Aircraft SE-BDY "Albertina"

Ndola 18 SEPTEMBER 1961

Accident Investigator's Report

to the Hammarskjöld Commission

KRISTIANSTAD, SWEDEN, 15 AUGUST 2013

[SIGNED IN ORIGINAL]

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Background

The writer of this report is engaged pro bono by *"the Commission of Jurists, set up to inquire into the cause of the death of Dag Hammarskjöld"* – here called *the Commission*. The investigative task is to support the preliminary inquiry carried out by the Commission, trying to determine whether there are enough new and/or interesting details to set up a new comprehensive survey of Hammarskjöld's death in Ndola on 18 September 1961.

Summary

The approach in this report is to examine the available facts around the SE-BDY accident, and to compare these facts to a number of the many theories surrounding Hammarskjöld's death. The purpose of this approach is to reduce the number of theories that can be considered as possible and credible.

Some basics about the accident facts are very hard to dispute. The report points out three of them, as a basis for the subsequent theory evaluation:

1. The swath cut in the trees and the wreck distribution pattern.
2. The topography below the aircraft.
3. The aircraft's altimeters.

The report contains analysis of the following theories: Sabotage on ground, The Search and Rescue operation, Accident due to fuel shortage, Land Rovers in the night, The Fouga theory, Bombing from a Dove, Other aircraft in the air, The Ndolo theory, and Wrong QNH. Many of the theories are dismissed; in some cases suggestions about further analysis are made.

The report ends with a conclusion, partly based on the analysis of the different theories but most of all on the factual findings. It is the investigator's opinion that all hard facts available in this investigation and all reliable findings in the accident with SE-BDY "Albertina" point at Controlled Flight Into Terrain (CFIT) – i.e. an accident without any external contribution.

An investigator can probably never totally exclude sabotage or hostile acts when examining a burnt wreckage. This is the case also in the Hammarskjöld accident. However, the conclusion in this report is that there is no need for external disturbances or hostile acts to make an accident look exactly like what we see in the SE-BDY case.

1. Introduction

Some things strike me when reading document after document and learning about facts, theories and discussions around Hammarskjöld's death.

A spontaneous impression is that there are interesting similarities between Hammarskjöld's death and e.g. the murder of the Swedish Prime Minister Olof Palme in Stockholm 1986, especially when it comes to some of the aftermath. A question that was raised after Palme's murder is: "*Can* a prime minister be murdered 'by mistake', that is, can the bullets have been intended for someone else?" I would like to put a different but similar question regarding Hammarskjöld: "*Can* the United Nations Secretary-General perish in a 'regular' plane crash?"

The investigator's point of view is of course that questions like that can be answered with a "Yes". This is not to say that Palme or Hammarskjöld with certainty were victims to "mistakes"; only that – despite the titles of the victims — it is *possible that this was the case.* As an investigator I must take this position before starting an exceptional accident investigation like this one.

My second impression is that the accident investigations made during the time immediately after the event are of a higher quality than I expected from what I have learned before studying them, from the media and other literature. I believe that the investigations are clearly better than the reputation they gained, at least in a Swedish context. This opinion is of course taking into account certain developments that have occurred in the area of accident investigation until today, and in comparison with other reports from that time period. This, however, does not mean that I find the investigations to be free of imperfections.

My third impression is that after about 1963 there has been a lack of professional air accident investigators involved in the discussion. Very experienced journalists, hugely skilled diplomats and talented engineers have over the years made great efforts — but remarkably often, important details have been lost and less important details have been given too much attention, due to lack of experience in the quite specific field of accident investigation.

My approach in this report is to examine the available facts around the SE-BDY accident, and to compare these facts to a number of the many theories surrounding Hammarskjöld's death. The purpose of this approach is to try to reduce the number of theories that can be considered as possible and credible, by pointing out conditions that weaken and in some cases overturn some of the prevalent theories. I would also like to present the basics for a reasonable conclusion on the cause of the incident, seen through the eyes of an accident investigator.

2. Accident Reports

The accident report from the ***Rhodesian Board of Investigation*** are seriously designed, and gives the impression that a quite proper technical investigation was carried out. Compared to today's (occidental) standards, the report is concise. It also includes facts and hints that today should have been investigated further. Overall, the report mainly consists of "hardware", that is, material analysis and technical facts.

The Report from the ***Rhodesian Commission of Inquiry*** has a more overall approach to the accident, and includes a number of witness statements. Some of the commission's statements and conclusions are obviously influenced by a political agenda, and comments on questionable actions are very carefully expressed. This is especially true for the Search and Rescue operation. Nonetheless, the report seems to be quite inclusive and open-minded. The discussion is held together and the drawn conclusions are logical.

The ***UN Commission of Investigation*** was decided by the UN General Assembly, with the broad mandate to investigate "all the conditions and circumstances surrounding this tragedy". It should, as it says, "provide answers to the rumours, fears and speculations to which the tragedy gave rise". The report includes inquiries about the pre-flight damage of the aircraft SE-BDY, as well as the time for the flight. It also deals with the conditions and circumstances around the flight and crash of SE-BDY and contains an analysis of possible causes.

The three reports seriously cover the various possibilities of attack and sabotage, which apparently immediately after the accident were topics of discussion. This approach is both noble and understandable, but what I think is lost in this context is a distinct focus on and a credible analysis of the accident hypothesis that the investigation board indicated being the most likely: "Descent of a fully controllable aircraft into the trees", or what today is called *"CFIT" (Controlled Flight Into [or Toward] Terrain).* The expression is defined by CAST/ICAO: *"In flight collision or near collision with terrain, water, or obstacle without indication of loss of control".*

My conclusion about the reports is that they seem to be fairly seriously conducted. However, some facts and conclusions are quite weak, and softer values such as flight safety culture and operational performance are not dealt with in depth. Among other things, the composition and experience of the crew are matters of my continued interest, as well as the operational conditions for the flight. These areas are not fully dealt with in the investigations.

3. Basic facts

Many theories about the accident assume that the reports are dealing with false facts and/or wrong conclusions. Some facts in the reports, though, are very hard to dispute. I will point out some of them, as a basis for the subsequent theory evaluation:

1. The swath cut in the trees and the wreck distribution pattern.
2. The topography below the aircraft.
3. The aircraft's altimeters.

The above points can hardly be challenged, which I will show below.

3.1. The swath cut

The swath cut ("crash street") (Fig 1) and the wreck distribution pattern show an investigator the manner in which the aircraft went down towards the ground (through the trees), hit the ground, wrecked and finally stopped. The evidence is documented in full transparency, in the presence of Transair's representatives, international investigators and the Swedish police (among others). There are excellent photographs of the swath cut, which appear consistent with some measurements performed in this present investigation. There is no conceivable way to create such a cut in the trees afterwards, so the approach path through the trees is a reliable fact.

Fig 1. The swath cut in the trees and the accident site
(photo from the Report of the Rhodesian Commission of Inquiry).

Furthermore, the different representatives involved would clearly react if there had been the slightest sign of relocation of wreckage parts. Such an operation is remarkably easy to reveal at least when bigger parts are involved, and rearranged parts would only create more questions.

The swath cut and the distribution pattern contradict a number of theories of sabotage and aggression. There was, for example, no explosion causing parts to fall off from the aircraft while it was still airborne. In such an explosion, debris would have been found around the position of the blast, and there was no such sign found despite extensive search. Instead, the swath cut itself is the clearest evidence for CFIT, i.e. that the airplane was in a controlled flight until it struck the treetops and then continued in an almost normal angle of descent towards the ground.

However, some sabotage and attack theories are not fully eliminated due to this pattern solely, namely those who speak of a certain but limited loss of controllability, alternatively distraction or injuries to the pilots. Theories like these have to be discussed with other facts involved than just the swath cut and the wreckage pattern.

3.2. The topography

The topography of the Ndola area is interesting. Topography is largely unmodified; changes are possible in details, but the big picture remains unchanged – for instance no summit has been removed from the area, et cetera. The pictures included in the reports and the ground level contours on the wreckage plan are found to be approximately consistent with the elevation profile presented in "Google Earth" (Fig 2).

