INTERNATIONAL STUDY TEAM

REPORT

Following the study

performed at the request of

The Minister in charge of the Department for Public Enterprise

on

the AER LINGUS VISCOUNT EI-AOM accident

occurred on March 24th, 1968

near TUSKAR ROCK

Ireland

VOLUME III : SUMMARY REPORT

November 27, 2000

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EXECUTIVE SUMMARY

- The accident which occurred in 1968 to Aer Lingus Viscount EI-AOM was never fully explained and was the subject of continuing controversy.

  In July 2000 the Irish Minister for Public Enterprise, Mrs Mary O'Rourke T.D., commissioned this independent study of the accident circumstances.

  The study did not constitute a formal investigation nor a re-opening of the original investigation. The objective was to shed further light, if possible, on the cause or causes of the accident.

- Other than a limited amount of paperwork there was no longer any material evidence available.

- However the Team took advantage of a much longer in-service experience of the Viscount fleet than existed in 1968, and performed a deep analysis of several accidents considered as "relevant", since they presented similarities with the Tuskar Rock accident. This resulted in the identification of a field of possible causal factors.

- This field was narrowed taking into account the technical considerations, based :

  1. on the data reported in the annexes of the 1970 report

  2. on the conclusions of the year 2000 Review of the files by the AAIU

  3. on personal experience.

- An operational analysis of the various scenarios generated after the publication of the inconclusive 1970 Accident Report showed that, although a mid-air collision (or near collision) with a manned or unmanned aircraft was possible, this aircraft could not be the one sighted over Fethard after the assumed collision.

  A call for witnesses, launched in September 2000, together with a careful examination of the witnesses' statements received in 1968 allowed for a flight reconstruction, different from the one presented in the 1970 report.

  The Viscount had been heard and/or observed on the following track: take-off from Cork, flight as per the flight plan reaching approximately 10.000 feet over Old Parish, a loss of control and spinning down to very low altitude and then flying in more and more disabled conditions from Old Parish to Tramore, Brownstown Head, Tory Hill, Kennedy Arboretum, Ballykelly, Fethard, North Saltees and finally crashing into the sea at Tuskar Rock.

  The flight reconstruction performed by the 1968 Investigation Commission was possibly misled by the transcript of the Shannon radio-communications.

- The study leads to the conclusion that :

  - An initial event , which cannot be clearly identified, disturbed the air flow around the horizontal tail surfaces and the pitch control of the aircraft. In the

light of what was observed by non-skilled people there was a strong indication that structural fatigue , flutter, corrosion or bird strike could have been involved.

- It is possible that the sensitivity of the engine fuel control units to high negative accelerations imposed during the initial upset , had an adverse effect on the subsequent flight path of the aircraft.

- The manoeuvres of the aircraft following the initial upset and the subsequent flight would have been outside the airworthiness certification envelope and may have resulted in some deformation of the structure.

- A number of possible causes for an impairment of pitch control were examined and it is considered very possible that excessive spring tab free play resulted in the fatigue failure of a component in the tab operating mechanism thus inducing a tailplane-elevator tab free flutter condition.

- The loads induced by the flutter condition would be of sufficient magnitude and frequency to cause a fatigue failure of the port tailplane within the timescale estimated for EI-AOM.

- There was no involvement of any other aircraft or missile.

- The flight crew demonstrated a high level of proficiency, using all available techniques known from their experience to keep the aircraft airborne for more than half an hour with very high stickforces and a progressive loss of control. It is remarkable that they maintained a semblance of control as long as they did.

- As a conclusion, the light shed on the cause or causes of the accident can be summarized as follows:

  - The flight track reconstructed according to the statements of all witnesses can be considered with some confidence to be of a factual nature, since all the statements fit one to the others.

  - The initial event, and subsequent degradation process can be accounted for from technical and operational arguments, but is to be considered of conjectural nature, since no piece of material evidence is longer available.

SUMMARY REPORT

1.1 HISTORICAL RECALL

Aer Lingus Vickers Viscount 803 EI-AOM flying from Cork to London crashed into the Irish Sea near Tuskar Rock in County Wexford on 24 March 1968. All sixty-one persons on board were killed.

A report on the investigation into the accident was published by the Irish Department of Transport and Power in June 1970. The report concluded that there was not enough evidence available on which to reach a conclusion of reasonable probability as to the initial cause of the accident.

In view of the circumstances pertaining at the time and certain unsubstantiated hypotheses raised in the report, the cause of the accident remained controversial. Indeed at least one book, many newspaper articles and television programs continued to raise various scenarios, including conspiracy theories, thirty years after the accident.

As a result of continuing speculation, the Irish Minister for Public Enterprise

Mrs. Mary O'Rourke T.D., in cooperation with the UK Government, requested an official review of all relevant files to see if the cause of the accident could be determined. The report of this review was published in June 2000.

The comprehensive review report found errors and omissions in the maintenance of the Viscount type aircraft, by the operator, Aer Lingus and by the Airworthiness Surveillance Office of the Department.

No evidence of UK involvement in the occurrence of the accident was found ; nor was there any evidence that the UK as a State conspired against the investigating body in an attempt to conceal any facts.

The cause of the accident was still not established.

Consequently, the responsible Minister, Mrs. Mary O'Rourke T.D., commissioned an independent team of aeronautical experts with the objective "to shed further light on the cause (s) of the accident", by making a study of all available documentation, material and/or sources.

This report sums up that study.

1.2 REVIEW TEAM

The independent specialists selected by the Minister were as follows:

a) **Admiral Yves Lemercier (Ret.)**

Consultant from Cabinet d'Expertise Aéronautique et Spatiale (EXP'AIR)

and his associate

Manuel Pech

36 rue A. Pallu - 78110 Le Vesinet, FRANCE

b) **Colin Torkington, MSc, C. Eng., FRAeS**

Australian Nominee on the Air Navigation Commission of the

International Civil Aviation Organization (ICAO)

Australian Delegation

999 University St.

Montreal, Quebec, CANADA H3C 5J9

A brief note on the experience of the team members will be found in Appendix 1a.

1.3 THE TASK

Mr. John Lumsden, Assistant Secretary General - Aviation, acting on behalf of the Minister Mrs. Mary O'Rourke T.D., set out the parameters of the study to be undertaken. These were as follows:

"The objective of the study is to shed further light, if possible, on the cause or causes of the accident. It is also important to indicate that the Minister has set no limits or restrictions on the nature or scope of this study or any subsequent inquiries which you may recommend or she may herself initiate. This study does not constitute a formal investigation, however, nor a reopening of the original investigation, the files of which have never been closed.

That said, you should in the first instance:

a) examine the existing documentary evidence, including the 1970 Report and its Appendices and the June 2000 Review of Files and so much of the source material prepared or collected in connection with the Report and the Review as you deem appropriate;

b) examine any new documentary material that may come to light in the course of your work;

c) examine all available records in relation to investigations of incidents and accidents involving Vickers Viscount aircraft;

d) be available to meet with representatives of the relatives of the victims of the accident, to hear their concerns, at an appropriate stage of your study.

You should aim to complete a report of your work by end November 2000 (if more time is needed, that will be afforded). Your report should make any conclusions, findings or recommendations which you see fit including any recommendations as regards further inquiries, tests or examinations which you feel should be undertaken either by yourselves or by others."

2.1 1970 REPORT METHODOLOGY

2.1.1 The methodology applied

The methodology applied was the one recommended by the Annex 13 of the Convention on International Civil Aviation in its second edition (March 1966).

2.1.2 Assessment

- The similar accidents studied did not include any comparison with an Aer Lingus Viscount EI-AOF, which crashed 9 months earlier.

- The wreckage examination and subsequent information was performed jointly by the Commission and the manufacturers.

- Their conclusions were exclusively based on the analysis of the recovered parts since the position of the manufacturers was not to open discussions on the non-recovered parts. As a consequence , no conclusions on what could have happened to the tail part were established.

- The same State organisation which was in charge of the investigation was also responsible for the regulation of airworthiness and operations.

- The considerations of probabilities eliminated without apparent substantiation all the causal factors with the exception of :

    - Collision with another aircraft

    - Upset due to evasive actions ,

  although it was stated in the conclusions that there was no substantiating evidence of such possibilities.

- The findings did not identify any causal factor and what is stated as the probable cause is, in fact, a consequence.

- But the statement that "the conclusion that there was such another aircraft in the area is inescapable" did open a door to the imagination of everyone, in order not to leave the relatives of the victims ignoring everything about this accident.

After the publication of the 1970 report, several scenarios were generated, from simple "mid-air collision" theories to "conspiracy " theories which include State (UK or Irish) misrepresentations.

This enlarged domain of imagination led the Irish Government to order a review which was performed from 1998 to 2000.

2.2 2000 REVIEW METHODOLOGY

This review resulted from the common desire of the Irish Minister for Public Enterprise together with the UK Ambassador to resolve the speculation concerning British military involvement in the accident.

The task was to review all files held relating to the accident to see if the cause of the accident could be established.

2.2.1 Methodology of the of the Review

The team was facing a considerable volume of material accumulated : 54 files were examined.

