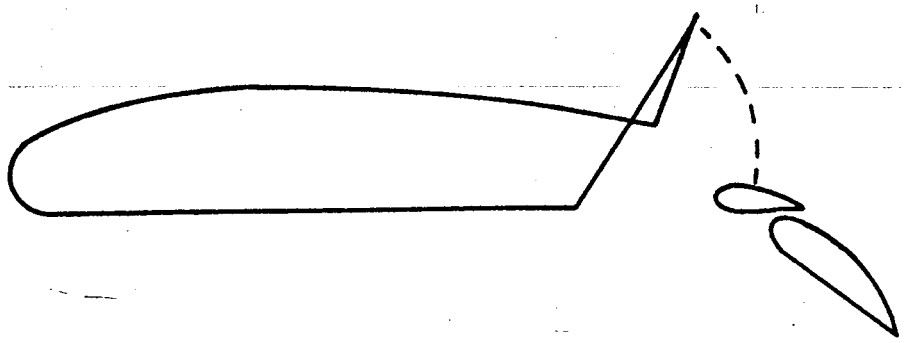
The approved check/overhaul times applicable to each powerplant and related components were verified with no deviation from the approved procedures and inspection schedules of the operator.

SCHEDULE II OF APPENDIX D
SPOILER SECTION SCHEMATIC



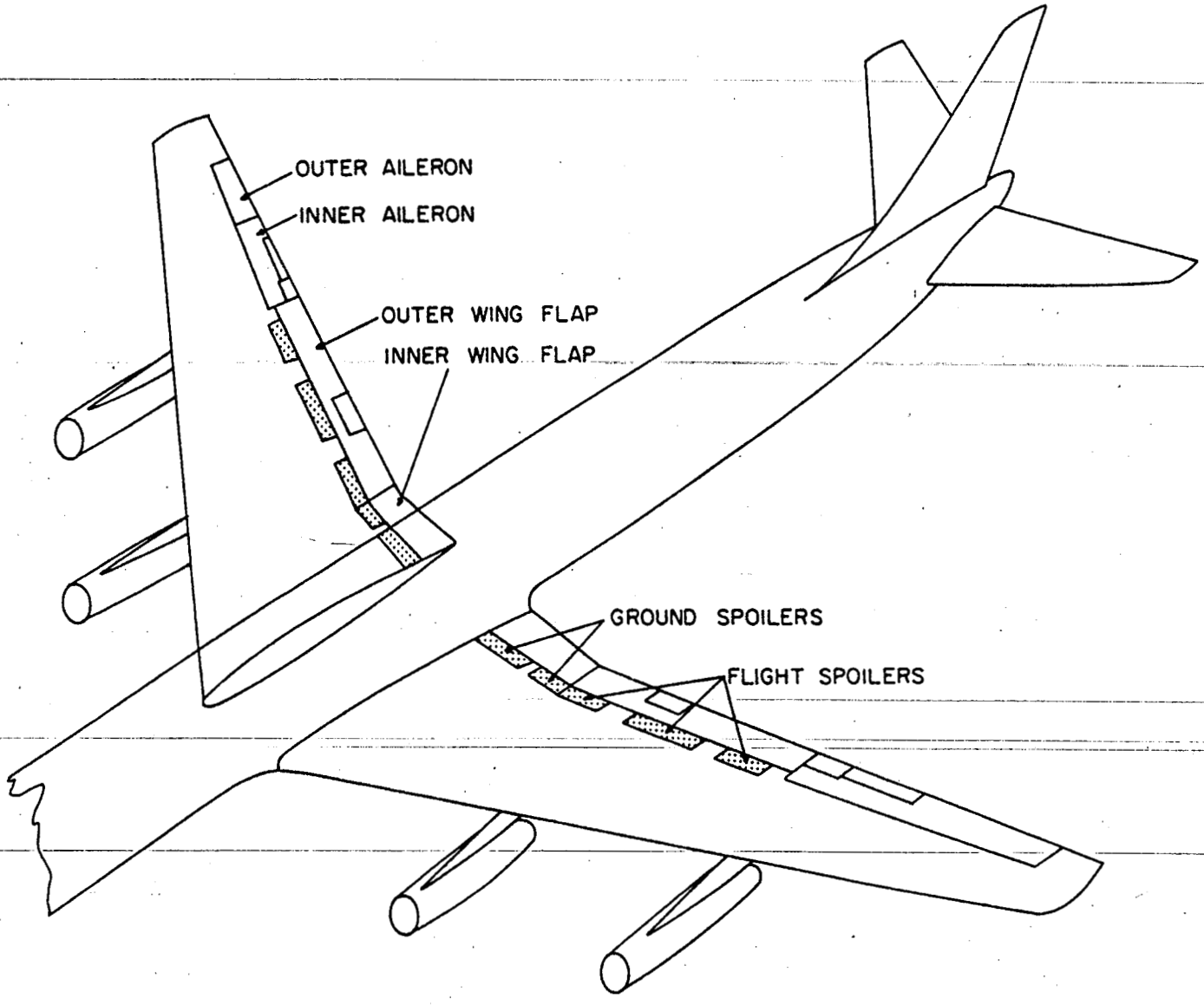
SIMPLE DRAG SPOILER

SCHEDULE 12 OF APPENDIX D
SPOILER SECTION SCHEMATIC



LIFT REDUCING SPOILER

SCHEDULE 13 OF APPENDIX D