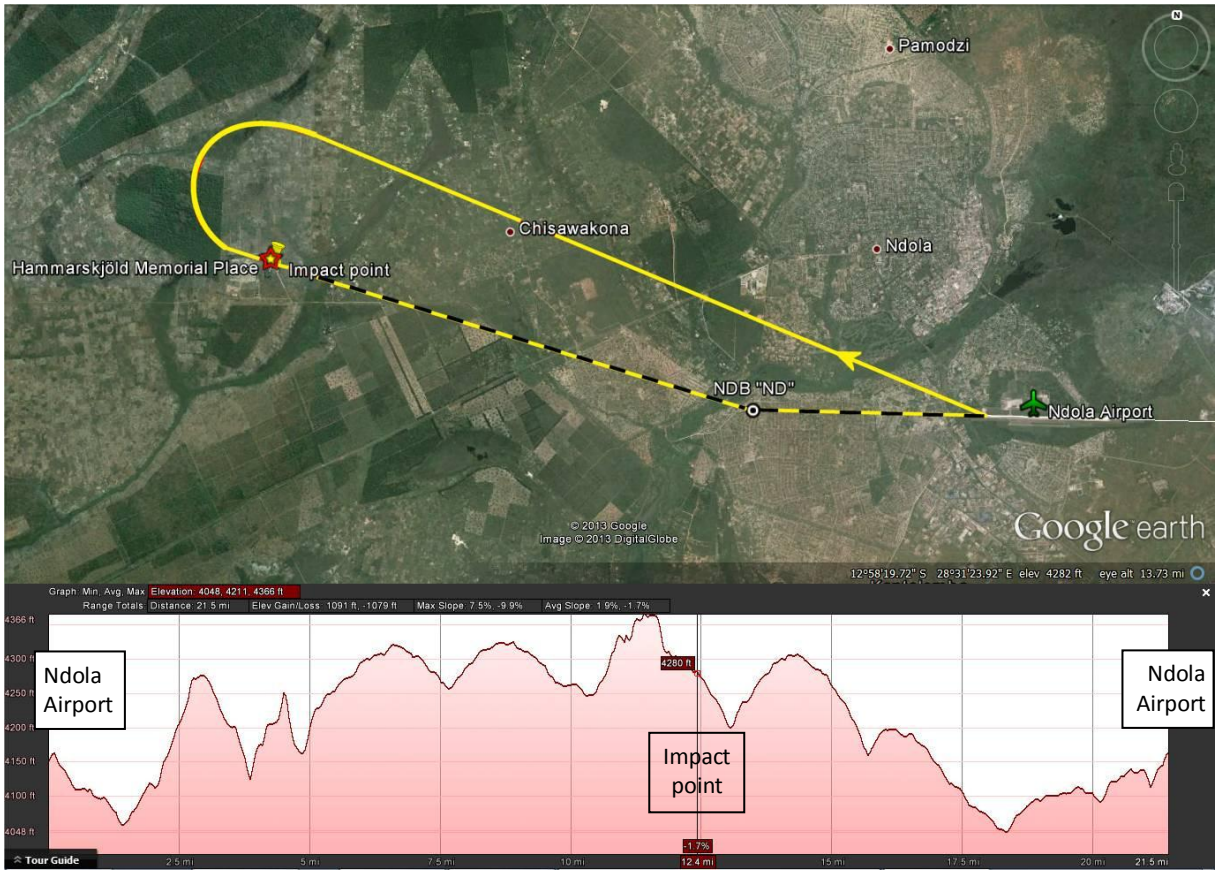

Fig 2. Elevation profile from Google Earth. The line on the map shows the probable and planned flight path; passage of Ndola Airport (lower right), north-westerly heading, and then a left turn towards the radio beacon 'ND'. The ground profile below the flight path is shown, from left to right, below the map. The vertical line in the elevation profile marks out the crash site. Note that the elevation scale is exaggerated.

Some theories imply that the aircraft should have flown into a hill or even a mountain wall. This cannot be true, because the ground at the crash site slopes gently downhill in the actual heading. The highest point passed between the airport and the impact point is about 4 370 ft (1 330 m) above mean sea level (MSL). The crash site elevation is approximately 4 290 ft (1 305 m).

Another conclusion from the topography study is that the crash site, "impact point" in the figure above, is not possible to see from the airport level. Furthermore, calculations suggest that an aircraft altitude of just below 5 000 ft MSL makes it impossible to get the airport lights in sight when returning after the turn in northwest.

3.3. The altimeters

An examination of the aircraft's altimeters was carried out by a team from the US Civil Aviation Board (CAB, now the FAA) with representatives from the manufacturer Kollsman Instrument Corporation in the United States. Some parts of the investigation were performed by the FBI. No evidence was found to indicate that the altimeters were malfunctioning prior to the impact.

All theories including that the altimeters would have been tampered with after the accident, assumes that the involved (named) investigators at these organisations would have been involved in a

conspiracy. (I do not even consider the possibility that they were very poor investigators.) Such manipulations are, in my view, almost impossible to execute on a damaged instrument without this being discovered in the thorough investigation that obviously has been performed. If adjustments of moving parts in a damaged meter are somehow possible, they would entail scrape marks easily revealed on a serious inspection.

That the same type of manipulation would have been carried out on all *three* altimeters without this being revealed is in my opinion totally unlikely. It is also unlikely that the CAB along with Kollsman deliberately would conduct a "rigged" examination. Such a theory would require a conspiracy of such dimensions that it is not credible.

My conclusion is therefore that the altimeters were not manipulated after the accident. This means that all three altimeters were functioning and correctly set at the event.

It has been suggested that it is strange that the third altimeter, placed before the radio operator (Mr. Rosén), was correctly set, because the operator was not used to flight instruments. On the contrary, I find it very likely that Mr. Rosén was able to set the correct QNH on the altimeter in front of him; it is a simple operation, possibly even requested by the captain in order not to have different perceptions of altitude on the flight deck.

3.4. Other facts

There are many other facts that could be considered in the same manner as above; for example the timing of the flight, which is decided by so many surrounding facts that it is impossible to recalculate without facing a gigantic conspiracy; or the condition of the engines and the landing gear, telling a pilot that no evasive manoeuvre was at hand. However, the analysis of such facts is mostly already done in the investigations executed. Therefore, in the following I will use some kind of "reversed analysis" and try to examine some of the theories in the light of facts.

4. Analysis of theories

4.1. Sabotage on ground

The theory that SE-BDY "Albertina" was a victim to sabotage on the ground before take-off from Leopoldville is carefully investigated. The only remaining possibility of such sabotage is, in my opinion, the use of a plastic bomb with very limited effect mounted in the gear compartment and ignited by extension of the landing gear.

What I *do not* get to fit into this context is how a bomb in a gear compartment, not giving rise to any visible damage after the crash, would allow the airplane to make a "good looking" descent through the trees. Possible influence on the flight control system (i.e. elevator locking) could be further investigated, but no control cables are routed through the landing gear compartments. The only possible influence remaining is *distraction of pilots,* which in just the wrong moment in a complex chain of events could be contributing to an accident.

However, it is unlikely that a sabotage operation would rely on this highly uncertain sabotage method, i.e. crash because of distraction of the pilots. The gear is normally extended in quite calm conditions, and this is therefore not a good opportunity if anyone wants to let a temporary distraction bring dire consequences. Thus the possibility remains that a bomb was placed on board SE-BDY, but was not functioning as planned. No trace of such a bigger bomb was found on the accident site, making this theory implausible.

4.2. The Search and Rescue operation

A lot has been written about the delayed rescue operation, caused by – as it seems – a remark from Lord Alport that Hammarskjöld's aircraft must have flown on to another destination. Shortcomings of responsible airport staff are mentioned, mostly concerning the Ndola air traffic controller and the airport manager who should have followed the rules and sent out sharper signals that the aircraft had disappeared without any notice of intention. The inadequacies are often said to be of such great magnitude that they are perceived to have been a part of a larger cover-up.

Some counterweight to this picture appears for instance in the different investigation reports, in Björn Virving's book "Termitstacken" and Bengt-Åke Bengs' "The Ndola accident". Here it is pointed at the overall uncertainty surrounding the SE-BDY flight, including radio silence and secrecy. This uncertainty does not completely explain the lack of decisions at the airport, but is needed as some counterbalance to overly simple "truths" about a cover-up from the airport staff. At the same time, there is evidence that the local police made some search for the aircraft during the night (i.e. testimony from police officers). That *nothing* would have happened in the rescue operation until just before lunch time 18 September appears to be incorrect.

However, I still find the lack of action from the ATC personnel and from the airport manager remarkable. The absence of timely and efficient Search and Rescue is in my opinion almost criminal. Nevertheless, such incompetence is found even today and is not a sign of sabotage or aggressive act; it is merely a question of poor training, maybe – in this case – combined with some degree of disregard and indifference.

There are also disdainful comments on the "incredible fact" that "no one would have seen the accident or the burning wreckage", with the underlying sense that all witnesses have been silenced. This description is not true, because both light and sound phenomena were observed by a number of persons, among them police officers. Some of these observations were reported, some of them not; fires and glow appeared from time to time in the area, for example in the form of bush fires or slag removal in the Nkana mine. Furthermore, it has to be noticed that the forest was at the time quite dense, and the night was dark.