The Irish and UK Officials agreed a structure based on the nature of the questions asked by the relatives:

- Initial upset and crash of the aircraft, immediate SAR efforts
- Search and salvage
- The possibility of the existence of another airborne mobile
- The aircraft, its airworthiness, its operation, its crew.

2.2.2 Assessment

An exhaustive review of the existing files could not establish the cause of the accident.

Certain shortcomings of the 1970 report were identified, and, in addition, the hearing of some new witnesses demonstrated that, in this respect, the 1970 report ignored some aspects of what had been observed from the ground.

As a consequence of this review, the Minister of Public Enterprise decided to call an International Team, not to establish the cause of the accident, but "to shed further light, if possible, on the cause or causes of the accident" .

2.3 METHODOLOGY OF THE PRESENT STUDY

The methodology selected by the Team was to use all information which could not be used in 1968 or which was only partially used; and to use this information for narrowing in the most logical process the large field of the possible causes of the accident down to a few probable causes and/or contributing factors.

2.3.1 "Similarities" Study

The first step is to present a "similarities" study, which identifies the similarities of the EI-AOM accident with other accidents/incidents, considered relevant when they presented a similar loss of control, and/or comparable flight attitudes in a disabled condition, and/or similar crash conditions.

This first step takes advantage of the lessons learned from all the accidents which occurred during the whole life of the Viscount (which was not feasible in 1968).

That study is concluded by the "Identification and ranking of several causal factors".

2.3.2 Technical Study

The second step is to take advantage of the technical considerations, observed on the

VISCOUNT fleet till the end of its life .

This "technical study" is concluded by two lists of causal factors ranked in terms of probability : extremely remote, improbable, possible or probable.

The first list refers to "Events"; the second list refers to "Aircraft components".

As such, the field of the causal factors is narrowed to the events or components identified as "possible" and "probable".

2.3.3 Operational Study

The third and last step is the operational analysis, where

- the various scenarios, as partially observed and partially built-up , are described;
- each scenario is assessed against the identified constraints resulting, from the operational characteristics and from the witnesses' observations, in order to check its internal consistency: track reconstruction, aircraft degradation process, etc…
- the different scenarios are assessed one against the other, in order to identify the most probable one.

That study concludes with the most probable scenario, as assessed by the International Team. This scenario includes the identification of the most probable causal factor (s), as much as feasible.

3. IDENTIFICATION OF SIMILARITIES WITH OTHER ACCIDENTS/INCIDENTS

3.1 AVAILABLE DATA

3.1.1 Viscount Occurrences (1976 – 1995)

3.1.2 ICAO Data

3.1.3 Accident Reports Examination

3.2 "SIMILARITIES STUDY" METHODOLOGY

Based on this available data, the study identifying which probable cause(s) produced the most "similar" accident(s) to that of EI-AOM follows the here-under described sequence :

1st step : Among all accidents in the whole life of the Viscount, identify those presenting the following characteristics :

- sudden loss of control
- continuing in a disabled flight
- ending in a crash.

17 accidents were selected, most of them with an identified "probable cause".

These "probable causes" are :

A- Icing

B- Stall

C- Bird Strike

D- Structural fatigue failure of the tailplane

E- Elevator Tab Circuit (Spigot) failure

F Rear pressure bulkhead failure

F- Alternative Power Supply Disruption

G- Propeller Control Unit contaminated

H- Propellers entering ground fine pitch in flight

I- Door strike

J- Door flapping

2nd step : Each selected accident is then described in elementary sequences, to enable comparison with the same sequences of the EI-AOM accident.

The EI-AOM accident is described here-under :

- Initial loss of Control

a) The initial event happens suddenly without any precursor announcement to the crew.

b) The loss of control initiation shows abrupt pitch-down or sudden lurch in yaw.

(Abrupt pitch-down results from large decrease of the (negative) lift of the tail plane. Sudden lurch in yaw results either from decrease of thrust or increase of drag.)

c) The loss of control phase shows the following typical attitudes and movements of the aircraft:

- A quickly accentuated nose-down attitude with the air speed increasing rather slowly (because of propeller drag.)

- Flutter can appear in the flight-controls where loads are transmitted to the yoke which is violently shaken in the cockpit. Forces of extreme magnitude must then be exerted by the crew.

  Abnormal attitudes in pitch, sudden changes in angle of attack and slide slip. Slipping and sliding generate violent accelerations, normal and transverse (+3g - 1,7 g) that can overstress the structure, and put components out of their certified domain.

- Recovery from the "initial out of control phase"

d) Recovery can be gained only if:

- Flow circulation is reinitiated through aerodynamic and engines' controls
- Appropriate pilot's actions
- Natural horizon seems to be an initial essential condition.

e) The flight after recovery is in reduced stability condition. The aircraft is at low or very low altitude; the aircraft is unsteady, shaken by fast angular movements and shows rapid changes in engine and propeller regimes, commanded or not commanded. Noises of engine compressor surge, explosive relight and emission of black smokes are characteristic.

- Ultimate phase

f) The ultimate phase is a non recoverable loss of control. The aircraft's mechanical qualities are degraded by overstressing and possible separation of flight control elements. The altitude margin is no longer available. Usually the aircraft pitches down and impacts the ground close to the vertical at high vertical speed. Crew actions are ineffective.

g) The wreckage examination shows that the integrity of the aircraft has been impaired prior to the crash: some parts of the aircraft may have separated in flight. Typical deformations or ruptures can be apparent on key structural items.

3rd step : Then each of the 17 selected accidents is compared, elementary sequence by elementary sequence, to the EI-AOM accident.

Each elementary sequence is qualified Similar (S), Different (D) or Not Applicable (NA).

4th step : As a conclusion, a ranking can be made :

- on a global aspect, the number of similar elementary sequences is a good indicator

- on more qualitative approach, the identification of similar groupings of elementary sequences is of interest

This ranking is then to be assessed against the technical analysis and the operational analysis.

3.3 IDENTIFICATION OF SIMILARITIES BETWEEN EI-AOM ACCIDENT AND THE "RELEVANT" ONES

The level of similarity between accidents caused by ICING and EI-AOM is quantified by : 3 S – 4 D

The level of similarity between an aircraft suffering a STALL and EI-AOM is

characterized by : 3 S – 4 D.

The level similarity between an aircraft suffering a bird strike and EI-AOM is characterized by : 4 S – 2 D - 1 NA.

The level of similarity between an aircraft suffering a structure failure and

EI-AOM is characterized by : 3 S – 3 D – 1 NA.

The level of similarity between an aircraft suffering a spigot rupture and

EI-AOM is characterized by : 4 S – 1 D – 2 NA.

The level of similarity between an aircraft suffering a failure of the rear pressure bulkhead and EI-AOM is characterized by 3 S – 3 D – 1 NA.

The level of similarity between an aircraft suffering an alternative power supply disruption and EI-AOM is characterized by : 2 S – 4 D – 1 NA.

The level of similarity between an aircraft suffering from a PCU contamination and EI-AOM is characterized by : 3 S – 3 D – 1 NA.

The level of similarity between an aircraft suffering from an uncommanded ground fine pitch in flight and EI-AOM is characterized by : 3 S – 3 D – 1 NA.

The level of similarity between an aircraft suffering from a door strike and EI-AOM is characterized by : 5 S – 1 D

The level of similarity between an aircraft suffering a disabled flight caused by a door flapping in flight is characterized by : 3 S and 4 NA (since there was no crash).

3.4 CONCLUSIONS

It may be considered that the number of NA is an indicator of the level of relevance of each accident.

It may be considered that[nb (S)] / [7 – nb (NA)] is a global indicator of the level of similarity.

	S	D	NA	$\frac{S}{7 - NA}$	Rank of similarity
Icing	3	4	0	0.4	9
Stall	3	4	0	0.4	9
Bird strike	4	2	1	0.7	4
Structure failure	3	3	1	0.5	5
Spigot rupture	4	1	2	0.8	3
Bulkhead failure	3	3	1	0.5	5
Alternative power supply disruption	2	4	1	0.3	11
PCU contamination	3	3	1	0.5	5
Uncommanded GFP in flight	3	3	1	0.5	5
Door strike	5	1	0	0.9	2
Door flapping	3	0	4	1.0	1

Note: 7 is the number of considered factors of the accident

Comments

The “door opening” similarity level shows that this part of the flight which was relevant (the disabled flight) is quite similar to the disabled flight of EI-AOM.

The strikes on the tail, whatever the cause (door, bird) produce the same effect. The main factor with respect to the consequences is the level of the initial damage on the tail : it will lead to a direct crash in the most serious case or a period of disabled flight as long as the aircraft degradation process is developing up to crash ; or in the best cases, just a damage on the tail allowing for a safe landing.

The different types of structure failures show the susceptibility of the tail section.

Conclusions

What appears characteristic, in term of similarity, is the degradation process of the aircraft capacity, and a good indicator is the duration of this process.

This process may be initiated by an external event (bird strike, door strike), but also a direct structure failure (spigot) or by an aircraft manoeuvre (stall recovery).

This initial event initiates a structure failure which will develop during 20 to 30 mn, before parts break, eventually separate from the aircraft and finally leads the ac to a crash.

The ranking of possible initial events is as follows :

- door strike
- bird strike
- spigot rupture
- structure failure
- severe in flight manoeuvres.