DC-8-63 FLIGHT & GROUND SPOILER CONTROL SURFACES



SCHEDULE 14 OF APPENDIX D

SKETCH OF DETAILS OF PYLON TO WING ATTACHMENT FITTINGS

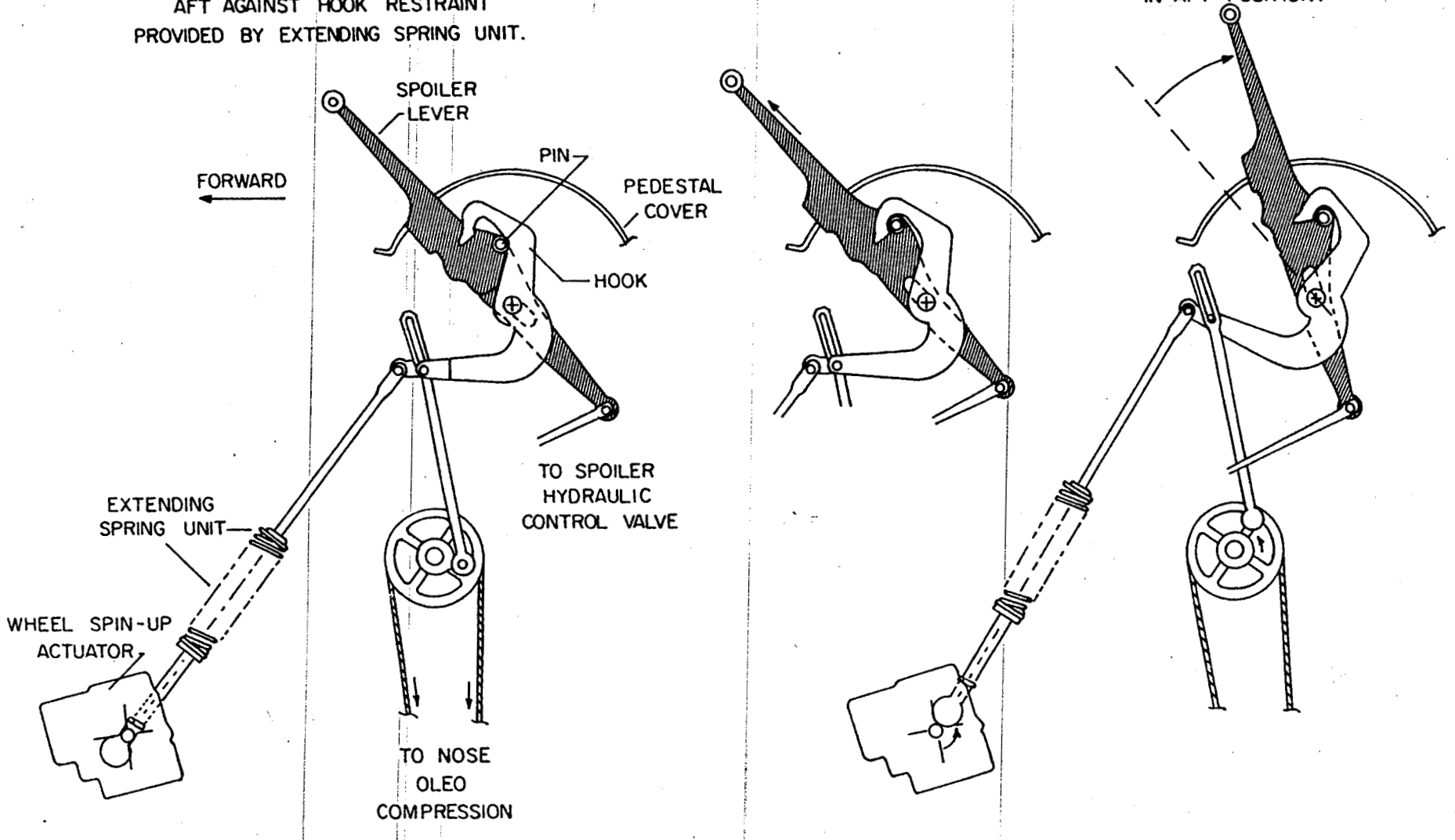
NORMAL CONFIGURATION IN FLIGHT BEFORE ARMING. SPOILERS RETRACTED

NOTE: MANUAL EXTENSION POSSIBLE WITH GEAR DOWN IF LEVER PULLED AFT AGAINST HOOK RESTRAINT PROVIDED BY EXTENDING SPRING UNIT.

NORMAL CONFIGURATION ON APPROACH. SPOILER LEVER ARMED TO ENGAGE PIN IN HOOK.