A couple of charcoal burners were obviously in close proximity of the crash site during the night, but did not report about it. During the morning the wreckage was discovered by locals, which, however,

did not report this. Failure to report and/or draw correct conclusions has many possible causes; in this case more probably a lack of confidence in the police and other authorities, than a wilful act of sabotage.

4.3. Accident due to fuel shortage

There are theories about the aircraft crashing due to fuel shortage, for example after erroneously completed refuelling before take-off at Leopoldville. Since this is not really a conspiracy theory, one should in this context be able to rely on the information in the radio communications between SE-BDY and the control tower in Ndola. The communication reveals that captain Hallonquist, on a request about fuel state, announces that they might need some refill after landing on Ndola ("may require a little") at 21.54Z/23.54 local time.

This statement, about 20 minutes before the estimated time of the accident, rules out the possibility that the aircraft started with too little fuel or sustained leakage along the way. Reasonably, captain Hallonquist indicates that he may need a little extra fuel for a flight back to Leopoldville, which means that the aircraft just before midnight had ample fuel left.

A leakage of fuel which would occur after at 21.54Z cannot entirely be ruled out. However, there is no indication of a sudden fuel shortage, neither in the radio traffic nor in the operational behaviour or by examination of the aircraft. Furthermore, the original technical investigation could conclude that all four engines were under power at the time of impact. The fire that occurred at the crash site also suggests that a relatively large amount of fuel was on board. All in all, the theory of fuel shortage can be discharged.

4.4. Land Rovers in the night

Testimonies about 'Land Rovers with white men' arriving at the crash site during the accident night, are taken as a pretext for theories that aggressors set fire to the wreck, manipulated the altimeters, eliminated important evidence and/or murdered Hammarskjöld.

The need to set a plane on fire after an accident is most likely very small. The amount of fuel on board was sufficient to cause the fire and the damage described in the accident reports. Any flare-up of fire, which is said to be observed, is most likely on an accident site; e.g. separate parts of the fuel tanks may have ended up in various places and thus been subjected to varying degrees of heat and flame effects, et cetera.

Structured behaviour like an extensive search operation at a wreck site where widespread fire is going on or just recently has been extinguished, is most certainly not possible at the time indicated. Finding a single person in the dark could perhaps be done, but finding let's say three altimeters or other specific devices is a very difficult task. Such an operation requires both light and a high level of knowledge, combined with either plenty of time (several hours) or an unbelievable luck. It also requires adequate protection from fire, heat and other hazards at the scene of an accident.

The extent and magnitude of such dangers, combined with difficulties in finding key components at a wreck site, means ever new challenges for experienced accident investigators. No two accident sites look the same, and the risks often remain for a long time. Taken together, a murder or cover up operation at the crash site would face the most serious difficulties.

If anyone planned to kill Hammarskjold by having him involved in an accident, the procedure to immediately show up at the crash site would be an unlikely big risk-taking. Letting a cover up operation be based upon an almost impossible mission (such as "find all shrapnel" or "set all altimeter on the following value") is not realistic.

The search for a crash site is quite often a very difficult task, requiring time and resources; especially when no emergency locator transmitter is activated. To be able to identify the crash site as soon as within 1-2 hours after the accident, would require either very large resources or – once again – a

good portion of luck. The resources would have to include aerial reconnaissance and/or a number of deployed observers, as it's basically impossible to – e.g. before a scheduled attack – figure out where a target might turn down. The theory also requires extensive coordination with the help of radio traffic.

There is an explanation for the presence of cars in the vicinity of the crash site, which is much closer at hand than a planned murder or cover up operation. According to testimonies from police officers they were engaged in a search operation with Land Rovers in the area during the night. This explanation has been rejected with the argument that the cars had the wrong colour compared to the police Rovers – black instead of grey. However, to distinguish between the grey and black can be a daunting task even during daytime, and at night it is basically impossible. The most likely hypothesis is that the witnesses saw the policemen driving back and forth in their search.

4.5. The Fouga theory – "the Lone Ranger"

4.5.1. Introduction

The Katangan Air Force – Avition Katangaise, "KAT" or "Avikat" – was originally in possession of three Fouga CM 170 "Magister" (Fig 3), a two-seated small jet designed for training and light attack. Reportedly the only Fouga in operational order on 17-18 September 1961 was #93, based at Kolwezi Air Base. #91 crashed 23 June 1961, and #92 was located in Elisabethville (under UN control) and not operational since 11 July 1961 due to engine failure.

Fig 3. Sketch of Fouga #93, "KAT-93"

Avikat had originally three pilots trained on the Fouga Magister: Dagonnier, Latte and Magain. Joseph Delin (or Deulin), the Kolwezi base commander, used to go with Magain as a navigator. Together the two attacked UN personnel and supplies in Katanga with the Fouga #93, and the attacking Fouga became known as "The Lone Ranger". There is a wide-spread theory that they also attacked SE-BDY and thus caused the crash.

The Fouga theory has been dismissed many times; Fouga #93 was examined shortly after the accident, Delin was (voluntarily) interviewed and denied any involvement, and some facts contradict the theory. The UN inquiry stated that "there is no evidence that the 'Fouga' was in the vicinity of Ndola at the night of the crash" (page 44, point 136). However, there might still be facts to examine about the Fouga and this crew.

4.5.2. The operational range

One recurring issue about the Fouga is the operational range. In this analysis, I will use the expressions below concerning range. These terms need to be defined, because there is some confusion about it in the reports. The following definitions are collected from Wikipedia and consistent with my experience:

1. ***Ferry range*** means the maximum range the aircraft can fly. This usually means maximum fuel load, optionally with extra fuel tanks and minimum equipment. It refers to transport of an aircraft for use on remote location.
2. ***Combat range*** is the maximum range the aircraft can fly when carrying ordnance. This measure is less than the ferry range, due to higher fuel consumption.

3. ***Combat radius*** is a related measure based on the maximum distance a warplane can travel from its base of operations, accomplish some objective, and return to its original airfield with minimal reserves. This measure is less than half the combat range due to fuel consumption during combat manoeuvring.

The Fouga was based at the Katangan air base Kolwezi. This means that the Fouga would need an effective *combat radius* corresponding to the distance between Kolwezi and Ndola.

Data on the maximal flying distance ("ferry range") for the Fouga varies a bit. The Report of the Rhodesian Commission declares that the "effective range" (combat radius) of the Fouga is about 135 nautical miles (p. 20). The Rhodesian Board states: *"After examining information from the aircraft manufacturers, the Board is satisfied that Ndola is beyond the Fouga's combat range[1] from Kolwezi"* (p. 26). Other sources talk about a *ferry range* of about 500 nautical miles (925-930 km).

However, the Hammarskjöld Commission has managed to find a Pilot's Handbook for the Fouga from 1959, and the maximum *combat radius* has been calculated from data in this handbook (Annex 1). ./ 1
Due to fuel capacity only, the calculations show that there is a theoretical possibility to perform a mission over Ndola from Kolwezi airbase with the two wing-tip tanks mounted (fig 4).

If one tried to start from Kolwezi air base, shoot down an aircraft at low level over Ndola and then go back to Kolwezi, the emergency margin of fuel, which should remain after landing according to the handbook, would be reached before landing. However, there would be enough fuel on board to complete the mission. The aircraft would land with only 7 imperial gallons (≈ 30 litres) of consumable fuel left in the tanks.

The calculated maximum combat radius for a Fouga, based at 5 000 ft and including a minimal fuel reserve, is 226 nautical miles (419 km). The distance between Kolwezi and Ndola is 228 nautical miles (423 km).

This means that the mission is possible if the pilot's own safety is not prioritised. The range is calculated under ideal conditions, and the mission demands that the handling of the aircraft is perfectly in agreement with the manual and that the shortest route is exactly followed.

The combat manoeuvring at ≈5 000 ft over Ndola could last only 5 minutes due to this fuel calculation. This is an unrealistically short time to find a target and intercept it, unless the operation is radar controlled. Furthermore, the timing with the arrival time for SE-BDY demands very good intelligence, since the Fouga had no fuel for waiting time. Both radar control and intelligence demand a number of people and good resources.

Anyhow, the possibility that the Fouga could reach Ndola from Kolwezi cannot be completely ruled out from fuel consumption perspective only.

The data above means that the accident reports (including the UN report) either do not give the full picture about this matter, or have had some other information available.

[1] Meaning: combat radius.

Fig 4. The Fouga CM 170 "Magister" #93 at Kolwezi Air Base, with nose-mounted guns and wing-tip tanks.