The accidents of VT-DIO (Indian – 1963), EI-AOF (AER Lingus – 1967), EI-AOM (AER Lingus – 1968), HK 1058 (Columbia – 1974) and PK-IVS (Bouraq – 1980) appear to be a “family” of accidents.

Inside this family, AOM and AOF present a particular level of similarity, as it appears in Appendix 3c.

4. TECHNICAL ANALYSIS

In Conclusion 11, the 1970 report states "The aircraft was substantially intact when it entered the sea, except for the probable loss of all or part of the elevator spring tab".

> In fact, it would appear that both left and right tailplanes (with the exception of the starboard tab) together with the tailplane centre-section spar were not lying in the sea bed with the main wreckage.

The year 2000 Review Report states (conclusion Nr 29) that the 1970 report did not adequately examine the possibility of a cause other than a collision or near collision although it does quote a Conclusion from Appendix 4. " The evidence available does not eliminate the possibility of a defect or failure on the elevator and/or tailplanes having contributed to the accident".

<u>With respect to the engines</u> :

The original investigation concluded that all four engines were alight, with the throttles closed, and with an airspeed at impact less than 130 kts.

Witness statements indicate the possibility of one (Number 3) or more propellers being feathered at some stage in flight.

<u>With respect to flight controls</u> :

> . A review of the above investigation, in the light of the subsequent service history of the aircraft type, has produced no evidence to vary the findings made at the time with respect to the aileron and rudder controls.
>
> However, it was not possible to eliminate the possibility of a defect or failure in the elevator and/or tailplanes having contributed to the accident as both elevators, both tailplanes, the tailplane centre-section, the tailcone and the rear pressure bulkhead were not found.

<u>With respect to systems</u> :

> The air conditioning and pressurisation system is of interest from the point of view of crew incapacity as a result of lack of pressurisation, sudden decompression or fire. However pathological evidence is that there was no sudden decompression (the Institute of Aviation Medicine of the RAF and its Irish equivalent performed all pathological work
>
> With respect to EI-AOM, sufficient material was recovered to establish that there was both A.C. and D.C. power on the aircraft at impact. This finding, together with the good visual weather conditions, make any electrical system causal factor extremely improbable.
>
> A defect in the Auto-pilot, which had been present when Aer Lingus purchased the aircraft from KLM, was the subject of much analytical, ground and flight test investigation following the accident. The 1970 report concluded that the defects found could not be the initiating cause of the accident.

With respect to doors strikes :

The Viscount, like a number of other aircraft types, has had a number of door defects and separations. A study of occurrence reports supplied by the UK Civil Aviation Authority which unfortunately only covers the last ten years of the aircraft service, shows 20 reports of door problems, all non-seriousOne difficulty with the proposition that one of the doors from the starboard side struck the tail is that the spring tab from the port elevator was found remote from the main wreckage whilst a portion of the trim tab from the starboard elevator was recovered from the main wreckage area. This is indicative of a port side tailplane or elevator failure but the possibility cannot be discounted of a partial failure on one side subsequently affecting the other side.

On the limited evidence available, this scenario must remain a possibility.

With respect to bird strike :

In looking at available evidence, it is considered that the possibility of a bird striking one tailplane resulting in partial failure may well be a triggering factor.

With respect to fuselage failure :

It is difficult to connect a possible bulkhead failure with the loss of EI-AOM although this part of the structure was not recovered or seen in the field of the wreckage.

With respect to metal fatigue :

Four Viscounts are known to have been lost in fatal accidents involving metal fatigue.

With respect to EI-AOM; if the tail plane time in service is the same as the aircraft, at 16923 landings (this was not always the case as some airlines are known to have rotated tailplanes between aircraft), then the following factors alone or in combination would be required for a fatigue failure to occur:

◊ An unconservative life estimation

An 'extreme probability' failure as accepted as part of the safe lifephilosophy

◊ An aircraft defect such as a badly drilled hole, a scratch or

◊ corrosion

◊ Some additional external loading

With respect to flutter :

One very well documented accident which occurred in 1980 resulted from failure of the elevator spring servo tab circuit and consequential tail separation and loss of control of the aircraft.

It was discovered that in spite of the high hours of the spigot, higher than normal loads were still required to induce failure. The Aircraft Manual maximum allowable free play at the spring tab is reported to be 0.10 inches for 700 and 800 Series aircraft and 0.05 inches for the 810 Series..

Note that the tab free play is obtained by measuring the free deflection at the trailing edge. The spigot fitting is a steel 1/4 inch spindle mounting which serves as a pivot point in the drive mechanisms.

In summary, it appears that exceeding the manufacturer's tab free play limits would be sufficient to eventually induce failure of the tailplane.

It is not known when the tab free play was last checked by Aer Lingus but the Vickers recommended interval was 900 hours.

A tab free play inspection was unlikely to have been included in the Aer Lingus 2.04 maintenance inspection, the records of which are missing.

In summary, a critical chain of events arises if the elevator spring servo tab free play or backlash exceeds allowable limits. In such a case, additional cyclic loading is induced into the spigot in the tab operating mechanism which may eventually cause it to fail in fatigue. In the event of complete failure of the spigot in flight, the oscillation of the elevator spring tab mechanism at normal cruise speeds could develop into tab/elevator/tailplane flutter, the severity of which could lead to fatigue failure of the tailplane root end attachment.

With respect to maintenance :

The many serious errors discovered in the maintenance plan of the aircraft at AER-LINGUS do not inspire confidence in the maintenance culture of the airline at that time. Whilst, for example, no maintenance mistakes or omissions were evident relating to the pitch control system of the aircraft we cannot be even reasonably sure that they did not exist

With respect to Regulatory action :

The regulatory control of Viscounts with respect to problems manifesting themselves in service was primarily done by the issuance of Preliminary Technical Leaflets (PTLs) or Service Bulletins (SBs) by the manufacturer and classified as mandatory in the United Kingdom.

A significant number of PTLs and ADs on the Viscount do however relate to serious structural problems, particularly ones relating to metal fatigue. The wings, fuselage and tailplanes were all affected in spite of the fact that these components were certificated with mandatory retirement lives.

CONCLUSIONS

From a technical evaluation of the circumstances surrounding the accident to EI-AOM, it is possible to summarize the probability of events or aircraft components being causal factors. These are presented in terms of Extremely Remote; Improbable; Possible and Probable.

EVENT	PROBABILITY
▪ Weather – general ▪ Weather – icing ▪ Internal pressure of tailplane ▪ Fire	Extremely remote
▪ Door Strike ▪ Bird strike ▪ Metal corrosion ▪ Maintenance	Possible
▪ Metal fatigue ▪ Flutter	Probable

AIRCRAFT COMPONENT INVOLVEMENT AS INITIAL CAUSE	PROBABILITY
▪ Engines ▪ Propellers ▪ Systems : · Electrical · Hydraulics · Anti-icing ▪ Systems : · Flight controls (excluding pitch control) ▪ Wing ▪ Fin-rudder	Extremely Remote
▪ Fuselage	Improbable
▪ Tailplane ▪ Elevator, including tabs ▪ Systems : pitch control	Probable

Accordingly it is concluded :

- A structural failure of the port tailplane is consistent with the evidence relating to the loss of EI-AOM.

  There are a number of possibilities which could explain the separation of whole or part of the tailplane but an analysis of the service history of the type suggests that this may have resulted from a fatigue failure of the main spar upper boom or attachment fitting initiated or exacerbated by excessive spring servo tab free play.

5. OPERATIONAL ANALYSIS

5.1 INCONCLUSIVE 1970 REPORT

5.1.1 1968 Flight Reconstruction

5.1.1.1 Data Available

The flight reconstruction performed in the 1970 accident report was based on :

- The radio-comms transcripts
- The time of the spin
- The position of the wreckage
- The statements of those witnesses who appeared to be "very reliable" (§ 2.1.3.3 and § 2.1.3.8) or "quite reliable" (§ 2.1.3.8).

5.1.1.2 : Positioning and Timing (GMT)

From 10 hr 32 min to 10.51.48, EI-AOM climbed regularly up to FL 170, reporting "by Youghal" at 10.40, and "by Bannow" at 10.57.07.

Since the flight was authorized direct to Strumble at 10.40, authorization acknowledged by the crew, and since the wreckage was discovered near Tuskar Rock, there is an ambiguity on the Viscount positioning at 10.58, when the crew reported "spinning". However an "uncertainty zone" may be defined, which, under the considered data, surely contains the position of the spin (refer Map 5a1).

After 10.58, there were no further radio-comms.

- The nearest points of the area of uncertainty from the position of the wreckage are not more than 5 nautical miles away, in direct line.

- This opens a possibility for the crash to occur from 11.00 if there is no recovery; up to an undetermined time if there is a recovery, and if the Viscount can have been flown in a disabled condition over the sea, out of the sight of any witness.

  It can be noted that, even if the spin occurred at the farthest point of the area of uncertainty, a crash between 11.10 and 11.15 remains possible.

  The time of the crash, as determined from the observations of two witnesses, considered by the Investigation Team as very reliable, could be between 11.10 and 11.14.

  If this observation is "reasonably reliable" then the Viscount cannot : spin at 10.58 at the nearest point of the uncertainty zone, fly in a disabled condition from this point to Fethard area, be observed from Saltmills (North Fethard) coming from a North West direction, and crash at Tuskar between 11.10 and 11.15.