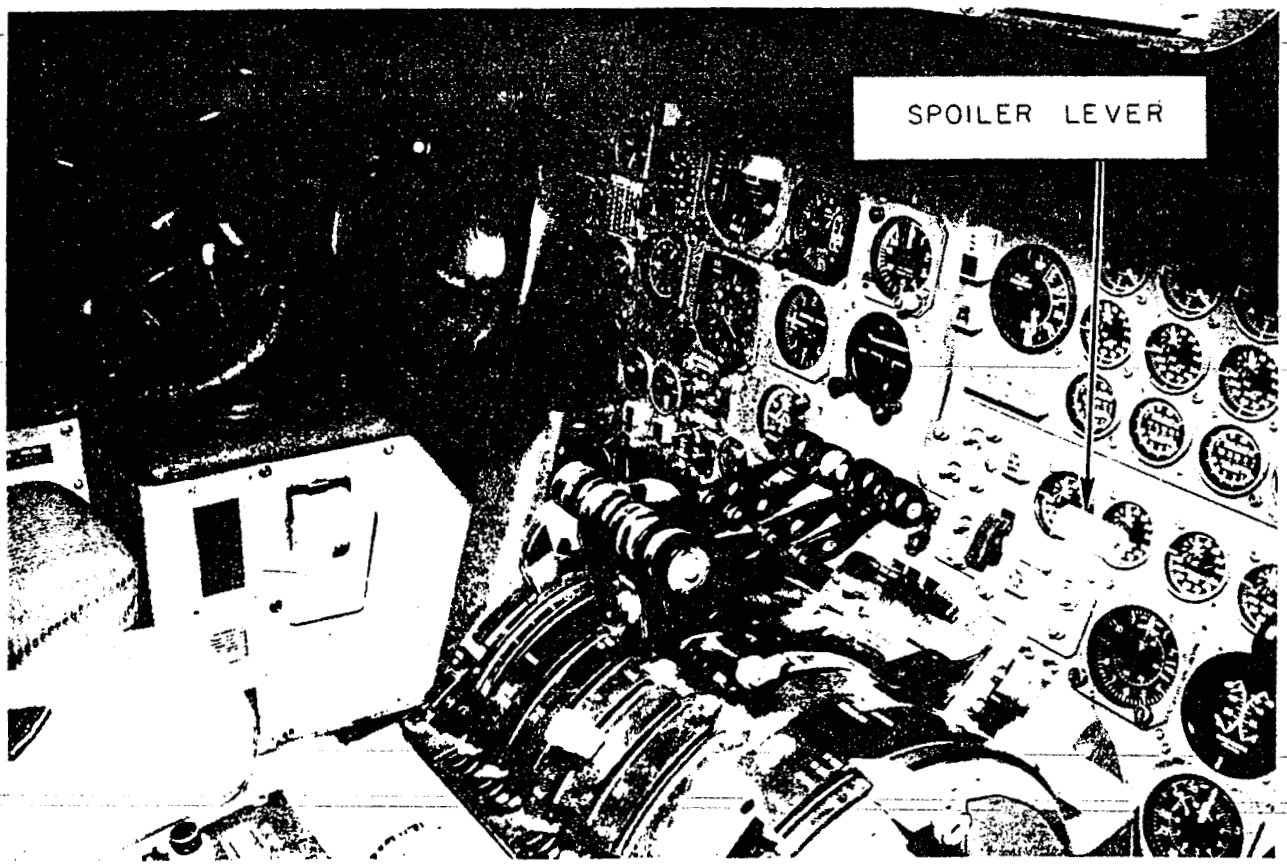
NORMAL CONFIGURATION AFTER TOUCHDOWN. SPOILERS EXTENDED BY AUTOMATIC ACTUATION

HOOK AND LEVER IN AFT POSITION.



SCHEDULE 15 OF APPENDIX D

PHOTOGRAPH OF PEDESTAL IN DC-8-63 SHOWING GROUND SPOILER LEVER



This is Schedule 16
of Appendix "D"

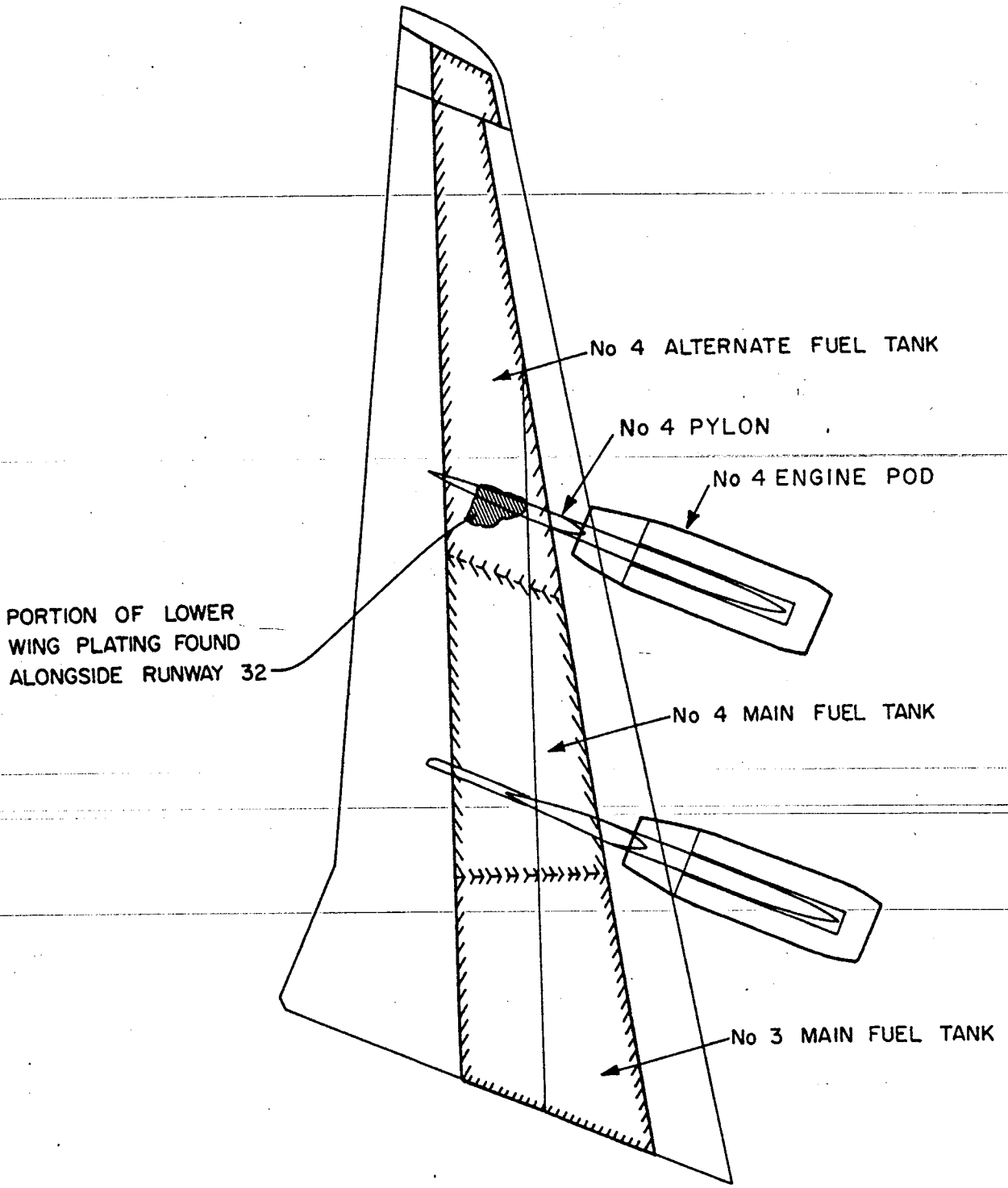
MAINTENANCE ENGINEERING MEMORANDUM

OPERATION	DC8-40	DC8-50, 60
Operation of spoiler hydraulic system.	Main landing gear must be down to energize motor-pump assembly.	Same
Arming before take off or anytime on the ground.	Not possible. Although lever can be pulled up and will stay in the "armed" position, it is not connected to the crank of the automatic system.	Not possible. Lever cannot be pulled up in the "armed" position because of the shape and location of the crank.
Arming before landing.	Possible. Pull spoiler lever up until it stays in the armed position.	Same
Automatic extension after landing, if lever is armed before landing will result from:	Compression of the nose landing gear. The nose gear ground shift mechanism will rotate the crank and the lever.	1. Wheel spin up, which gives a signal to an electric actuator connected to the crank. 2. Compression of the nose landing gear the same way as for the DC8-40 to act as a back-up system.
Manual extension after landing or anytime on the ground.	Lever must be pulled back with a force of 12 lb. and can then be locked by pulling it up. If not locked, lever will spring forward.	Same.