Given that the fuel is a limiting factor, the question about other landing bases closer to Ndola is raised. Kolwezi is mentioned in the Rhodesian Board report as *"the only known airfield from which [the Fouga] could operate"* (p. 26). This conclusion is questioned in the UN report, saying that *"nothing would appear to preclude the use of a track within range of Ndola"* (p. 44). The Rhodesian Commission says that *"Kolwezi runway was not then equipped for night take-off or landing, and in fact obstacles had been placed on the runway on the night of the 17th/18th September"* (p. 20). However, imagine that the aircraft – despite the darkness and with the obstacles removed – started from Kolwezi and used another airfield to fill up fuel, either before or after the presumed attack? This possibility is worth investigating.

The question about other landing bases seems to have been analysed in a report from the Swedish Air Force (SwAF) to the Swedish Civil Aviation Authority, dated December 1961. I have had only a picture of the first page of this report[2] available, where it says that *"no appropriate bases for jet aircraft are likely to be found [within Katanga] south of Elisabethville.[3]" "Any other airports where jets might operate is not known in southern Katanga; however, the possibility that simpler airfield can be used by jet aircraft is not precluded"* (translated from Swedish). This conclusion is stated to be based on "AERAD Flight Guide" and information from Swedish pilots with experience from Congo missions.

Since I have no further information available on presence or status of air bases in Katanga around 1961, I suggest that this SwAF report is being searched for and analysed if this particular question is of further interest.

4.5.3. Capability and ability

There is a degree of uncertainty related to the Fouga's equipment and other limitations. As a former fighter pilot, I am interested in mainly three limitations (except from the operational range treated above):

- **Darkness capability**. Reportedly, there was no opportunity to fly in darkness with available equipment on the Fouga. I have not seen any indication that the Fouga carried out any attack other than during daytime; in fact, the Rhodesian Board is referring to local witnesses at Kolwezi stating that "the Fouga had never been operated at night" (p. 26) (fig 5).
  A comment on night flight limitation is, that if it is difficult to fly "as usual" in darkness with a particular aircraft, it is impossible to carry out the mission as a night fighter: i.e. to find and shoot

[2] The picture is collected from Mr. Björn Virving, Stockholm, Sweden. The document is probably photographed at the Swedish Foreign Ministry archives.

[3] Today Lubumbashi International Airport, also known as Luano airport.

down another aircraft in darkness. That the Fouga was not equipped with radar is a fact; this makes it almost completely impossible to operate it as a solo fighter during darkness.

- **Fighter ability**. I have so far not found any indication that the Fouga would have been used as a air-to-air fighter in the Katangan Forces, but only for strikes against land targets. (Damage on the SE-BDY which was recorded the same day as the start was caused by ground fire.) The two disciplines are fundamentally different, and there is nothing saying that an attack pilot with certainty can perform air-to-air fighter tasks (or vice versa). Both types of mission require training and practice. Furthermore, it is not a simple task even during the daytime with a fast jet aircraft as the Fouga to attack a comparatively slow-moving aircraft like the DC-6, especially at low altitude and with decreasing speed. This is valid despite the fact that the DC-6 is a relatively large aircraft (length approx. 105 ft/ 32 m).
  The Fouga is reported to have had two AA52 machine guns, 7.62 mm, mounted in the nose (fig 6). 7.62 is a very small calibre for air target attack, and the calibre can be supposed to have assured effect against "soft ground targets" only (that is, people on the ground).
  In terms of armament it can generally be said that it usually requires either very accurate hits or several attacks, firing long bursts to bring down a large aircraft such as the DC-6. No trace of this kind of gunfire was observed on either the aircraft wreckage or on bodies. (The bullets in some of the soldier's bodies are considered to come from exploding ammunition, since thorough investigation has shown that none of them have passed through the barrel of a gun and all bullets were of the same calibre as the ammunition carried by the soldiers themselves, UN report p 39-40.)
- **Fighter Control.** Out of the above constraints arise the need for fighter control. The need cannot be filled solely by individual observers (e.g. in the control tower at Ndola, as proposed), but an organization with access to radar (among other things). I find no signs that such an organization was available for the Katangan air force, except from the (conspiratorial) possibility that such support was provided by the Royal Rhodesian Air Force, RRAF.

The limitations above are each one on its own preventing the Fouga theory from being credible. My opinion is that taken together the limitations, if they are valid, reject the theory completely.

Fig 5. The Fouga's cockpit

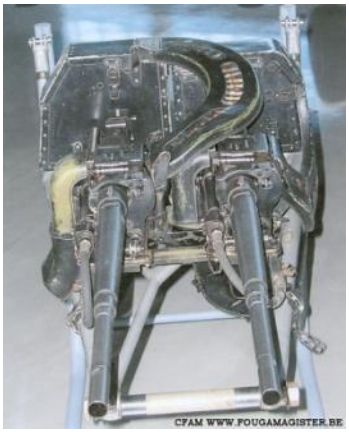

Fig 6. The Fouga's guns

4.5.4. Radio traffic I

Charles Southall (US Navy, linguist and pilot) was according to his own statement in 1961 on mission stationed at a naval communications facility of the NSA just outside Nicosia, Cyprus ("a major communications relay station"). Southall claims to have been called to the station, about three hours before midnight (local time) on 17-18 September. Normally, Southall was in service only during daytime. Shortly after midnight he, along with 4-5 other officers, heard a recording (or possibly reading a print, "there is a very slim chance that he read a transcript "), of a communication that was

reported to be 7-8 minutes old – "history in the making". It was one-sided communication from the pilot, "a cockpit narrative" with only the pilot's voice.

Quote from Susan William's book *"Who Killed Hammarskjöld?",* p. 143:

> *"They heard the rushing noise of an aircraft engine and the commentary of the pilot:*
>
> *'I see a transport plane coming low. All the lights are on. I'm going down to make a run on it. Yes it is the Transair DC6. It's the plane.'*
>
> *The pilot's voice was 'cool and professional'. Then they heard gun cannons firing – and the pilot exclaiming:*
>
> *'I've hit it. There are flames! It's going down. It's crashing!'*
>
> *At this point, noticed Charles, the voice had some 'excitement'. He had the impression that the pilot was 'expecting the plane'.*

[...]

> *In Charles's opinion, the communication must have been transmitted to a field command post on Very High Frequency (VHF); a communications technician would have stuck a header on it and then retransmitted it on High Frequency (HF) to Nicosia, for relay to Washington.*

[...]

> *Charles recalls, too, that the Communications Watch Officer or another officer cried out something like, 'It's the Lone Ranger! We know him! He must be waiting for Hammarskjöld's plane!' This pilot was known to the intelligence community, comments Charles, and there was a dossier on him marked 'L.R.'"*

The story raises some questions, which I partially have succeeded in getting answers to; there was certainly an American listening station on Cyprus, and from there messages on long distance from Africa via HF-radio could be heard. The distance from Ndola to Nicosia is > 5 350 km. The Fouga was equipped only with VHF radio; hence the communications could not have come directly from the aircraft to Cyprus since the range of the radio is vastly insufficient, especially at low altitude. There is, however, reliable information about an American aircraft, parked at Ndola airbase during the 17-18 September 1961, which possibly could have been used as a relay station ("field command post") for any VHF transmission in the area.

Some comments on Mr. Southall's testimony can be made:

- Why is cannon fire heard in the broadcast? Was the pilot pressing down the radio transmitter button while pulling the trigger? In the Fouga, both controls are placed on the joystick and must then be operated simultaneously with one hand – a procedure that must be characterized as very unusual. There is a joystick in both the forward and the rear seat; one solution could be that the rear-seat operator used the radio while the front-seat pilot controlled the aircraft, but using buttons on the stick is certainly not normal behaviour for the non-flying crew member.
- If someone was reading from a transcript neither engine noise nor cannon fire should be heard, and nobody would have recognized "the Lone Ranger's" voice.

If the story is true, the staff at the NSA station must have been aware of some planned action a few hours before the event (when Southall was called to the station). Due to Mr. Southall's testimony, the staff at the NSA station must also have known that Hammarskjöld was going to fly (with a DC-6) that night, as well as from where the communication arrived. Both these circumstances suggest, according to Southall, that the CIA[4] and/or NSA[5] were involved.

It is not unreasonable to assume that the "intelligence community" could have had a dossier on "the Lone Ranger" available on Cyprus, because of the Fouga attacks on UN in Katanga.

[4] U.S. Central Intelligence Agency
[5] U.S. National Security Agency

If the Fouga theory falls, key parts of Southall's testimony fall. On the other hand, if some new information could be found supporting Southall's narrative, then the theory would be really interesting.