  This led the Investigation Team to state that (§ 2.1.4.10) "the conclusion that there was such another aircraft in the area is inescapable".

5.1.2 Unsolved Inconsistencies

Such a flight reconstruction, with the presence of a second air-mobile in the area, yet left some unsolved inconsistencies.

- The first one referred to the impossibility to lose 12000 feet in 7 sec : this was the first interpretation of the last two messages emitted by EI-AOM :

  - 10.58 : EI-AOM with you

  - 10.58.^{07} : 5000 feet , descending spinning at rapidly.

  After a considerable interpretation work performed in the "International Institute for Research Industrial and Standards" of Dublin, and in US laboratories of acoustics, 5000 feet were read instead of 12000 feet , and it was considered that the first message "EI-AOM with you" was emitted when the aircraft was already spinning.

- There was no possibility to identify the second air-mobile : no manned aircraft was signalled missing, the UK test centres of the Welsh coast were closed, no dangerous military activities had been NOTAM warned, no Irish Air Corps activity was in the air before the flights for SAR taking off in the early afternoon ……

  In conclusion, no positive evidence : this was stated in the report (§ 2.21 line 12).

- Several statements had to be rejected, in particular those given by witnesses located West of Waterford and by those eye witnesses having positively identified an AER LINGUS Viscount, flying (in an abnormal attitude) over Old Parish, or Ballykally.

The statement of one witness was considered reliable for what he observed at Hook Head, and not reliable for what he observed at Ballykally.

5.1.3 Inconclusive 1970 Report

Under the headline "Conclusions", the Report states in the "Findings" (§ 2.2.1) :

For a reason that cannot be determined ….the aircraft went into a spin …

- The aircraft flew in a disabled condition over the sea (no witness) for a period of at least 10 mn (based on two independent witnesses) during which no radio signals were received from it (no evidence that it was flying)

- There is evidence which could be construed as indicative (evidence or

  indicative ?) of the possible presence of another aircraft or airborne object in the vicinity ….There is no substantiating evidence of such a possibility…..

  and in the "Probable cause " (§ 2.2.2)

- There is not enough evidence available on which to reach a conclusion ……

  The probable cause of the final impact ….was impairment of the controllability of the aircraft ….(The probable cause of the final impact is the consequence of the unidentified probable cause of the accident !).

5.1.4 Consequences of this inconclusive Report

5.1.4.1 Since there was no probable cause identified, nor causal factors, the responsibility of the aircraft manufacturer, his subcontractors, and of the operating airline could not be a matter for claims.

5.1.4.2 Since there was nothing clearly explained about the accident process, together with very few bodies recovered, the relatives of the victims were deeply frustrated, asking for further explanations about a fully consistent accident process.

5.1.4.3 As a consequence, several attempts were made to generate consistent scenarios; but in order to be consistent, they had to deliberately ignore those parameters which should have made this scenario inconsistent.

Thus opening the door to pure imagination, imagination going up to the most sophisticated "Conspiracy theories".

5.1.4.4 The foregoing factors led to much speculation. It is the aim of this study to clarify the

facts surrounding the accident.

5.1.5 Operational Analysis Methodology

5.1.5.1 The scenario including the existence of a second air-mobile in the vicinity of the Viscount and a mid-air collision between both, as "suggested" in the 1970 report, is based on the following :

- If EI-AOM was, at 10.58, at a position near to the one conforming to the flight plan, in accordance with the radio-comms transcripts

- If EI-AOM crashed at Tuskar Rock between 11.10 and 11.15, as stated by two witnesses considered as reliable

- Then, the air-mobile which was sighted over Fethard, coming from a North West direction at low altitude could not be the Viscount.

- As a consequence, it had to be another one which could have collided with EI-AOM before it was sighted over Fethard.

It is of interest to observe that "the conclusion that there was such another aircraft in the area is inescapable", is valid if, and only if :

- This aircraft collided with the Viscount at 17.000 ft

- And was sighted over Fethard at low level after the collision.

5.1.5.2 This scenario calls for the following observations:

- The existence of the second air-mobile does not result from a positive evidence, but from a deduction in the conclusions.

  Consequently, the first check is to state if, and under which conditions, a mid-air collision is feasible in the environmental conditions existing in 1968.

  Several scenarios of mid-air collision are proposed today. An assessment of each of those against the realistic constraints existing in 1968 will conclude if these scenarios are plausible, and which one is the most plausible.

- The existence of the second air-mobile is the consequence of a reasoning based

  on :

  - The position of the spin

  - The time of the crash

  - The sighting of an air-mobile, considered "non identified", over Fethard, around noon.

  If one of these three considerations is demonstrated not valid, then there is no need for the existence of a second air-mobile.

- The questioning of the time of the crash was the basis of a scenario generated by a retired British Airways Captain.

- The position of the spin, and the "non-identification" of the low altitude air-mobile may also be matter of questioning.

- An assessment between a "realistic mid-air collision" scenario, and those scenarios resulting from the questioning of the basis of this scenario could allow to determine the most probable scenario fitting with the most probable technical cause (s) of the initial upset and subsequent degradation process of the aircraft.

5.1.5.3 The resulting Methodology of the operational Analysis is :

1st step :

Description of the different "mid-air collision scenarios", assessment of each of them against the constraints existing in 1968 , and conclusion with respect to their probability of occurrence.

2nd step :

Description of the different scenarios generated by the questioning of one or several considerations on which was based the reasoning of the 1968 Investigation Commission.

Assessment of their internal consistency. Identification of those scenarios externally consistent.

3rd step :

Identification of the most probable scenario.

5.2 "MID-AIR COLLISION" SCENARIOS OPERATIONAL ANALYSIS

- A mid-air collision may result from :

  · A human error of the pilot of an aircraft flying near the Viscount :

    During a military exercise at sea,

  · A wrong identification of the target by the operations officers on board the ship

  · Technical failure of the guidance system of a long/medium range missile

  · During a weapon system flight testing including the use of a drone, 2 technical failures in the remote-controlled destruction and in the self-destruction systems of the drone (if fitted).

"Mid-air collision" Scenarios

Several "mid-air collision" scenarios have been suggested or created:

· The first one was suggested by the Investigation Team's Final Report, when concluding that the presence of a second aircraft in the vicinity was inescapable.

  It can be considered that the "Tragedy at Tuskar Rock", by Dermot Walsh, complements this scenario , since the author often states that this book was written with the support of Mr O'Sullivan, then retired, so not further linked by the "Reserve Duty".

· The second one is proposed by a retired RAF Captain, who supports also some victims' relatives.

Collision with an unmanned Aircraft .

Description :

§ 2.2.1-12 : …….”another aircraft or airborne object in the vicinity” of the Viscount……

- By reason of collision, or by its proximity causing an evasive manoeuvre, or by its wake turbulence

- Might have been the initiating cause of an upsetting manoeuvre resulting in the Viscount entering a spin or a spiral dive.

§ 2.1.4.10 : ….an unmanned aircraft had fallen in the sea, and remained afloat for some hours.

This may be described :

- A drone collided (or near-collided) with the Viscount just before 10.58 (GMT).

- The Viscount flew in a disabled condition for about 15 mn

- The drone flew in a disabled condition over Fethard and crashed between Hook Head and the Saltee’s around noon and remained afloat for some hours.

Conclusion :

Taking into account the characteristics of the UK weapons systems in tests or in operations in 1968, a “collision” or a “near collision” near Tuskar with a drone or a missile is possible.

But in no case the colliding drone or missile can be observed over Fethard in such conditions where an air mobile was observed.

As a conclusion, it can be stated as in the 1968 report, that :

> If the location of the initial spin is that one reconstructed from the radio-comms transcripts

> If the time of the crash as observed by two independent witnesses is the good one

> Then the air mobile which was sighted over Fethard is not the Viscount

> Consequently there is a second air mobile in the vicinity

Today the conclusion is that :

> This second air mobile cannot be a missile or a drone having “collided” or “near collided” with the Viscount.

Collision with a manned Aircraft.

Description

The collision could result from an error of one of the two pilots flying in formation without being sufficiently trained ; as an example, a scenario was generated by an experienced pilot, ex-RAF sqadron leader: the Viscount Capt'n should have called one of his friends of the IAC to help him for an outside inspection. Unfortunately, since flying too near one from the other , both aircraft collided.

Conclusion:

This scenario takes place in a logical reasoning aimed at the identification of the second air mobile over Fethard.

- This scenario is internally consistent, and expresses a deep air military experience.
- Some interpretations of the individual witnesses' statements are of interest, but it was not possible to reconcile the track of the scenario together with the witnesses' statements.
- The duration of the pilotless flight seems too long, for a disabled aircraft.
- The sequencing of the crash is difficult to understand.
- The key factor is that there is no IAC aircraft which could have disappeared that day.

Although this scenario is internally consistent, it lacks of substantiation :

> No aircraft missing in IAC

> The flight of the disabled IAC aircraft after the collision is difficult to reconstruct, in particular in the Tory Hill area, and in the Fethard area when pilotless.