OPERATION	DC8-40	DC8-50, 60
Spoiler retraction in case of go-around after landing	Lever must be disarmed manually by knocking it down, after which the lever will spring forward to the retract position.	Disarming of the spoiler lever is automatic when the #4 throttle lever is pushed forward. Manual disarming is also possible the same way as for the DC8-40.
Spoiler extension in case of aborted take off.	Lever must be pulled back manually with a force of 12 lb. and can then be locked by pulling it up, provided the nose landing gear is compressed. If gear is not compressed, a pull of 70 to 90 lb. is required, and locking is not possible.	Lever must be pulled back manually with a force of 12 lb and can then be locked by pulling it up, regardless of the position of the nose gear.
Manual operation in flight.	Spoiler lever can be pulled. A pull of 70 to 90 lb. is required. Pulling force will be slightly less if lever is armed prior to pulling.	Spoiler lever can be pulled. A pull of 35 to 40 lb. is required. Pulling force will be slightly less if lever is armed prior to pulling.
Lever travel on pedestal from retract position to position where extension commences, as indicated by the blue indicating light.	Between $1\frac{1}{4}$" to $1\frac{1}{2}$" measured on the pedestal cover.	Same.
Ground Spoiler blue indicating light.	Light comes on as soon as the L.H. or R.H. ground spoilers are just off their retract position. Light is located on the center instrument panel.	Same.

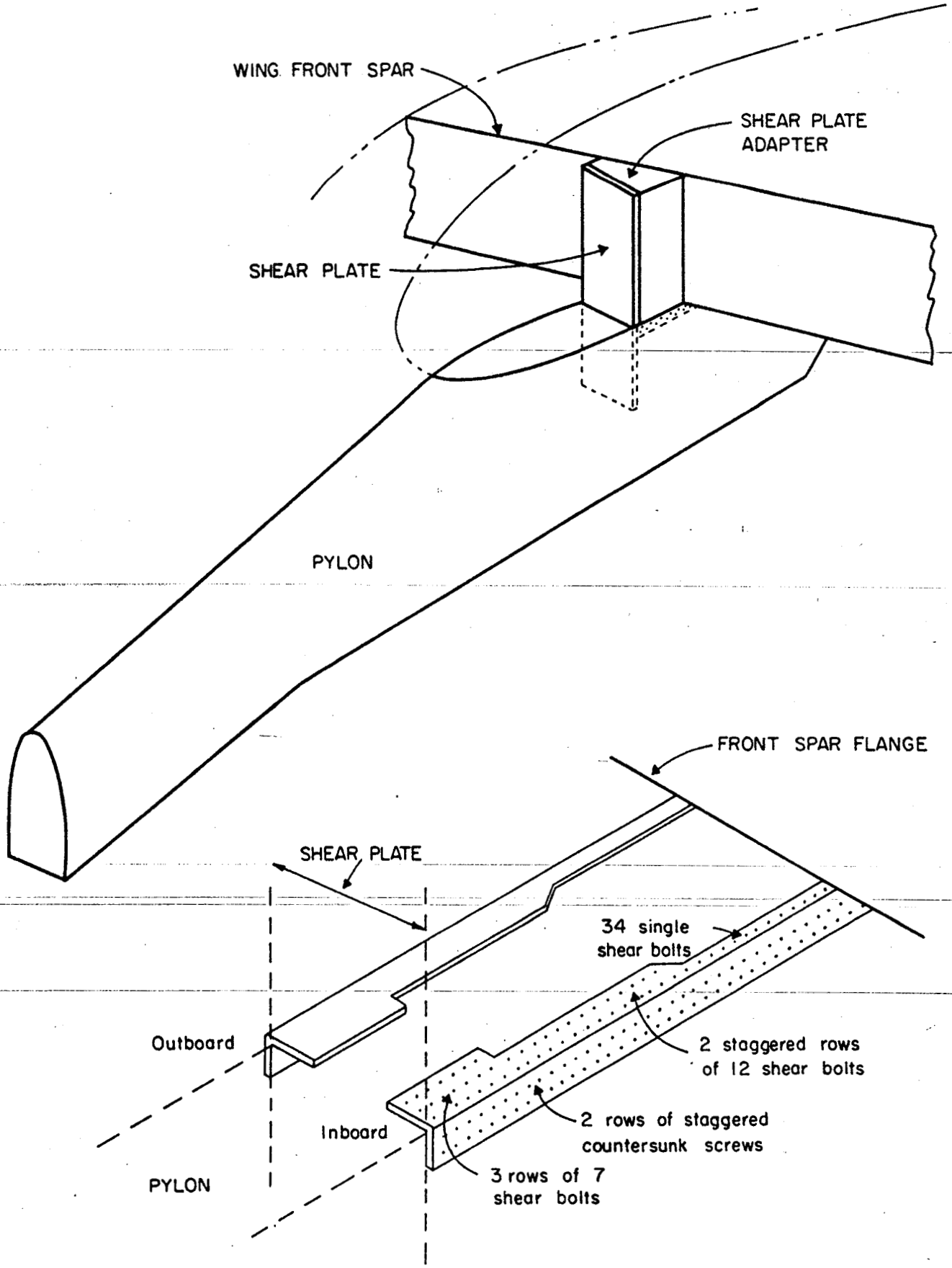
SCHEDULE 17 OF APPENDIX D

EXTRACT FROM ENQUIRY EXHIBIT 28 SHOWING PORTION OF LOWER RIGHT WING PLATING OF CF-TIW WHICH FAILED AT THE PYLON ATTACHMENT



SCHEDULE 18 OF APPENDIX D

SKETCH OF DETAILS OF PYLON TO WING ATTACHMENT FITTINGS



ENLARGEMENT OF AREA UNDER SHEAR PLATE ADAPTER

This is Schedule 19
of Appendix "D"

CREW INFORMATION

CAPTAIN PETER CAMERON HAMILTON

Captain Hamilton, age 50, occupied the left pilot seat. He held valid Canadian Airline Transport Licence #AT-180 endorsed for the following aircraft: North Star, Super Constellation, Vanguard, Viscount and Douglas DC8.

He was employed by Air Canada on January 4, 1946, and promoted to Captain on October 26, 1951. His flying time previous to being employed by Air Canada was 2000 hours and 15 minutes, accumulated in the RCAF during World War II. His total Air Canada flying time is 18,990 hours and 33 minutes including 2,899 hours and 35 minutes on DC8 type aircraft, 197 hours and 01 minutes being on the DC8-63, the accident series.

His total DC8 flying time in the previous 90 days, April 11 to July 5, was 170 hours and 36 minutes including 56 hours 57 minutes on the DC8-63 series aircraft. His total DC8 flying time in the previous 30 days, June 7 to July 5, was 74 hours and 18 minutes including 9 hours and 51 minutes on the DC8-63 series aircraft.