4.5.5. Radio traffic II

There is also a testimony from a Swedish pilot, Tore Meijer, who at the time was in Ethiopia. Tore tells that he heard a HF conversation from Ndola tower, about an airplane (Hammarskjöld's) that suddenly had another aircraft behind (quote from Williams' book, p. 152):

> *"The voice says, 'he's approaching the airport, he's turning... he's levelling' – where the pilot is approaching the actual landing strip.*
> *Then I hear the same voice saying, 'another plane is approaching from behind, what is that?'*
> *- The voice says, 'He breaks off the plan...he continues.'*
> *At this point, explained Meijer, the transmission ended abruptly."*

Further studies could be done on this information. Because the testimony does not include any attack, connections can be made to all theories about a second aircraft. It is worth noting that Meijer's and Southall's testimonies neither fully support nor contradict each other.

4.6. Bombing from a Dove

A number of testimonies indicating that one (or two) slow-moving propeller aircraft was observed in the vicinity of Ndola at the time for the accident, has given rise to a theory that SE-BDY was attacked in the air with one or more dropped bombs. An aircraft of the type de Havilland DH 104 "Dove" (fig 7) would, according to these theories, have been waiting for Hammarskjöld's arrival and flown in over SE-BDY in order to force the plane to Katanga. The hijacker would presumably have communicated via radio trying to persuade Captain Hallonquist to fly to Elisabethville or Kamina. The reason for this kidnap attempt would be to prevent Tshombe from meeting Hammarskjöld.

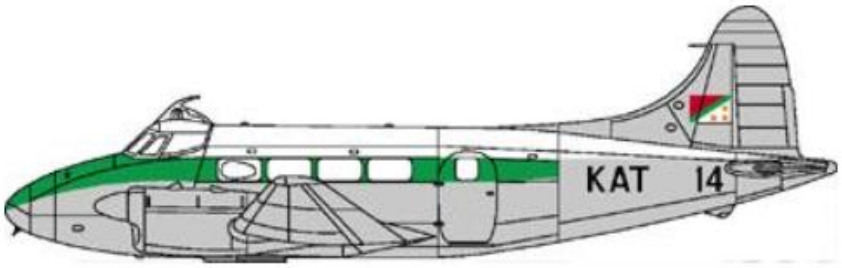

Fig 7. De Havilland Dove, in the paintings of the Katangan air force, "KAT" or "Avikat".

To reinforce the threat, the Dove crew would have tossed down a bomb on the DC-6 through a hole in the aircraft's belly. The bomb would then have detonated in such a way that the pilots of the DC-6 became frightened, hurt or distracted to such an extent that they flew down in the trees.

The Dove is a twin-engine propeller aircraft, with a maximum speed of approximately 180 kt (340 km/h). There were originally most probably eight Doves handed over by Belgian troops to "Avikat"; one disappeared during a mission January 31, 1961. Different information is found about the position of the remaining Doves on 17-18 September, but according to the Rhodesian Commission, two Doves were in UN hands in Elisabethville and three were in South Africa undergoing examination (p. 21). Other sources claim that two Doves (possibly KAT-11 and KAT-22) were based at Kolwezi.

The Dove theory was maintained by the Transair's Chief technical officer, who participated in the accident investigation as the operator's technical expert. It may be appropriate to note here the different roles that are often held, or ingested, in an accident investigation. The operator's role is often to ensure that *other* factors than aircraft failure or pilot error are thoroughly examined. (Interpreting miscellaneous documents, it seems to me that many involved Swedes adopted this role.) It is worth noting that the representatives of the TSA already on the day of the accident is said

to have appeared on Swedish television with an explicit assurance that the event certainly could not have pilot error or aircraft malfunction as a cause. Such confident statements are usually not a good idea immediately after an incident; they may call into question the objectivity in further investigation work.

The Dove theory makes me react on certain details. There are a number of uncertainties with regard to physical and skill constraints that should make the proposed sequence practically impossible. Certainly it is known that such attacks were carried out against land targets – but to perform a "manual bomb operation" against another aircraft by flying above and even obliquely in front of another aircraft is a completely neck-breaking manoeuvre. A basic rule for all combat flying is to never turn the belly against any wingman or opponent; by doing this you definitely lose all perception of where the second plane is going, making the risk of a collision imminent and any attack unsuccessful. To succeed in adjusting a distance both above and ahead, so that a released bomb comes in close proximity of another aircraft, is an extreme adventure which cannot be rehearsed on land targets. Finally, to implement this operation in darkness and during a turn at a very low altitude would require great skill combined with extreme foolhardiness. However, I cannot currently fully write off the theory. Further investigation could focus on the question if such a spectacular bomb attack could have been performed in practice.

4.7. Other aircraft in the air

Except from the Fouga and the Doves, Avikat reportedly[6] had the following aircraft in service in August 1961:

- Light aircraft: Five Piper L-18C and one Piper PA-22.
- Helicopters: Two Aérospatiale Alouette II, one Sikorsky H-19D.
- Military transport: Two Douglas C-47 "Skytrain", one de Havilland DH-114 "Heron" (a development of the Dove with stretched fuselage and four engines).

At the end of August 1961, the helicopters and the heavier transport planes came under UN control at Elisabethville airbase. According to some information, Avikat had at the time of the SE-BDY accident control only over a few light aircraft based at Kipushi[7], and the single Fouga plus two Doves based in Kolwezi.

(In October 1961, Avikat got five Dornier Do 28A "Skyservant", and later four Piper PA-24, one DC-4 and one DC-3 were purchased. Ten ex-Belgian T-6Gs "Texan" were bought and delivered in 1962.)

The question about other aircraft available for any kind of attack on the 17-18 September seems to be thoroughly investigated. Even the possibility of Rhodesian military aircraft involved was investigated; the Royal Rhodesian Air Force (RRAF) had for example some 30 jet "Vampires"[8], about 15 "Provosts"[9] and about 18 "Canberras"[10].The Rhodesian Commission of Investigation states the following: *"There was evidence that no aircraft of the Royal Rhodesian Air Force was flying on the night of 17th/18th September. That evidence was not queried at all. In the Congo, other than in Katanga, there was no aircraft capable of offensive action which was not under United Nations control"* (p. 20).

The Rhodesian Board states: *"The overwhelming weight of reliable evidence is that at the time SE-BDY was the only aircraft in the air in the vicinity of Ndola"* (p. 31).

[6] Information from internet; http://www.likasi.be/Aviation Katangaise.htm
[7] Kipushi is a town about 35 km southwest of Lubumbashi/Elisabethville, with a small grass field
[8] de Havilland DH.100 Vampire: jet-powered trainer/bomber/fighter aircraft
[9] BAC Provost: jet-powered trainer aircraft
[10] English Electric Canberra: high altitude jet bomber/recce aircraft

However, the conclusion from the UN Commission is: *"...no radar watch was maintained in the Ndola area during the evening and night of 17 September 1961 and, therefore, the possibility of an 'unknown aircraft' cannot be entirely excluded"* (p. 44).

Witness statements about other planes in the air are interesting, and I understand that a study of a number of testimonies is performed by the Commission in order to find a reliable picture to build a trustworthy hypothesis upon.

No such consistent picture is found in the investigation that I have made, based on material available to me. I do not find the testimonies consistent with each other, or with the timing of the SE-BDY flight. On the contrary, other witnesses state that there was no other aircraft in the vicinity of SE-BDY "Albertina" as long as it was observed over Ndola.

Witness psychology is a very interesting area. It is after all nothing new that different witnesses have different opinions about what they have seen and experienced, although they have witnessed the same event. The human brain tends to "fill all holes"; if you don't remember every part of a chain of events, your brain will most probably fill it in for you so that the picture becomes more complete. This process can proceed for the rest of the life, which makes it more difficult to interpret witnesses' statements after long time. Therefore, it is not necessarily a gain in an investigation when old witnesses are coming forward years after an incident. N.b. that such "filled-in memories" do not mean that the witnesses are consciously lying; they probably believe that they actually saw what they are telling.

4.8. The Ndolo theory

The Ndolo theory implies that the crew could have used the instrument landing chart for Ndolo Airport (Leopoldville, Congo) instead of Ndola's chart. Many before me have dismissed this theory, and I fully agree with them in their objections. It is not likely that an experienced crew would have mistaken these two maps in their preparations for such a VIP flight – although it is of course possible.