Conclusion of the Operational Analysis of the "Mid-Air Collision" Scenarios

- On the 24th March 1968, at noon, and taking into account or not the UK official statements on the closure of their ranges or on the position of their ships, a collision or a "near collision" with a missile or a drone is possible, but in no case, this missile or this drone could be observed over Fethard as stated by some witnesses.

- A collision with an Irish Air Corps aircraft looks like "a murder without corpse".

The proposed track reconstruction is very difficult to reconcile with the witnesses' statements.

As a consequence, there is an extremely remote possibility of a "mid-air collision or near collision".

So the logical attitude is to question the assumptions which made inescapable the presence of a second aircraft in the vicinity.

5.3 :“NO RECOVERY” SCENARIO

The “mid-air collision “ scenario suggested in the 1970 report was based on the following assumptions :

> The Viscount was at the position estimated by the flight reconstruction based on the Shannon radio-comms transcript.

> The Viscount crashed between 11.10 and 11.15 GMT.

The “No recovery” scenario, created by a retired Captain of British Airways, calls into question the time of the crash, since there was no recovery from the spin, and the aircraft did not fly for around 10 mn in a disabled condition.

Description

> The Viscount followed its flight plan, without flying “off airways”.

> When flying over Tuskar, a sudden event occurred; the most plausible one being a door strike, since there was an “ inherent design fault with the doors “.

> The Viscount went into a spin, which the crew did not recover, since this was very difficult , and experienced only at one occasion, by the Vickers Chief test pilot.

> The Viscount crashed at that place where the wreckage was located, 90 sec later, around 11.00 (GMT).

Conclusion

This scenario is internally consistent, but the basis on which it has been elaborated seems too short:

> The main one, the difference in the timing of the message “by Bannow” seems to be the result of typing errors.

> The position where the part of the trim tab has been recovered does not mean that the tab separated in flight at that position, nor that it separated in flight.

In addition, this scenario ignores the statements of all witnesses.

This scenario is not enough substantiated to be considered realistic. But some aspects are of interest: the probability for a door strike has been assessed in the technical analysis; the fact that the author thinks that a radio-transcript can be “amended” shows that , in his Captain’s life, he may have experienced a situation of such “obfuscation“.

5.4 : "AS PER WITNESSES" SCENARIO

5.4.1 :Methodology

Coming back to the assumptions on which were based the 1970 report conclusions, the last assumption to be questioned was the one of the geographic position of the Viscount at 11.58 (local time).

"Questioning the geographic position of the Viscount at 11.58 " means :
"Questioning the validity of the contents of the Shannon R/T transcript.

Two possible Scenarios

If the scenario generated from the witnesses' statements implies that the content of the transcript is wrong, it may be wrong for one of the two following reasons :

> The first one is that the last two messages between the Viscount and the Shannon ATC result from an error introduced by the ATC officers.
> The second one is that the Viscount crew irregularly reported the aircraft position.

Both scenarios have to be analysed .

The Scenario "Disabled Flight"

In this scenario, the statements of the witnesses are interpreted out of any constraint related to the R/T transmissions.

The witnesses' statement describe the track of the Viscount, a timing consistent with this track and a degradation process which appears technically logic. But, if the aircraft is disabled from mn 42 on, the error in the transcript is introduced by the ATC.

The Scenario "Deviation from the Flight Plan"

If it is assumed that the error in the transcript is introduced by the crew, the statements of the witnesses are elaborated taking into account the necessity for the Viscount to emit a message in such conditions that it could be received by Shannon ATC at 11.51 and at 11.57 (local time).

The assessment aims at identifying the probability of occurrence of such a scenario.

Shannon R/T Transcript critical Analysis

If the probability of occurrence of the scenario "Deviation from the Flight plan" is considered remote, and in order not to feed another 30 years of imaginary production, the assumption of an error introduced in the transcript of Shannon radio-comms is inescapable.
The distortion between the original recording and the R/T comms transcript may result from a misinterpretation of an unreadable message, or from an intentional addition of two non-existing messages.

It is not in the skills of the team to determine why and how this happened. However, some observations, limited to the aeronautic domain, may be of interest in that difficult matter.

5.4.2 Scenario "As per Witnesses/Disabled Flight"

5.4.2.1 Description

5.4.2.1.1 Track Reconstruction

5.4.2.1.1.1.1 Positioning of the Viscount. (refer maps in Appendix 5.4a2)

Between Cork and Old Parish.

Between Cork and Old Parish area (Dungarvan) :

The Viscount had a route "as per its flight plan", possibly slightly North of it

It was climbing, steadily, at the normal rate of climb.

Over the "Old Parish" area :

- A Viscount crossing 9 to 10.000 feet suddenly interrupted its climbing, and dived in a spin (possibly a spiral), right handed, over land or most likely quite a few nautical miles at sea.
- It recovered from its dive, and appeared to a witness to be attempting to go back to Cork.
- It was seen for two left turns, above the cliffs at Crobally, then heading North-East, seen or heard from Ballytrissane, Ballymacart, Ballinroad and Ballitlea.
- During this phase of the flight, it flew at low altitude, at a maximum height of no more than 1000' to 2000' feet.

Between Old Parish and Tramore, and over Tramore Area

From Old Parish to Tramore, the Viscount was not observed. It was presumably low altitude, most of the time over the sea.

It then was observed flying low, over Newtown (South Tramore), crossing Tramore Bay, heading slightly South of Brownstown Head, gaining some hundreds of feet.

Then, suddenly turned left, descending down to nap of the earth, heading North.

Between Brownstown Head and the Kennedy Arboretum.

From Brownstown Head to Tory Hill, a Viscount was seen heading to Tory Hill, at very low altitude.

After a steep turn right, it gained altitude for about 3 to 4 mn , and then, again, suddenly, dived

From Kennedy Arboretum, around Slievecoiltia Hill, to Fethard

The Viscount, in the area of Kennedy Arboretum, experienced presumably a second dive, which was seen from Tory Hill and heard from Ballykelly.

Once again, the crew recovered at very low altitude, flew around Slievecoitlea Hill, over Ballykelly; then headed to Fethard at an altitude around 1000 feet.

Over Fethard Area

An accurate track reconstruction over Fethard is difficult to obtain. However, it seems probable that a Viscount arrived from Campile, Dunbrody Abbey over Saltmills, slight turn right for heading to Baginbun Head, then it carried out a steep turn right towards Slade, after which heading North and again turn right and fly over Fethards, slightly South of Grange, heading to the Keeragh Islands, when after one minute, something happened which made a big sound.

The altitude did not vary too much, presumably around 1000 feet.

Several witnesses were definitely persuaded that it was a Viscount.

From Fethard Area to Tuskar Rock

The track reconstruction, between Fethard and Tuskar cannot be precise, since the aircraft flew over the sea.

However, it is probable that a part separated from the aircraft when it was flying 4 to 5 nautical miles East of Fethard: this was heard, and the separated part was observed.

It is possible that some other part separated between Black Rock and Carnsore Point; but this is not cross checked visually.

It is certain that two witnesses saw the final impact point, since their statement is consistent with the location of the main wreckage.

5.4.2.1.1.2 Timing

A timing which appears to be consistent with the statements of most of the witnesses, and which fits with the performance characteristics of the Viscount is the following:

.	11.32 h	take-off from Cork
.	11.42 – 11.44h	first dive over Old Parish
.	11.58 h	second dive over Kennedy Arboretum
.	12.14 h	crash

which means 32 mn flight in a disabled condition.

5.4.2.1.2 Aircraft Degradation Process

First Spin over Old Parish

An assumption which fits with the observations of the witnesses and with the characteristics of the Viscount could describe the sequence prior to the first spin as follows:

A sudden event decreases the negative lift of the port tailplane. This event may be :

- A bird strike, destroying only the skin of the tail. At 10.000 feet in the Dungarvan area, such birds are relatively common (refer Appendix 3a).
- A disconnect of an elevator tab.
- A leakage of pressurized cabin air through a crack in the rear bulkhead , which could "derivet" the skin of the lower surface of the port tailplane.

The loss of the negative lift induces a movement of the plane nose down, right wing down, turning right, resulting in negative accelerations with particular effects upon engines Nr 3 and Nr 4.

These engines will auto-feather, thus increasing the diving and turning movement in a spin.

A single loud sound was heard by two witnesses. It is not clear if this sound has been generated by the initial event or during the spin and recovery phase.

Crew Reaction: Spin Recovery

The only experience of a spin successfully recovered was by the test pilot of Vickers together with a CAA co-pilot.

They succeeded when they re-created the air flow around the tailplanes surfaces, by use of power, in order to make them efficient.

They succeeded also because the test pilot experienced during his training courses spins on Spitfire, Buccaneer, …..(all aircraft quite difficult to recover from a spin), and because of his psychological characteristics.

The crew of the EI-AOM Viscount succeeded in the recovery taking benefit of the Captain's experience on Spitfire.

It is possible that this time was used for unfeathering the propeller Nr 4.

Afterwards, there remained, possibly, 2000 to 3000 feet consistent for the recovery, which may have resulted, presumably, in large positive accelerations, which could have caused further degradation in the structural

integrity of the aircraft, mainly in the tail. It is considered a good estimation that 1500 feet are necessary to recover the plane, after the initiation of the first recovery action.