His total DC8 flying time in the previous 7 days, June 29 to July 5, was 16 hours and 59 minutes including 9 hours and 58 minutes on the DC8-63 series aircraft. His last Class I IFR check was on May 19, 1970, valid until December 1, 1970. His

last en-route flight check was on March 3, 1970, during which he was checked through Toronto.

Last examined January 26, 1970. Holder of an Airline Transport Licence #AT-180 valid to August 8, 1970. Passed ECG July 31, 1969 and valid until July 31, 1971. Physical profile: 1 1GA 1 1, indicating that his licence is valid only when the required glasses are available; these are for near vision.

Captain Hamilton had a small stomach ulcer in 1959, but has had no trouble since then. Following medical examinations in 1969, Captain Hamilton was found to be symptom free of stomach irritability noted in a previous medical examination.

He was off duty for a total of four days plus 5 hours and 15 minutes prior to the accident flight. His total duty time on the accident flight was approximately 2 hours. His off duty activities during the 48 hours prior to the accident consisted mainly of relaxing. He visited friends on Friday night and returned home at approximately 1:00 A.M.

Saturday was spent at home due to inclement weather. In the evening he read a book and retired at 11:00 P.M. falling asleep at once. When awakened at 5:15, two hours prior to flight departure, he remarked that he had slept well. There is no indication of involvement with either medication or drugs.

Schedule 19 of Appendix "D"

FIRST OFFICER DONALD ROWLAND

First Officer Rowland, age 40, occupied the right pilot seat. He held valid Canadian Transport Licence #VRA-800, endorsed for the following aircraft: Douglas DC3 and DC8.

He was employed by Air Canada on October 15, 1957. His flying time previous to being employed by Air Canada was 2219 hours and 50 minutes accumulated in the RAF between August 1949 and August 1957. His total Air Canada flying time is 7103 hours and 43 minutes including 5626 hours and 27 minutes on DC8 aircraft, 115 hours and 24 minutes being on the DC8-63, the accident series. His total DC8 flying time in the previous 90 days, April 7 to July 5, was 196 hours and 38 minutes including 61 hours and 51 minutes on the DC8-63 series aircraft.

His total DC8 flying time in the previous 30 days, June 7 to July 5, was 30 hours and 14 minutes, including 8 hours and 7 minutes on the DC8-63 series aircraft. In the previous 7 days his total DC8 flying time was 52 minutes, all on the DC8-63 series aircraft.

His last Class I IFR check was on May 19, 1970, valid until December 1, 1970. His last en-route flight check was on August 20, 1969.

Last examined January 26, 1970. Holder of an Airline Transport Licence valid to July 28, 1970. Physical profile:

1 1 1 1. Passed ECG September 30, 1968.

First Officer Rowland's medical history is normal and he has remained fit for his licence.

Mr. and Mrs. Rowland had just returned from a holiday in the United Kingdom. He remarked that he felt well rested. The day before the flight was normal and uneventful.

His off duty activities during the 48 hours prior to the accident consisted of gardening, grass cutting and other week-end household chores. Saturday night he and his wife entertained another couple at home with cocktails and dinner; the guests left early.

He retired at 11:00 P.M., slept normally until awakened at 4:45 A.M., two hours and thirty minutes prior to flight departure. There is no indication of involvement with either medication or drugs.

SECOND OFFICER H. GORDON HILL

Second Officer Hill, age 28, occupied the second officer's seat. He held valid Canadian Commercial Licence #ULC-8165. He was employed by Air Canada on September 18, 1967. His flying time previous to being employed by Air Canada was 239 hours and 27 minutes, accumulated at a flying club between September 1965 and February 1967.

Schedule 19 of Appendix "D"

His total Air Canada flying time is 1045 hours, all on DC8 type aircraft; 122 hours and 34 minutes being on the DC8-63, the accident series. His total DC8 flying time in the previous 90 days, April 7 to July 5, was 55 hours and 43 minutes including 22 hours and 39 minutes on the DC8-63 series aircraft.

His total DC8 flying time in the previous 30 days, June 7 to July 5, was 10 hours and 01 minutes including 5 hours and 19 minutes on the DC8-63 series aircraft. His total DC8 flying time in the previous 7 days, June 29 to July 5, was 00 hours 52 minutes which was on the DC8-63 series aircraft.

His last Class II IFR check was on October 28, 1969, valid until November 1, 1970. His last en-route check was on October 8, 1969.

Last examined January 26, 1970. Holder of an Airline Transport Licence valid to February 27, 1971. Passed ECG March 13, 1967. Physical profile 1 1 1 1.

Second Officer Hill's medical history is completely negative.

His off duty activities during the 48 hours prior to the accident consisted of preparing his new home; there were no social activities during this period.

Saturday was spent carrying out normal household chores

and during the evening he updated his manual and charts preparing for his flight on Sunday morning. He retired at 10:30 P.M. and was awake shortly before 5:15 A.M. approximately two hours prior to flight departure. There is no indication of involvement with either medication or drugs.

Pilot's Training on the DC8

Captain Hamilton

Captain Hamilton attended an Air Canada DC8-40-50 ground school course in Montreal, from February 14 to March 9, 1966, which included the following:

Ground school	-	20 days
In-flight instruction	-	15:50 hours
In-flight simulation	-	32:00 hours
Line check-out	-	59:49 hours

Captain Hamilton attended a DC8-60 series ground school course in Montreal on July 26 and 27, 1967. His line check-out on DC8-61 aircraft was completed on Flight 803-14, October 1967, and his line check-out on DC8-63 aircraft was completed on Flight 621-2, April 1969.

Captain Hamilton's records indicate he successfully passed all conversion training courses and check flights. There was one en-route flight check dated April 17, 1968, that contained the remark: "Review proper method of arming and using spoilers".

As the meaning was not entirely clear, a statement was obtained from the supervisory pilot, J.W. Reid, who indicated the remarks stemmed from the fact that Captain Hamilton did not wish to arm the spoilers on the before-landing check but to extend them manually after touchdown. The required method of arming the spoilers at the proper time was reviewed by the check pilot.