The Ndolo instrument landing chart was not included in the Jeppesen manual, but was brought on board Albertina as a part of an American military manual (USAF/USN Flight Information Manual). Some people believe that this Ndolo chart was used by the crew, and claim that this could have been the cause of the accident because Ndolo (Leopoldville) had a field elevation of 951 feet. Ndola (Northern Rhodesia) had an altitude of 4 160 ft. The presumed mistake means that a descending aircraft meets the ground about 3 200 feet earlier than expected, to put it simple.

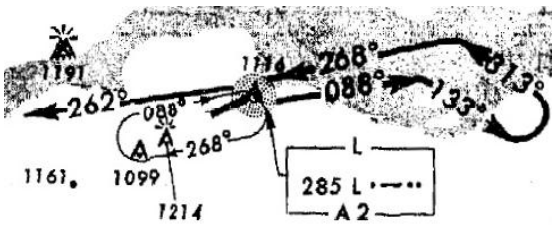

Fig 8. The landing procedure at Ndolo (Leopoldville)

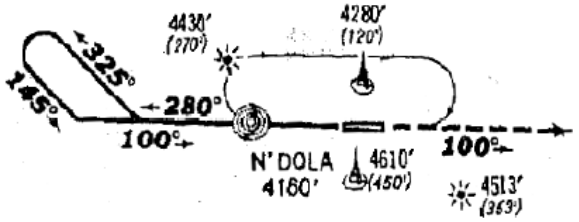

Fig 9. The landing procedure at Ndola

This theory is quite easy to dismiss for several reasons. Ndolo (Leopoldville) had at the time no approach control and no tower, which is clearly stated on the instrument landing chart in question. Having the wrong chart up in front of the pilots should be revealed as soon as the first contact with the tower was to be established, because the pilot would search for the tower frequency on that chart. Furthermore, the approach altitude of 6 000 feet would to an experienced pilot clearly appear to be far too high for a normal landing procedure at an airport with the elevation of only 951 feet.

Additionally, the instrument approach procedure at Ndolo (Leopoldville) (fig 8) started with an inbound heading towards east, proceeded with a right turn to 133° and then a left turn for final. This

is close to reversed to the Ndola approach (fig 9), which the SE-BDY "Albertina" crew clearly followed when they went down.

Finally, the best indicator that the Ndolo (Leopoldville) chart was not in use is that it was found inside the military manual mentioned above. The Ndola plates were missing from the recovered Jeppesen manual, and the best and most natural explanation to that is that they were placed in front of the pilots (where they should be) at the time of the crash.

4.9. Wrong QNH

There is a theory of improper altimeter setting implying that the air traffic controller at Ndola, Mr. Martin, deliberately would have given the SE-BDY crew an invalid QNH value. Thus the aircraft would have been too low already at the left turn towards the final, which would have caused the crash. The QNH would just prior to the crash have been forwarded by Hallonquist to Swedish personnel at the Kamina base (obviously via HF radio), asking if the QNH value given could actually be reasonable.

Flight safety is to a high extension based on redundancy and dual checks. No experienced pilot would begin to descend if he was so unsure of a given QNH value that he calls another air base for a safety check. In addition, the crew had just passed a fully illuminated runway at the relatively low height of about 1,800 feet above ground. (According to all the witnesses at the reconstruction of the flight, the altitude when passing the airport was below 6 000 feet. The airport's altitude was 4 160 feet.) This means good opportunities to credibility checks of the obtained QNH value.

Furthermore, a deliberate submission of inaccurate QNH is an extremely uncertain method if a controller wants to lead an aircraft into the ground. Experienced pilots, like those on board SE-BDY, make an analysis of obtained values of this importance. Therefore, it is very likely that a faked QNH value will not be accepted by a crew, after which the current controllers are at very high risk for being the subject of investigation. (A skilled but evil controller would certainly come up with a number of much smarter ways to succeed in such a mission.)

Finally, the theory includes that the altimeters were set incorrectly at the accident, which was not the case (see above).

I completely reject this theory, which seems to be based on real lack of expert knowledge. The story from the informant includes sudden knowledge of the Kamina personnel that Hammarskjöld was on board a DC-6 at Ndola, as well as the aircraft due to incorrect altimeter setting flew into "Ndola Hill". In fact (see above), the aircraft went into the ground where it slopes gently downhill. This means that the aircraft had commenced a descent before the crash.

The theory is very weak, and weakens further from the fact that interviewed Kamina veterans do not know about the informant – despite his high alleged position on the base.

5. The CFIT theory

5.1. Background

5.1.1. Sources

The two main sources to in-depth analysis of the CFIT theory are:

- Bengt-Åke Bengs, "The Ndola Accident", published by the author in 1966.
- Åge Röed, "The N'dola disaster – An accident investigator's point of view", add. 8 (in English) to Ambassador Bengt Rösiö's PM (in Swedish) to the Swedish Ministry for Foreign Affairs, 1993.

As stated before, I do not believe that the previous investigations' conclusions are particularly thorough or complete in the CFIT context. I will try to briefly complete this picture, basically subsequent to Mr. Röed's excellent report.

5.1.2. CFIT history

"CFIT", *Controlled Flight Into [or Toward] Terrain,* is defined by CAST/ICAO as *"in flight collision or near collision with terrain, water, or obstacle without indication of loss of control".*

This definition does not cover external hostile action intended to disturb a crew; that kind of influence would cause something that I would characterize as an *uncontrolled* flight.

More than 20 CFIT accidents happened each year before the introduction of the Ground Proximity Warning System (GPWS) in the 1970's. Still CFIT is behind a devastating large number of accidents around the world. According to Boeing[11], CFIT is a leading cause of airplane accidents, causing over 9 000 deaths since the beginning of the commercial jet age and almost 1 100 deaths between 2002 and 2011. CFIT was identified as a cause of 25% of USAF "Class A Mishaps" between 1993 and 2002.

For some years in the 1990's, the CFIT rate seemed to descend. However, in 1999-2001 the CFIT rate started to rise again, causing concern in the flight safety world. Then, the widespread introduction of Terrain Awareness Warning System (TAWS) began to make a real impact on the number of CFIT accidents, and the decline in the accident rate resumed.

Of course, there was no GPWS and no TAWS invented when SE-BDY "Albertina" crashed in 1961.

CFIT accidents include trained and experienced crews flying fully operational aircraft into the ground. For different reasons, the crews make mistakes and misjudge altitude, terrain and other factors. One quite common mistake is to make visual approaches to airports at night over dark terrain.

5.2. Accident facts pointing at CFIT

A number of facts are pointing at (or are totally consistent with) CFIT, at the accident site and the wreckage as well as in surrounding details.

The accident site:

- The crash site is located roughly under a normal procedure turn to the airport.
- The swath cut in the trees shows that the aircraft hit the trees in a very shallow descent, approximately in accordance with a normal descent towards the runway.
- The first impacts were made by the aircraft's propellers.
- There were no signs of any impact, or aircraft parts, before this point.

The aircraft:

- The landing gear was down and locked, and the flaps in approach position.

[11] "Statistical Summary of Commercial Jet Airplane Accidents Worldwide Operations 1959 – 2011", Boeing International, www.boeing.com

- All engines were working at impact, approximately at approach power.
- The altimeters were correctly set, and no pre-impact damage was indicated or found.
- The instrumentation standard at the time was not sufficient for safe flight in poor visibility.

The weather:

- Light breeze, 7 kts.
- Visibility good, 5-10 miles; light smoke haze.
- Very low moon.

The terrain:

- Covered by trees and bushes.
- No city or street lights.
- Possible charcoal, mining and bush fires, et cetera.
- Hilly, with tops up to 4 350 ft (plus appr. 70 ft high trees).
- A hill obscured the visibility to the airport from the crash area.
- The high terrain was not marked on the Ndola approach chart.
- The altitude above ground at 5 000 ft is declared as 840 ft on the chart. Real height above treetops at the crash site was 640 ft.

The flight:

- Conducted under partly stressful conditions, with calculated risks of being shot at with a highly respected VIP on board.
- Safety precautions, like a correct flight plan and continuous radio contact, was not undertaken due to security reasons.
- The departure was at 15.51Z; the accident happened about 6 h and 20 minutes later.

5.3. Accident analysis

The aircraft was well below the given altitude (6 000 ft) at the accident site, about 1 640 ft below. It is not unusual to perform the descent to the minimum altitude, in this case 5 000 ft, during the procedure turn in the approach (in this case the left turn west of the field). This procedure is roughly according to the landing chart instruction, where the descent should begin 30 seconds after passing the field.