After the successful unfeathering of the propeller Nr 4, and the successful recovery of the aircraft, the crew succeeded in the unfeathering of propeller Nr 3.

But the aircraft may have been sufficiently damaged at that stage to have reduced handling capabilities

It is however understood why the crew gave priority to these urgent manoeuvres versus the emission of an alarm message. After the recovery,

something in the radio VHF subsystem could have been damaged, and the aircraft was too low in altitude to have good radio-comms with Shannon.

Handling Capabilities of the disabled Aircraft

After the recovery, the Viscount may had suffered, at least, further damage in the tail plane, resulting in the need of a high control effort by the crew..

In order to avoid crashing, the crew could only, by time, roll on to transform a nose-down movement towards the ground, in an horizontal turn which became very difficult to control because of the damages in the rear part of the aircraft. The crew could also lighten the muscular effort on controls by applying power on the engines, thus being unable to descend for a safe forced landing, or ditching.

Second Spin over Kennedy Arboretum

A second spin is technically possible, following a crew member's inadvertent over-correction, or aircraft deformation ,whilst the plane was climbing at high rate of climb, with engines set at full power.

This action could induce a high Angle of Attack leading to a stall, and the asymmetry in tail-lifts , triggering a spin or a spiral.

The aircraft could have been again recovered out of the spin. The people in Ballykelly church heard the power increase of the engines, necessitated by the recovery procedure, but supplementary damage may have been suffered by the aircraft.

Between Ballykelly and Tuskar Rock

> The Viscount was observed at Ballykelly and by Campile, steady, slightly climbing , without any external sign of being damaged.

> Over Saltmills, it was descending, unsteady, it emitted 3 small black "clouds", but sounded "normal".

> Over Fethard, it was spraying around itself what could be "swirling clouds" which, when looked at against the sun, could be similar to a fire accompanying the plane when seen in the direction of the sun.The plane then was emitting a loud and rough noise, like a motor bike.

> Over Ralph, it continued to spray fuel.

> Over Grange, 3 to 4 minutes later, it continued to spray fuel . East of Grange for one minute, a loud bang was heard, at least by two witnesses.

> A part of the Viscount, shaped like a wing, possibly separated from the Viscount when the bang occurred, since 4 witnesses saw it from 1.30 pm to 3.30 pm, drifting South-East in the sea.

> No one saw or heard anything from the plane from East Grange to a line between Carnsore point and the Barrels. A mushroom of water was observed on that line and a low darkish cloud.

Several people in the area around Carnsore point heard a heavy noise, or a bang, or a tyre burst, but it is not possible to identify the time when they heard this noise to conclude if it was the separation of a second part of the aircraft, or the final crash.

- The same observations with regard to the sequence of steady and unsteady phases call for the same explanations as between Old Parish and Tory Hill.

- In addition, presumably as a consequence of the second spin, the fuel system and the engines have initiated a degradation process.

  > The FCU delivered in the Saltmills area an uncontrolled fuel flow to 3 of the 4 engines, resulting in the 3 observed black clouds.

  > A leakage in the fuel circuit became apparent from the time when flying over Fethard, and during the 4 to 5 minutes the Viscount was observed over the peninsula.

  This leakage could come from a partial disconnection of two pipes, or from a damaged valve ; as an example, it can be noted that, in the wreckage, the starboard valve of the Refuel/Defuel system was found partly open r(refer Appendix 5.4f).

  This assumption may be given more confidence following the 6.08.1.NA statement about the bird which landed in the garden of a farmer at Gorteens; this bird was completely immersed in a sort of liquid which could not be lubricating oil, but which could be fuel or hydraulics.

  During its flight over Fethard, the sound emitted by the Viscount became different, and from a normal sound of turbine (as a Hoover…) became a sound as the one of a motor bike… This latter could be the sound of a part of the tail fluttering more and more.

> As a consequence of this increasing flutter, it is not technically unacceptable that a part, like the port elevator, separated from the plane, East of Grange.

The metallic piece has the form of a wing, however much smaller. It may have, when separated, an air trajectory and an attitude when entering the sea which allows it to float, without being destroyed at the impact. It seems that it floated for at least three hours.

> The trim tab, which is a part of the port elevator was found on a beach, near Carnsore Point. This means that, when the elevator separated, the trim tab should have remained linked to the fuselage by the actuating rods.

It then detached shortly before or at the crash.

> It is not so easy to assess if there had been a second part separated, in the vicinity of the Barrels, should this part be the starboard elevator or the port tailplane.

> After the second spin, the degradation process of the aircraft accelerated. This was illustrated through :

- Engines dysfunctionning = black clouds
- Fuel streaming = swirling cloud leakage
- Increased flutter = generating noise like a motor bike .

This resulted in the separation of what may have been all or part of the port elevator, East of Fethard peninsula.

> After that separation, the crew succeeded in keeping the Viscount in flight for about 8 minutes.

> After 5 to 7 minutes of such still controlled flight of the disabled aircraft, it probably lost its port tail plane, in the vicinity of the Barrels.

The Crash

However operating conditions at the time of the crash “Steady state conditions of the engines and the aircraft, with zero fuel flow and a true forward speed of less than 200 kts “ are possible, it seems more probable that the crash resulted in the separation of the port tailplane, following the separation of the port elevator that occurred 5 minutes before, thus making the aircraft uncontrollable;

The operating conditions at the time of the crash should have been :

- Steady state of the engines at idling fuel flow, and of the propellers at flight fine pitch stop.
- The attitude of this uncontrollable aircraft should show the following :

> Nose down by at least 45°

> Left bank angle by 45°

> Airspeed much more than 200 kts, with a forward component less than 130 kts and a considerable vertical speed.

In this case, the vertical speed should not result from a stall, but from the pitch down movement due to the cancellation of the negative lift of the tail.

This fits with the statement of the Spanish sailor, "……it seems to me that it fell on its left wing" . From that distance, he could not have identified a left wing low if the bank angle was no more than 15°.

5.4.2.2 Assessment of the Scenario "as per Witnesses"

In this scenario, the positioning and the timing are self consistent; they fit with the witness statements; except during its legs over the sea, the flight was continuously observed, and the air mobile identified as a Viscount.

The statements given by the witnesses allow for technically logic assumptions explaining the degradation process of the aircraft; the duration of this degradation process is similar to this of the other accidents of the same similarity family, around 30 mn.

But two messages transcripted from the Shannon radio-comms cannot fit with this scenario.

10.51.[48]	712	- Level at 170
	Shannon	- Roger, report at Bannow
10.57.[07]	712	- 712, By Bannow, level 170, estimating Strumble at 03
	Shannon	- Roger, say again time By Bannow. I got the Strumble estimate OK
	712	- 57
	Shannon	- OK, time 56.5. Change to London AWYS 131,2. Good Bye.
	712	- 131,2.

The information contained in this messages is entirely incompatible with the track reconstructed here-above, which shows that, at that time, the aircraft was at lower altitude, somewhere between Old Parish and the Kennedy Arboretum.

5.4.3 Scenario "As per Witnesses/Deviation from the Flight Plan

Since it is difficult to imagine that the Shannon ATC introduced a distortion between the original recording and the R/T comms transcript, the first assumption is to consider that the crew, deliberately, decided to divert from their flight plan and to report wrong positions at regular timing.

5.4.3.1 Flight Reconstruction

Based on this assumption, the low altitude flight observed by several witnesses is not the consequence of a damage suffered by the Viscount , but the execution of the deliberate will of the Captain. Explainable reasons : touristic or familial flight over a place or a person well known by him, or deviating flight at the request of a passenger, (for instance, an American passenger may have asked to fly over the Kennedy's house).

Consequently, the track reconstruction should be described as follows:

11.32 h	Take off from Cork
11.42 h	After having established the R/T liaison with Shannon, and having given the ETA Strumble, beginning of the deviation from the flight plan. Rapid descent and flight at low altitude over Old Parish, then to Tramore.
11.51 h	Pop-up over the sea to transmit the message "Level at 170"
10.57 h	When passing 3000 feet, climbing, heading towards the Saltees and Strumble, reporting as if at the FIR boundary.
10.58 h	While climbing, above 5000 feet, a sudden event damages the tail of the Viscount, thus resulting in a spin turning right, which was observed from Tory Hill. Distress message : "EI-AOM with you.." relayed to London ATC by two aircraft in flight, but also recorded on London tape. Then, flight similar to what has been described in the here-above scenario "disabled flight".

5.4.3.2 Assessment

Although an irregular deviation from the flight plan is possible, since :

- There was no positive radar coverage in that area, at low altitude
- The "aura" of the Captains, ex Combat pilots, was imposing enough not to take care of the risks that such a manoeuvre could make them to incur.
- The Viscount was the only aircraft flying in that area, all weather conditions being excellent.

The assessment drives to the conclusion that this scenario is of a very remote possibility, because of :

- The psychological characteristics of the Captain , as reported by several of his relatives and friends.
- The several existing procedures, at that time, to make a “regular” diversion from the flight plan. If the Captain had decided to satisfy the request of a passenger, for instance, there is no doubt, according to his fellow captains, that he would not have chosen to proceed irregularly.
- The inconsistency of the ETA Strumble correction, if the crew had decided to proceed in that irregular diversion. All along the diversion path, this ETA became more and more unrealistic; and the Captain knew that this was the key information for London to manage at the best his arrival trajectory to London airport.
- The excess of fuel consumption to be justified to the Airline.
- And mainly, this supposition is contradicted by the witnesses located in Youghal or Old Parish, and raise questions with regard to the statements of the witness at Tory Hill.