First Officer Rowland

First Officer Rowland attended an Air Canada DC8 ground school course in Montreal on January 4, 1961. On completion of this course he flew as Second Officer until March 31, 1962, at which time he was laid off due to reduction of pilot staff. He was recalled effective April 15, 1964 and attended a DC8-40-50 Second Officer ground school course in Montreal from April 15 to May 14, 1964, which included:

Ground school	-	20 days
In-flight instruction	-	1:58 hours (right seat)
In-flight simulation	-	22:40 hours

First Officer Rowland was cleared as competent to act as Second Officer on DC8 aircraft effective June 1, 1964.

During the month of May 1966, First Officer Rowland completed a DC8 conversion course that would allow him to act as a First Officer on DC8 aircraft. The course consisted of the following:

In-flight instruction	-	5:51 hours
In-flight simulation	-	12:00 hours
Line check-out	-	30:15 hours

On May 30, 1966, First Officer Rowland was considered competent to act as First Officer on DC8 aircraft.

First Officer Rowland attended a DC8 ground school course in Montreal on July 4 and 5, 1967. An en-route check-out to determine the competency of DC8 First Officers was not a requirement on DC8-60 series aircraft.

At the completion of his initial course with Air Canada, there are comments from various instructors that "although he appears to be capable, his attitude and application is below standard". There was nothing significant until his conversion course on to DC8 aircraft in which the report that considers him competent to act as a Second Officer on the equipment indicates he learns procedures slowly and lacks confidence in his work. However, his knowledge was considered average and his attitude good. On June 1, 1964, a DC8 simulator check report indicated he was very slow to learn. This is again reported in the summary sheet for DC8 conversion training also dated June 1, 1964. On May 30, 1966, after completing thirty hours and fifteen minutes of line check-out, an en-route flight check report cleared him to act as a First Officer on DC8 equipment. He was considered to have reached a good Air Canada First Officer standard.

A letter dated September 19, 1967, indicates Rowland was considered to have satisfactory potential to become an Air Canada Captain. A letter dated July 31, 1968, from Captain G.K. Edwards, Assistant General Manager, Flight Operations, to Rowland with a copy to Flight Operations, considers Rowland to be: "extremely doubtful Captain material". The letter points out certain errors and omissions made by Rowland on two round trips from Montreal to London, England. The defects in Rowland's flying were not of the aircraft handling variety (except for sloppy climb) but missing checks and not making required calls. Rowland was given an en-route flight check on August 16, which was assessed as satisfactory but with further improvements still required.

An en-route flight check report dated August 20, 1969, was satisfactory. A simulator report dated November 13, 1969, indicates, "a very good standard".

Second Officer Hill

Second Officer Hill attended a DC8-40-50-60 ground school course in Montreal from September 18 to October 13, 1967. The ground school course actually continued until November 10, 1967, as additional subjects such as Flight Operations and Meteorology were also covered. The course relating to DC8 aircraft operation included:

Schedule 19 of Appendix "D"

Ground school - 20 days

In-flight instruction - 2:00 hours (right seat)

In-flight simulation - 26:40 hours (left & right seat)

11:50 hours (S/O Panel)

On completion of the above training, Second Officer Hill was considered as competent to act as a Second Officer on DC8 aircraft. He attended a voluntary DC8 refresher course in Toronto on April 14, 15, 16, 1970.

Records indicate that Second Officer Hill was competent to act as Second Officer on DC8 aircraft.

Position in Aircraft Prior to Impact

Captain Hamilton

The Captain was occupying the left-hand seat prior to impact. This was established by:

(a) the blood stains on a seat cushion positively identified as the captain's seat are compatible with group "A" (Captain Hamilton);

(b) the shoulder harness was fastened on impact. Captain Hamilton was known to use his shoulder harness during take off and landing.

First Officer Rowland

Attempts to establish the First Officer's position

on impact have not been entirely conclusive. These right-hand seat components were recovered:

(a) seat cushion with blood stains;

(b) left-hand armrest with tissue contamination;

(c) inertia reel components of shoulder harness in retracted position with tissue embedded;

(d) fragments of lap and anti-G straps with questionable evidence of strain on the former.

It has not been possible to group the blood stains on the seat cushion cover. The tissue recovered from the right armrest and inertia reel housing is probably group "A" and results from the proximity of the Second Officer to these components. All that can be stated with certainty is that the First Officer (blood group "O") was not occupying the left-hand seat with its group "A" blood stains.

Second Officer Hill

The armrests were the only parts of the Second Officer's seat recovered. The tissue recovered from the left armrest and inertia reels of First Officer's seat has tentatively been identified as group "A" and "SO". The Second Officer's proximity to these components also supports the fact that he was probably facing forward between and behind the other two pilots.

Yellow Paint

There was some evidence given at this Public Inquiry that some yellow paint was found in the hand of one of the air crew; *viz*, the Captain or the First Officer. The testimony was that such was found in one of the First Officer's hands; but this was subsequently changed to read in one of the Captain's hands[1].

It is not possible from this evidence to make any inference as to the respective positions in the aircraft of these two air crew prior to impact.[2]

Voice Recorder

The signals fed to the respective earphones of the Captain and the First Officer which were listened to from the tape by the investigating group, unequivocally established that the Captain was in the left-hand seat and the First Officer was in the right-hand seat, the correct seats for each of them in this DC8 aircraft as prescribed by Air Canada's operating manual.

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1 This information was communicated to this Board in December, 1970, immediately after the formal hearing of the evidence.

2 See again Footnote number 1 at pages 73-4.

This is Schedule 20
of Appendix "D"

The following is an extract from Information Circular 0/6/65, dated May 28, 1965, signed by the Director, Civil Aviation.

SECTION III

MANUALS

In order to prevent any confusion as to nomenclature and application, the manuals used by aircraft operators in Canada are defined as follows:

AIRCRAFT FLIGHT MANUAL

This manual outlines the parameters and envelope within which each aircraft of a specific type must be flown and prescribes the appropriate normal and emergency procedures. It is the basic performance document approved by the airworthiness authority of the country of manufacture. All amendments must also be approved.

AIRCRAFT OPERATING MANUAL

This manual is for a specific aircraft and is compiled by a Canadian operator. It prescribes in greater detail the procedures and limitations adopted by the operator for his operations. It is the operator's responsibility to ensure that all data adopted and amendments thereto remain within the limitations outlined in the Aircraft Flight Manual and that the use of the Aircraft Operating Manual would ensure operation of the aircraft in accordance with the Aircraft Flight Manual.