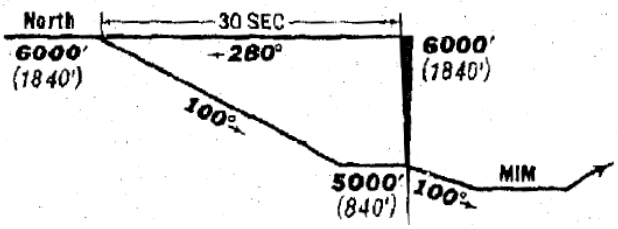

Fig 10. Altitude instructions on the Ndola chart

The clearance to the ground should be 840 ft according to the chart (fig 10), when flying at 5 000 ft. However, in reality the safety margin was only 640 ft. The landing chart can give a pilot the impression that there are no obstacles or higher ground west of the field, since all except from one of the marked obstacles are situated north, east and south of the field (fig 11).

The low safety margin could not be revealed by looking down on the ground, because there were no lights to be used as height references; it is impossible to estimate the aircraft's altitude above such a dark surface, often called a "black hole". Furthermore, distant lights from the airport, the town, distant bush fires and the moon can give the crew a false impression of flying at a safe altitude.

Such "black hole accidents" are shown to be possible also with well-trained crews. Simulator tests show that the sensory illusions can be so strong that crews even neglect GPWS warnings and fly into

the ground. Many accident investigations show that this kind of sensory illusions and occasional lack of attention to instruments are applicable even to very well experienced crews. Today this threat is well known, but at the time most of accident reports ended with a "pilot error" and therefore the underlying factors were not identified or known to pilots in common.

It is probable that the pilots switched from instrument flying to flying with visual references when passing the airport.

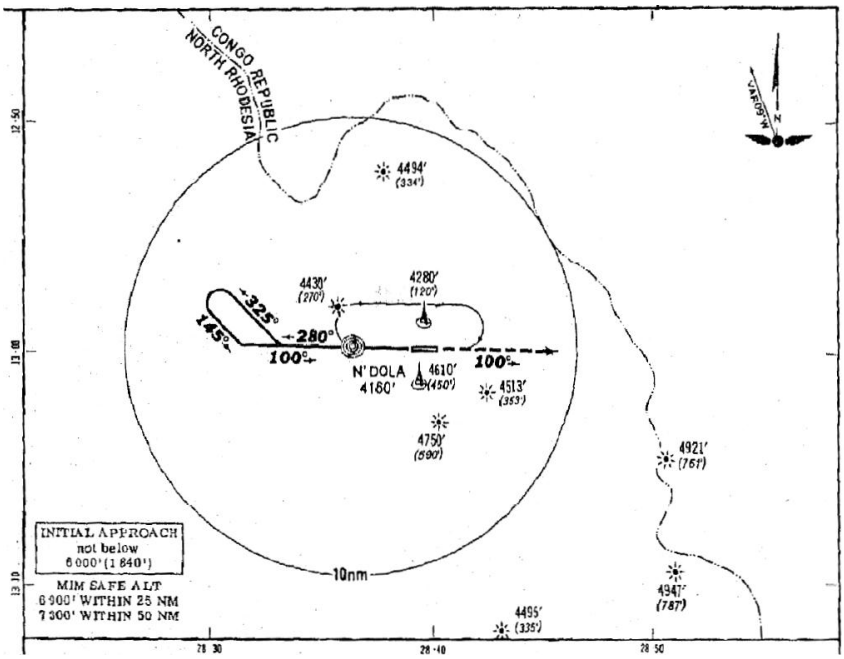

Fig 11. Part of the Ndola landing chart, showing obstacles and the instrument approach.

The swath path shows that SE-BDY was flying at a low rate of descent when striking the first treetops, and probably in a gentle left turn. In this position the crew were possibly trying to re-establish visual contact after the 180° turn, not realising that the field was now hidden behind a ridge. The search for the field could have contributed to the accident, in that the instrument monitoring could have been lower priority for some seconds. Being too low already, the time to impact would not be many seconds.

Flying with visual reference to the ground and instrument flying are two different arts. Trouble may arise when there is a mixture of the two methods of flight, or when transitioning from one to the other. This is the case when, after an instrument approach, the runway lies ahead and the pilot visually makes the last part of the approach.

6. Investigator's conclusions

I find many of the different theories about sabotage, cover-up and attack quite hard to believe.

Most theories require conspiracies to an extent beyond belief. The more people involved in a covert operation, the greater the risk for leakage. With so many years gone after the accident, many people involved would have had the chance – and probably the need – to reveal their secrets. This has not happened.

It is striking that many of the theories end in an ordinary accident; distraction of the pilots, because of a neck-breaking aggressor manoeuvre including hand-held bombs thrown from above, is only one example of an advanced theory construction ending up with – an accident.

Using the "Ockham's razor" is not always correct, but in this case I find the method most usable: *Among competing hypotheses, the hypothesis with the fewest assumptions should be selected; the simplest explanation is usually the correct one.* An investigator can probably never totally exclude sabotage or hostile act when examining a burnt wreckage. This is the case also in the Hammarskjöld accident. Still some kind of disturbance could be there; I can see a slim chance that some kind of outside distraction caused the pilots to look out and lose their concentration for a moment. But this "other aircraft", or whatever, could as well have been there for any other reason than trying to bring down the aircraft or to kidnap Mr. Hammarskjöld.

However, my conclusion is that there is no need at all for external disturbances or hostile acts to make an accident look exactly like what we see in the SE-BDY case. Thus, "the attack" is not needed. The "other aircraft" is not needed. No bombs, no world-wide conspiracies are necessary to bring down an aircraft. Unfortunately not. Actually, all the factual findings point toward another, much simpler, conclusion.

All findings in the accident with SE-BDY "Albertina" point at CFIT, Controlled Flight Into Terrain. I would be surprised if any other aircraft accident investigator, going through the information available today, would come to a different conclusion.

- The visual conditions were good concerning horizontal visibility, but with high risk of illusions known (today) to cause lack of awareness of height above ground.
- The landing chart didn't support full safety in that it didn't show the high ground level west of the field, and it could be interpreted as to permit descent to 5 000 ft too early.
- The crew was in the circumstances to fall in an illusion trap of being at safe altitude, caused by the "black hole" conditions.
- Fatigue after a long flight may very well have contributed to the accident, especially in combination with the relief of having reached the destination.

It is possible that a higher overall safety level would have revealed the risks associated with this particular flight. It is clear, and ironic, that flight safety in this case was degraded because of security precautions.

The classification as a CFIT does not mean that the crew was incompetent or ignorant. Instead, had the community earlier promoted in-depth analysis of causes to accidents and reports not been concluded with just "pilot error", the risks connected to flying over dark areas could have been known to the crew thereby preventing the accident.

As mentioned above, I find some weaknesses in the accident reports. Some of the weaknesses are concerning hard facts, some of them smell of political considerations, but most of them are deficiencies in the "soft" area of flight safety and operational performance. It is most often in these areas the explanation to CFIT accidents are found.

It is possible that an investigation with these "soft" areas better covered had narrowed the scope of alternative theories, provided that the investigators had been able to demonstrate broken safety

barriers and credible links in the event chain leading to the presumed likely cause. It should be noted, however, that such "soft" inquiries were not commonly performed at the time.

The CFIT theory clearly means that there is no need for external disturbances to make an accident look exactly like what we see in the SE-BDY case. The risks, the difficulties and the circumstances connected to this flight and this particular turn over a dark area, are simply enough to make an accident happen. All the conditions are there to create the catastrophe.

I have found that I fully agree with Mr. Age Röed's analysis and conclusions, in his report dated 1993 to ambassador Bengt Rösiö. I take the opportunity to conclude this report with his final words:

"Many accidents have happened since N'Dola. Had the reports on this accident stressed the need to develop methods to prevent black hole accidents it is possible that the rate of these accidents might have been reduced earlier. None of the reports did this and from an accident prevention point of view they have no value.

Accident investigation reports must be used to promote accident prevention. We must continue to solve problems and strive towards increased safety. Blame has no place in a modern society."

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Annex 1

Fuel Consumption and Combat Radius for the Fouga aircraft

Calculations are made after study of the Fouga CM 170 Pilots' Handbook, issue June 1959.

Conclusions

If anyone tried to start from Kolwezi air base, shoot down an aircraft at low level over Ndola and then go back to Kolwezi;

- ⇨ The emergency margin of fuel that should remain after landing would be reached before landing.
- ⇨ However, there would be enough fuel to complete the mission. The aircraft would land with only 7 imperial gallons (≈ 30 litres) of consumable fuel left in the tanks.

The calculated maximum combat radius for a Fouga, based at 5 000 ft and including a minimal fuel reserve, is 226 nautical miles. The distance between Kolwezi and Ndola is 228 NM.

This means that the mission is possible if the pilot's own safety is not prioritised. The mission demands that the handling of the aircraft is perfectly in agreement with the manual, and that the shortest route is exactly followed.