Consequently, at this stage , the present study is in a situation quite similar to the one of the 1970 report :

In 1970, the (non) conclusion was : under the assumptions that the transcripts are exact, and that the time of the crash is exact, the air-mobile sighted over Fathead cannot be the Viscount ; “the conclusion that there was such another aircraft in the area is inescapable”.

This sentence fed a 30 years controversy.

Today, the conclusion could be : under the assumption that the crew did not do anything irregular, the conclusion that the transcript of the Shannon radio-comms does not describe the exact R/T is inescapable.

In order to avoid a new 30 years war, a deeper analysis of that conclusion is to be made.

5.4.4 Shannon R/T Transcript critical Analysis

5.4.4.1 Aim of this critical Analysis

- Despite the apparent similarities between both situations, at this step of the present study and at the end of the 1970 investigation, they are fundamentally quite different.

  Indeed, in 1970, the inconsistency between the estimated position of the Viscount at 58 and the observations made around noon by the witnesses located in Fethard drove the Investigation Commission to envisage a possible mid-air collision : this collision had a direct impact on the accident process.

  Now it is clear that the inconsistency between the last two messages of the Shannon R/T transcript and the positions of the Viscount as observed by the witnesses has no impact on the accident process : these two messages do not influence the initial event, the degradation process of the aircraft, the crash, and they do not influence the reaction time of the ATS for launching the Search and Rescue actions, since everything was adequately made by London ATC.

  So the scenario "as per witnesses/disabled flight", cannot be a source of imaginative speculations : it is the only answer of the Intern'l Team to their task "to shed further light on the Tuskar Rock accident".

- Consequently the Shannon R/T transcript critical analysis is aimed simply at reducing the inconsistency which still exists inside this unique answer.

  It does not present any interest for the Intern'l Team to identify who is at the origin of this possibly incorrect transcript; the Team is not skilled for that.

  What is of interest is to assess on the probability of occurrence of such an irregular transcript , which misled the 1968 Investigation Commission when they based the track reconstruction on the R/T transcript.

  This assessment is to be conducted keeping in mind that the Shannon ATC is a governmental service, with strict operating procedures and highly motivated civil servants (as observed during the interviews which were conducted by the Intern'l Team).

  The subject matter of assessment will never be the actors themselves, but the procedures, as they appear through the data remaining available and the interviews of the still alive witnesses.

5.4.4.4.2 Assessment

A valuable assessment should need some complementary information which is not available at the present day .

The unavailability of the original tapes is of importance.

The duration of the two Shannon radio and telephone transmission transcripts should have covered up to 11.25, when the “full alert” was declared.

A valuable information could refer to the conditions under which were executed the previous EI 712 flights between Cork and Heathrow.

5.4.4.3 : Conclusion of the critical Analysis of the Shannon R/T Transcript

- Since there are on one hand about 50 independent witnesses,
- since each of their statements is consistent with the other ones, and allows for a complete track reconstruction and for a technically logical description of the degradation process of EI-AOM,
- since there is on the other side, the transcript of two messages which were exchanged on the Shannon ATC frequency during a period of time when EI-AOM was the only flight under their control,
- since several questions are still pending, and cannot be answered , unfortunately,.

the opinion of the Intern’l Team is that the weak side of the inconsistency is that of Shannon ATC. But this opinion cannot be evidenced.

This opinion gives some light on the reasons why the 1968 Investigation Commission could not conclude their accident report.

Neither this opinion, nor the final truth, if it can be obtained at a time, has a direct impact on the accident process, from the initial event to the Search and Rescue activities.

5.5 CONCLUSIONS OF THE OPERATIONAL ANALYSIS

5.5.1 The 1970 Report concluded that :

- if EI-AOM was, at 10.58, at a position near to the one according to the flight plan, in accordance with the radio-comms transcripts,
- if EI-AOM crashed at Tuskar Rock between 11.10 and 11.15, as it results from the statements of two witnesses considered as reliable,
- then the air mobile which was sighted over Fethard, coming from a North West direction at low altitude could not be the Viscount,
- as a consequence, it had to be another one, which could have collided with EI-AOM before it was sighted over Fethard.

5.5.2 The first check was to assess on the internal consistency of such a suggested scenario :

- was a collision by an unmanned aircraft possible ?
- could the colliding air mobile be the one which was observed over Fethard ?

Taking into account the location of the UK ground bases and the performance characteristics of the 1968 air-to-air and surface/ship-to-air missiles, it can be stated without ambiguity or restriction that :

- it is possible that a collision or a near collision occurred,
- it is impossible that the colliding missile or drone be the air-mobile sighted over Fethard.

This scenario presents a fundamental inherent inconsistency, and cannot be an acceptable explanation of the accident.

5.5.3 The second step was to assess on a possible collision with a manned aircraft.

In this respect, several possible occurrences of mid-air collisions with a manned aircraft have been presented, most of them based on partial realistic observations. Their weakness comes from the fact that they have to ignore several other observations which should have made the story inconsistent if they had not been ignored.

When complete scenarios are implemented, their probability of occurrence is to be assessed against the complete set of observations made from the ground, the technical and operational considerations to be fulfilled for a collision to occur, and the technical and operational considerations which cannot be ignored after the occurrence of a mid-air collision.

On that day, none of the eventual collisions with a manned aircraft, reported to the team, could be successfully assessed against the witnesses' observations, and the relevant technical and operational considerations.

5.5.4 Since the "mid-air collision" scenarios could not describe a fully consistent accident sequence, it was time to question the assumptions on which it was based :

- the first assumption questioned was the time of the crash, and the questioning was due to the fact that there were no obvious technical reasons allowing for a partial recovery,

- this scenario is internally consistent, but it is not technically or operationally evidenced. In addition, it ignores all the statements made by several witnesses.

5.5.5 The last point to be checked was to question the position of the Viscount at 10.58, which means to question the validity of the transcripts on which is based this estimated position.

The real position of the Viscount at 10.58 may be different from the one estimated from the contents of the transcript for two reasons :

- either the position of the ac was irregularly reported by the Flight crew in the two last messages received by Shannon ATC

- or the transcript of the two last recorded messages was irregularly produced by the ATC officers.

5.5.6 Although an irregular deviation from the flight plan is possible, since, in particular, the radar coverage was not positive, at low altitude, in the area of Waterford, a detailed assessment drives to the conclusion that such a scenario is of a very remote possibility.

5.5.7 Consequently the scenario "as per witnesses/disabled flight" is the ONE which fits with all the ground witnesses statements, and which describes in an acceptable operational and technical way the degradation process of the Viscount.

Its reliability comes from the number of independent statements which fit one to the other; its reliability cannot come from evidence, since, at the present stage, no pieces of material evidence are available.

5.5.8 The last two messages transcripted from the Shannon R/T comms cannot fit in that scenario, but the real existence or not existence of these two messages has no consequence in the Viscount accident sequence.

In 1968, a track reconstruction based on these messages has driven the Investigation Commission to a non-conclusive report.

Now the questioning of these two messages allows for a unique and consistent explanation of what was observed from the ground.

6. CONCLUSIONS OF THE STUDY

The International Team (IT) reached the following conclusions :

6.0 : Historical background

6.0.1 The formal accident report (AAP) N° 6 issued on 30 June 1970 was deficient in that insufficient effort was made to thoroughly reconstruct the track of the aircraft and that pertinent material was excluded.

6.0.2 The Review Report issued in June 2000 is a thorough, impartial and professional review of files pertaining to the accident. It clarified many issues and uncovered significant new material.

6.0.3 The data still available today, on which to base a study, are as follows :.

- All requested accident reports from other Viscount accidents obtained from the respective national AIUs.
- Partial files of AOM accident investigation
- Partial technical data of the Viscount aircraft.
- Partial operational data.of the Viscount.

No Aer Lingus maintenance record and no material part of the EI-AOM were provided for examination but several witnesses' statements, either delivered in 1968 or later, were available.

Consequently, the present study cannot lead to the issuance of an ICAO type accident report. In accordance with the mission letter, this study is aimed at shedding further light on the circumstances surrounding the accident to Air Lingus Vickers Viscount 803 EI-AOM.

6.1 : With respect to the presence of another air mobile :

6.1.1 The 1970 accident report AAP N° 6 was inconclusive and although no cause was found, the suggestion was made in the report that the presence of another aircraft in the area was inescapable.

As a consequence, several "Theories" attempted to provide consistent answers, such as :

- Collision or near collision with a missile,
- Collision or near collision with a drone,
- Collision with a manned aircraft.

And some others, including "conspiracy" theories, which are still alive …..

6.1.2 An analysis based on the technical and operational characteristics of the British missiles and drones operated in 1968, shows a collision between such air mobiles launched from the U.K ranges or ships and the Irish Viscount, in the vicinity of Tuskar Rock, was technically possible but it is impossible that, after the collision, this un-manned aircraft be seen over Fethard, in the conditions reported by the witnesses.