When such an Aircraft Operating Manual is carried in the aircraft, it will satisfy any Departmental requirement to carry the Aircraft Flight Manual.

OPERATIONS MANUAL

This manual is compiled by a specific aircraft operator. It is the overall control document for the operations of a particular Commercial Air Service. It is usually divided into chapters concerning: operational directives; crew duties; responsibilities and training; flight despatch; load control procedures; maintenance procedures relating to flight operations; types of flight; radio reporting procedures and communications in general; in-flight information data to be

provided including thunderstorm and icing conditions; all emergency and safety procedures; air traffic control and other special and related information.

This document and any amendment thereto must be approved by the Director, Civil Aviation.

This is Schedule 21
of Appendix "D"

MANUAL	REFERENCE	MANUAL WORDING
DC-8-63 FAA Approved Airplane Flight Manual	Sec. III Page 32 15 June 67 All Series	When the control lever is in the "RETRACT" position (forward) the ground spoilers are retracted and automatic spoiler operation is disengaged.
	Sec. III Page 33 15 June 57 60 Series	Failure of the electric actuation system to reposition after take-off will physically prevent arming of the spoiler control lever. A mechanical interlock (arm on #4 throttle) will disarm (thereby retracting) the ground spoiler control when #4 throttle is advanced above approximately maximum continuous thrust.
DC-8 Operation Manual Douglas Aircraft Co. Inc. NOTE: This manual is not FAA approved. In case of conflict between information in this manual and the FAA Approved Airplane Flight Manual the latter shall take precedence. AND Air Canada 55 DC-8 Operating Manual	2-152 Page 4 Code 1 1 May 63 40 Series Chap. 17, Pge. 39 1 January 68 40 Series	WARNING - AFTER TAKE-OFF, SHOULD THE NOSE GEAR STRUT REMAIN COMPRESSED OR THE GROUND SHIFT MECHANISM MALFUNCTION, ALL SPOILERS COULD INADVERTENTLY BE EXTENDED MANUALLY DURING FLIGHT. THEREFORE, MOVEMENT OF THE SPOILER LEVER TOWARD THE "EXTEND" POSITION SHOULD NEVER BE ATTEMPTED DURING FLIGHT. ALSO, UNDER THESE CONDITIONS, THE SPOILERS WILL NOT AUTOMATICALLY EXTEND ON TOUCHDOWN, EVEN THOUGH THE SPOILER LEVER IS IN THE "ARMED" POSITION. THHEY MUST BE EXTENDED MANUALLY BY MOVING THE SPOILER LEVER TO THE "EXTEND" POSITION AND PULLING IT UP TO LOCK IT.

Schedule 21 of Appendix "D"

MANUAL	REFERENCE	MANUAL WORDING
DC-8 Operations Manual Douglas Aircraft Co.Inc.	2-152 Page 4 Code 8 1 August 69 60 Series	(Normally the lever is prevented from going to the "EXTEND" position while in flight by a mechanical system operated by extension of the nose landing gear oleo strut.
Braniff International Operations Manual	Page 16 10 May 68	WARNING: IF, AFTER TAKE-OFF, SHOULD THE NOSE GEAR STRUT REMAIN COMPRESSED, OR THE GROUND SHIFT MECHANISM MALFUNCTION, ALL SPOILERS COULD INADVERTENTLY BE EXTENDED MANUALLY DURING FLIGHT. THEREFORE, MOVEMENT OF THE SPOILER LEVER TOWARD THE "EXTEND" POSITION SHOULD NEVER BE ATTEMPTED DURING FLIGHT. ALSO, UNDER THESE CONDITIONS, THE SPOILERS CANNOT BE ARMED AND THE SPOILERS WILL NOT EXTEND AUTOMATICALLY ON TOUCHDOWN. THEY MUST BE EXTENDED MANUALLY BY MOVING THE SPOILER LEVER TO THE "EXTEND" POSITION AND PULLING IT UP TO LOCK IT.
Air Canada 55 DC-8 Operating Manual	Chap. 17 Page 36 1 Jan.68 All Series	General Description . . . . The two inboard spoilers on each side are called the ground spoilers. They do not extend in flight. They are used only on the ground along with the flight spoilers.
		Normally, the lever is prevented from going to "EXTEND" while in flight, by a mechanical system operated by the nose ground shift mechanism.
Air Canada 55 DC-8 Operating Manual Transmittal 38 Note on this trans- mittal reads "This	13 March 68	This transmittal outlines the action of ground spoiler extension on touchdown when landing in a crosswind. To quote the transmittal in part " Because of this feature and early training, some pilots are landing the aircraft in a crosswind without ground spoilers ARMED, i.e. by extending them manually during the landing roll." The last paragraph states "Landing without the spoilers abnormal procedure to be followed only

Schedule 21 of Appendix "D"

MANUAL	REFERENCE	MANUAL WORDING
Air Canada Lesson Plan No. 21	Page 10	This document produced by an Air Canada ground school instructor contained the following handwritten note "Ensure statement to class: It is possible on 50/60 aircraft to pull spoiler lever back to extend, armed or disarmed, if a force of approximately 40 pounds is used." The instructor stated this note was entered after July 5/70 and that there is no reference on this page or any other pages in the lesson plans to the fact that the spoiler lever could be put in the "EXTEND" position in flight.
Air Canada "Spoiler Systems Training Aid - Questions for pilot supervisors"	Page 2	Question 24 "What normally prevents the spoiler lever from being moved toward the "EXTEND" position while in flight?"
Air Canada DC-8 Check Yourself Cockpit Levers 40/50/60	Page 7 Sept 69	Under "Spoiler Control Lever" the following statement is made: "In flight, control lever locked by ground shift mechanism in the "RETRACT" position."
CP Air Regulations DC-8 Flight Manual	Page 6-7 17 April 69	Under "Ground Spoilers" NOTE: The ground spoiler lever cannot be placed in the "ARMED" position on the ground. WARNING: The spoilers can be extended in flight by manual selection of the lever to the "EXTEND" position. DO NOT APPLY ANY REARWARD PRESSURE ON THE SPOILER LEVER WHEN ARMING THE SPOILERS.
Eastern Air Lines DC-8-63 Flight Manual	1 Oct 69	Under "Ground Spoiler Automatic Operation": CAUTION: MOVEMENT OF THE SPOILER LEVER TOWARD THE "EXTEND" POSITION SHOULD NEVER BE ATTEMPTED IN FLIGHT. "

Schedule 21 of Appendix "D"

MANUAL	REFERENCE	MANUAL WORDING
KLM DC8 Flight Manual 60 Series		**Main Wheel Spin Up Ground Spoiler Activation** WARNING: WITH THE LANDING GEAR DOWN AND THE SPOILER LEVER IN "ARMED" IT IS POSSIBLE TO EXTEND THE SPOILERS IN FLIGHT. FOR THIS REASON MOVEMENT OF THE SPOILER LEVER TO THE "EXTEND" POSITION SHOULD NEVER BE ATTEMPTED IN FLIGHT.

This is Schedule 1
of Appendix "E"

MANUAL	REFERENCE	MANUAL WORDING	REMARKS
DC-8-63 FAA Approved Airplane Flight Manual	Sec. III Page 32 15 June 67 All Series	When the control lever is in the "RETRACT" position (forward), the ground spoilers are retracted and automatic spoiler operation is disengaged.	Misleading statement. The automatic operation is not disengaged when the control lever is in the "RETRACT" position, unless it is also pushed down out of the "ARMED" position.
	Sec. III Page 33 15 June 57 60 Series	Failure of the electric actuation system to reposition after take-off will physically prevent arming of the spoiler control lever.	Incomplete statement. Failure of the ground shift mechanism or the nose oleo remaining compressed would have the same effect.
		A mechanical interlock (arm on #4 throttle) will disarm (thereby retracting) the ground spoiler control when #4 throttle is advanced above approximately maximum continuous thrust.	Misleading statement. This statement is only true when the spoilers are in the aft extended and locked position. If the spoilers are armed and retracted, the opening of #4 throttle will not disarm the spoilers.
DC-8 Operation Manual Douglas Aircraft Co. Inc. NOTE: This manual is not FAA approved. In case of conflict between information in this manual and the FAA Approved Airplane Flight Manual the latter shall take precedence. AND Air Canada 55 DC-8 Operating Manual	2-152 Page 4 Code 1 1 May 63 40 Series Chap. 17, Pge. 39 1 January 68 40 Series	WARNING - AFTER TAKE-OFF, SHOULD THE NOSE GEAR STRUT REMAIN COMPRESSED OR THE GROUND SHIFT MECHANISM MALFUNCTION, ALL SPOILERS COULD INADVERTENTLY BE EXTENDED MANUALLY DURING FLIGHT. THEREFORE, MOVEMENT OF THE SPOILER LEVER TOWARD THE "EXTEND" POSITION SHOULD NEVER BE ATTEMPTED DURING FLIGHT. ALSO, UNDER THESE CONDITIONS, THE SPOILERS WILL NOT AUTOMATICALLY EXTEND ON TOUCHDOWN, EVEN THOUGH THE SPOILER LEVER IS IN THE "ARMED" POSITION. THEY MUST BE EXTENDED MANUALLY BY MOVING THE SPOILER LEVER TO THE "EXTEND" POSITION AND PULLING IT UP TO LOCK IT.	The WARNING in the Air Canada Manual is identical, except the words "(such as due to a deflated oleo) are inserted after the words "remain compressed" in the first sentence. This is a misleading statement in that the spoilers may be extended at any time in flight, gear down, providing the 70 to 90 pound spring force is overcome; with the conditions in the WARNING the force becomes about 12 pounds.

Schedule 1 of Appendix "E"

MANUAL	REFERENCE	MANUAL WORDING	REMARKS
DC-8 Operations Manual Douglas Aircraft Co.Inc.	2-152 Page 4 Code 8 1 August 69 60 Series	(Normally the lever is prevented from going to the "EXTEND" position while in flight by a mechanical system operated by extension of the nose landing gear oleo strut.	This is a false statement. In no DC-8 owned by Air Canada does such a mechanical system exist to prevent the lever from going to the "EXTEND" position.
Braniff International Operations Manual	Page 16 10 May 68	WARNING: IF, AFTER TAKE-OFF, SHOULD THE NOSE GEAR STRUT REMAIN COMPRESSED, OR THE GROUND SHIFT MECHANISM MALFUNCTION, ALL SPOILERS COULD INADVERTENTLY BE EXTENDED MANUALLY DURING FLIGHT. THEREFORE, MOVEMENT OF THE SPOILER LEVER TOWARD THE "EXTEND" POSITION SHOULD NEVER BE ATTEMPTED DURING FLIGHT. ALSO, UNDER THESE CONDITIONS, THE SPOILERS CANNOT BE ARMED AND THE SPOILERS WILL NOT EXTEND AUTOMATICALLY ON TOUCHDOWN. THEY MUST BE EXTENDED MANUALLY BY MOVING THE SPOILER LEVER TO THE "EXTEND" POSITION AND PULLING IT UP TO LOCK IT.	Misleading statement in that the spoilers may be extended any time in flight, gear down, providing the 30 to 40 pound spring force is overcome. With the conditions in the WARNING pertaining the force is as on the 40 Series, i.e. about 12 pounds.
Air Canada 55 DC-8 Operating Manual	Chap. 17 Page 36 1 Jan.68 All Series	General Description . . . . The two inboard spoilers on each side are called the ground spoilers. They do not extend in flight. They are used only on the ground along with the flight spoilers.	This is an inaccurate and misleading statement. Although the ground spoilers are not for use in flight, they can be made to extend in flight very easily.
		Normally, the lever is prevented from going to "EXTEND" while in flight, by a mechanical system operated by the nose ground shift mechanism.	This is an inaccurate statement. No mechanical system prevents ground spoiler operation in the air. On the 40 Series a 70 to 90 pound spring and on the 50 and 60 Series a 30 to 40 pound spring acts as a retarding force.
Air Canada 55 DC-8 Operating Manual Transmittal 38 Note on this transmittal reads "This	13 March 68	This transmittal outlines the action of ground spoiler extension on touchdown when landing in a crosswind. To quote the transmittal in part " Because of this feature and early training, some pilots are landing the aircraft in a crosswind without ground spoilers ARMED, i.e. by extending them manually during the landing roll." The last paragraph states "Landing without the spoilers [illegible] an abnormal procedure to be followed only	This is the only document put into evidence to indicate that Air Canada had warned the pilot group against manually deploying the spoilers on touchdown. Unfortunately, this did not touch on the subject of arming the spoilers on the Before Landing Check and the dangers of not doing so.