The analysis of the scenario based on a collision with a manned aircraft shows that, although such a scenario is operationally possible, it does not fit in with the statements of witnesses. And there is no aircraft which could have crashed on that day.

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The scenario based on the assumption that AOM never recovered from its initial loss of control ignores the statements of all the witnesses and is lacking substantiation.

The International Team have carefully examined all aspects of the tests conducted in the U.K ranges and of the sea and air activities performed on that Sunday. It is their opinion that all theories involving the presence of another aircraft can be rejected.

6.2 : With respect to the Flight reconstruction :

6.2.1 All ways explored being "dead ends", the only one remaining was to question the basis on which the 1968 investigation was built.

This basis, used for the AOM Flight reconstruction, was the radio-comms transcript of Shannon ATC.

6.2.2 Following the statements of the witnesses, who answered the "call for witnesses" emitted at the end of the year 2000, and taking into account the statements received in 1968, which were discounted at the time, since they could not fit with the flight construction based on the R/T transcripts, it was possible to reconstruct the following EI-AOM accident process.

- First loss of control over Old Parish between 11.42 and 11.44 (local time)

- Disabled flight from Old Parish to Tramore Bay, Brownstown Head, Tory Hill and Kennedy Arboretum

- Second loss of control over Kennedy Arboretum at 11.58 , and emission of the distress message on London Airways control frequency

- Disabled flight around Slievecoiltra Hill, over Ballykally, Fethard, Saltees Islands , the Barrels

- Crash at Tuskar Rock.at approximately 12.15 .

The aircraft degradation process lasted for around 30 minutes and included the separation of an object, possibly the port elevator or part of it , East of Fethard , and probably the separation of the port tailplane over the Barrels.

It is to be noted that the above description is based on the statements of 46 witnesses, 24 of them being eye witnesses, and 8 of them having identified a green and silver coloured Viscount. The statements given in March/April 68 were laid with the Gardai.

As a consequence of the number of eye-witnesses, the opinion of the International Team is that the Flight track reconstruction is essentially as described in § 6.2.2, and not as described in the 1970 accident report.

6.2.3 : The content of the last two messages radioed on the ATC Shannon frequency reporting " levelling at FL 170" and " By Bannow, flight level 170", cannot fit with

that flight reconstruction.

6.2.4 A possible assumption has been to consider that the crew irregularly reported the aircraft position in each of these two messages. However, a detailed assessment drives to the conclusion that this deviation out of the IFR flight plan is an hypothesis which is extremely unlikely.

6.2.5 Consequently, the inconsistency between the track reconstruction and the R/T Shannon transcript can be solved only if it is possible to identify the cause of an error in the transcript of the R/T communications issued by Shannon ATC.

The data available today, and the interviews of the two still alive witnesses do not allow for such an identification.

However some observations may be significant :

- The original tapes are not available: either they have been lost when the holder Service moved, or they have been re-used by Shannon ATC (in the seventies) with the authorisation of hierarchical Authorities.

- The extracts of the tapes, transcripted as relevant by Shannon ATC do not cover the complete period to be analysed.

- There is no exhaustive detailed chronological reports of the controllers and of the supervisor acting at the time of the accident.

- A detailed analysis of the contents of the messages indicates some discontinuities in the flight parameters, or some atypical reactions either from the acting Controller, or from the Captain (e.g: ETA Strumble).

Consequently, the opinion of the International Team is that the procedures which were applied in ATC Shannon at the time of the accident were either not well adapted (in particular for specific period of a transition between routine and emergency), or not carefully applied.

6.2.6 However, it is of importance to note that a dysfunction in Shannon ATC, if any occurred, did not have any detrimental consequence on the cause of the accident, nor on the degradation process of the Viscount.

6.3 With respect to the cause of the accident :

6.3.1 The method for identifying the probable cause of the AOM accident could not be based on the observation of the material parts of the wreckage, which were not available.

As a consequence, the International Team took advantage of the lessons learned from events in the whole life of the Viscount and certain other aircraft types, and compared to the AOM accident, those accidents which showed a similar loss of control, followed by some period of disabled flight.

6.3.2 This comparison concludes that the initial events causing a degradation process of the aircraft similar to the one suffered by EI-AOM could be :

- Door strike

- Bird strike

- Spigot rupture in the spring tab mechanism

- Structure failure

- Severe recovering manoeuvres,

alone , or in conjunction one with the other (s).

6.3.3 The technical investigation carried out as part of the initial investigation and presented as appendix material to the 1970 report was thorough and shows the enormous amount of dedicated work which went into the search, salvage and engineering investigation of the accident. Nevertheless it must be noted that with the exception of the fin, portion of the rudder and portions of two elevator tabs, nothing was recovered aft of the rear pressure bulkhead. The tailplanes, elevators and fuselage structure in the tailcone area were all missing.

6.3.4 Since the Investigation Commission accepted the position of the manufacturers which was not to open discussion on the matters related to the non-recovered parts, no conclusions on what could have happened to the empennage were established.

6.3.5 No maintenance documentation specific to the actual aircraft, was made available to the International Team.

There is no reason that the International Team contest the 2000 Review

conclusions :

- There is no evidence to suggest that any omission or error in the Inspection Visit 2.04 of the previous 1967 December contributed in any way to the accident.

- But serious errors in Aer Lingus maintenance scheduling may be indicative of a less than ideal work culture existing in the airline at that time.

6.3.6 The present technical analysis, which accepted that there was impairment of the pitch control and lack of lateral stability of the aircraft, resulted in the identification of the need to consider as possible causal factors, the following events :

- Door strike

- Bird strike

- Metal corrosion

- Maintenance error

- Metal fatigue

- Flutter

which could have damaged or affected the following components :

- Tailplane

- Elevator, including tabs

- Systems : pitch control

6.3.7 Operational considerations made possible to "narrow the field" of the possible assumptions.

A door strike or a failure of the main structure of the aircraft could be discounted as an initial triggering factor of the EI-AOM upset.

A review of the aircraft in-service experience, and, in particular, a number of defects and accidents which occurred posterior to that of EI-AOM, lead to the International Team's opinion as follows :

- **An initial event, which cannot be clearly identified , is considered to be some form of distress affecting the horizontal tail of the aircraft. Possible causal factors are metal fatigue, corrosion, flutter or a bird strike.**

- **It is possible that the sensitivity to negative accelerations of the engine fuel control unit and oil pressure supply to torquemeter system were contributory factors.**

- **The recovering manoeuvres of the aircraft following the initial upset and the subsequent flight would have been outside the airworthiness certification envelope and may have resulted in some deformation of the structure.**

- **A progressive failure of the structure of the port tail plane and elevator is consistent with the observations relating to the ultimate attitudes of the aircraft.**

Excessive spring tab free play resulting in the fatigue failure of a component in the tab operating mechanism could have induced a tailplane-elevator tab free flutter condition.

The consequence of a 6hz tab free induced elevator/tailplane flutter, according to the manufacturer, would be the generation of large elevator and tailplane forces capable of exciting the fuselage, thus producing severe vibrations.

The loads induced in the tail-plane would be sufficient to cause a structural fatigue failure within the time scale observed for EI-AOM.

6.3.8 : There was no involvement of any other aircraft or missile.

6.4 : With respect to the crew behaviour:

6.4.1 : Several witnesses statements support the opinion that the Viscount EI-AOM left the track planned in the Flight Plan.

6.4.2 : From the available data, it may be concluded that this deviation from the Flight Plan was most unlikely to have been due to a deliberate decision of the Captain.

6.4.3 The observed aircraft attitudes, with sudden and rough variations of the flight and engines parameters led to the opinion that the impairment of the stability of the aircraft was the cause of such exceptional movements for a transport aircraft.

6.4.4 The crew had to face a situation when, after the first upset, the aircraft was out of its certification envelope.

Extremely high control forces, possibly reaching as high as 450 pounds, had to be manually countered. The crew probably used the pitching effect of the engine power to stabilize the aircraft in pitch.

The tail, probably asymmetric from suffering damage may have affected the stability of the Viscount.

The very poor manoeuvrability of the Viscount during the degradation process explains why the crew could not come back to Cork, nor land or ditch on the large strands they know along the coast.

It is the International Team's opinion that it was a major achievement for the crew to be able to keep this aircraft flying for more than half an hour, with such poor manoeuvrability characteristics. This showed remarkable intrinsic and professional level of experience : It is equitable to acknowledge such a performance.

6.5 : Final comments :

6.5.1 : It is the International Team's opinion that the track reconstruction can be considered of factual nature, since it is substantiated by the consistent statements of so many witnesses, whilst the cause and the causal factors of the initial event and the description of the degradation process of the aircraft are of conjectural nature, since there is no longer available any piece of evidence.

6.5.2 The quest of further objective technical data appears to be an lengthy (and possibly unsuccessful) process, and, very costly in the present conditions.. For information, an estimate from BAe to the very first Request For Quotation is given in Appendix 6.a.

6.5.3 The Maintenance Files are no longer available in the Aer Lingus or in the Irish CAA archives.

6.5.4 The last 25 mn flight of AOM and AOF aircraft show noticeable similarities.

A further examination of the EI-AOF accident files may be of interest.

As a conclusion, the International Team is of the opinion that the files of the EI-AOM accident should be closed.