In other words, the possibility that the Fouga could reach Ndola from Kolwezi cannot be completely ruled out from fuel consumption perspective only.

The Fouga CM 170 "Magister" #93 at Kolwezi Air Base.

1. Calculation of fuel consumption for the Fouga CM 170

The calculation below is what I expect Delin/Magain to perform, if they got the idea or the order to shoot down an aircraft at Ndola.

Mission

- Start from Kolwezi air base
- Perform low-level air interception at Ndola
- Return to base

Conditions

- Optimum fuel saving conditions, collected from the Fouga Pilots' Handbook:
  - Climbing pattern: 200 kts
  - "VFR descend", N = idle and IAS 200 kts
  - Level flight at FL 300, at 20 000 rpm and TAS 260 kts (≈ 480 km/h)
- Total distance between Kolwezi and Ndola: 228 nautical miles, NM (423 km)

Units

- 1,00 imperial gallon equals 4,55 litres (1,20 US gallon)
- 1 statute mile (StM) or land mile is 1 609 meters (5 280 feet)
- 1 nautical mile (NM) is 1 852 meters (6 076 feet) at the equator.
- 1,00 StM = 0,87 NM

All consumptions and conditions are according to the Fouga Pilots' Handbook (ch 1.4 and fig 64), issue June 1959.

N.B. I: No data is available in the manual on aircraft equipment for the used figures. The fuel consumption is probably counted on a "stripped" aircraft, i.e. without armament, making the calculations optimistic.

N.B. II: The manual states that 11 imperial gallons of fuel should remain after landing (emergency margin). Of these 11 gallons, 2 gallons are non-consumable.

N.B. III: I have had access to two Fouga CM 170's manuals, one in English from 1959 and one in French from 1975 (revision 06/1977). In the newer manual two wing tip fuel tank types are listed: a metal 123-liter (27 imp galls) tank, and a polyester resin 230-liter (50 imp galls) tank. The bigger tank is not mentioned in the older manual, and all available pictures of the Katangese Fougas shows that the smaller tanks are mounted. The bigger tank enhanced the combat radius with about 20 minutes of flying at FL 300 (about 85 NM/157 km). However, it is probable but has to be confirmed that the bigger tanks were introduced well after 1961.

Fuel calculation

Fuel before start

Fuselage tanks, total:	160 imp galls
Wing tanks, total:	54 imp galls (2*27)
Total fuel on board:	**214 imp galls** (including 2 imp galls non-consumable fuel) (≈ 980 litres)

Engine start and taxi

Fuel consumption: 12 imp galls
Remaining before start: **202 imp galls**

Climb after start

Climb from Kolwezi air base (elevation about 5 000 ft) to Flight Level 300 (30 000 ft STD)
Consumption to FL 300: 47 imp galls
Remaining at FL 300: **155 imp galls**
Distance flown: 77 StM; 67 NM

Cruising towards Ndola

Fuel flow at FL 300: 70 imp galls/h
Distance at level: 228 – 67 – 66 NM = 95 NM
Time: 22 minutes; 0,36 h (with True Air Speed TAS = 260 kts, 482 km/h)
Consumption at FL 300: 26 imp galls (70 imp galls/h * 0,36 h)
Remaining before descent: **129 imp galls**

Descend towards Ndola

Ndola airport elevation about 4 160 ft; assume descent to 5 000 ft altitude
Consumption: 17 imp galls
Remaining at 5 000 ft: **112 imp galls**
Distance: 76 StM; 66 NM

Combat manoeuvring at 5 000 ft

Time: 5 minutes (unrealistically short time!)
Fuel flow at 5 000 ft: 153 imp galls/h
Consumption at 5 000 ft: 13 imp galls (153 imp galls/h * 0,083 h)
Remaining before climb: **99 imp galls**
Distance: 0 NM

Climb after combat

Climb from Ndola (5 000 ft) to Flight Level 300 (30 000 ft STD)
Consumption to FL 300: 47 imp galls
Remaining at FL 300: **52 imp galls**
Distance: 77 StM; 67 NM

Cruising towards Kolwezi

Distance at level: 95 NM
Time: 22 minutes; 0,36 h (TAS = 260 kts)
Consumption at FL 300: 26 imp galls (70 imp galls/h * 0,36 h)
Remaining before descent: **26 imp galls**

Descend towards Kolwezi

Fuel amount needed: 17 imp galls
Fuel level at touch-down: **9 imp galls** (including 2 imp galls non-consumable fuel)

Conclusion:

The emergency margin of 11 imperial gallons of fuel that should remain after landing will be reached before landing at Kolwezi.

However, there will be enough fuel to complete the mission. The aircraft will land with 7 imperial gallons (≈ 30 litres) of consumable fuel left in the tanks.

2. Calculation of max combat radius for the Fouga CM 170

Combat radius is a related measure based on the maximum distance a warplane can travel from its base of operations, accomplish some objective, and return to its original airfield with minimal reserves.

A. Climb phase – Airborne to cruising altitude.
B. Manoeuvre phase – Receipt of initial vector to target until beginning transition to attack speed and altitude.
C. Transition phase – Increase or decrease of speed and altitude required for the attack.
D. Attack phase – Turn to attack heading, acquire target, complete attack, and turn to breakaway heading.
E. Recovery phase – Breakaway to landing.

Calculated for an airbase at 5 000 ft (enhancing the combat radius).
"Some objective" = low-level air interception, short time (5 minutes)
"Minimal reserves" = 11 imp. galls (according to the manual), including 2 imp. galls non-consumable fuel.
All numbers, consumptions and conditions according to the Fouga Pilots' Handbook.

Combat radius calculation

Fuel before start

Fuselage tanks, total: 160 imp. galls
Wing tanks, total: 54 imp. galls
Total fuel on board: 214 imp. galls

Engine start and taxi

Fuel consumption: 12 imp galls

Climb after start

Climb from an air base at 5 000 ft to Flight Level 300
Consumption to FL 300: 47 imp galls
Distance: 77 StM; **67 NM**

Cruising at FL 300

"x NM"

Descend towards the mission area

Assume descent to altitude 5 000 ft
Consumption: 17 imp galls
Distance: 76 StM; 66 NM

Combat manoeuvring at 5 000 ft

Time: 5 minutes (short time for combat manoeuvring!)
Fuel flow at 5 000 ft: 153 imp galls/h
Consumption at 5 000 ft: 13 imp galls (153 imp. galls/h * 0,083 h)
Distance: 0 NM

Climb after combat

Climb from 5 000 ft to FL300
Consumption to FL 300: 47 imp galls
Distance: 77 StM; 67 NM

Cruising at FL 300

"x NM"

Descend towards home base at 5 000 ft

Consumption:	17 imp galls
Distance:	76 StM; **66 NM**

Fuel consumed:	153 imp galls (except from 2 * level flight at FL 300)
Fuel left on board:	61 imp galls (including 11 imp. galls of reserve)
Fuel left for flying:	50 imp galls

*2 * Cruising at FL 300*

Fuel flow at FL 300:	70 imp galls/h
Time available at FL 300:	43 minutes (=50/70 h); 21,5 minutes each way
TAS (True Air Speed):	260 kts (482 km/h)
Distance at FL 300:	**93 NM** (single way)

Total distance, single way: 67 + 93 + 66 NM = **226 NM**

Conclusion:

The maximum combat radius for a Fouga, based at 5 000 ft and including a minimal fuel reserve, is <u>226 nautical miles</u>.

The distance between Kolwezi and Ndola is 228 NM.

Chapter 1.4 from the Fouga Pilots' Handbook (Text) (hand made comments of unknown origin):

1.4. - FUEL SYSTEM

1.4.1. - General (fig. 14)

The fuel necessary for the operation of the engines is located in two fuselage tanks, two wing tip tanks and an inverted flight accumulator.

The compressed air required for the operation of the inverted flight accumulator and for the fuel transfer from the tip tanks, is tapped from the engines, downstream of the compressor.

This installation makes it possible to carry out 30 seconds of inverted flight, with full throttle, at sea level.

Figure 14 is a perspective drawing of the layout of the various components of this system.

1.4.2. - Tanks

- There are two fuselage tanks, which are permanently interconnected.

Type : Rubber, not self sealing

Capacity: ..... 255 L Front ....56 imp.galls
475 Rear ....104 imp.galls
730 L TOTAL ...160 imp.galls

Non-consumable fuel ..... 10 L about .....2 imp.galls

They are filled by gravity, through the plug located on the rear tank.

- There are two wing tip tanks, one on each wing.

Type : Metal, non-jettisonable

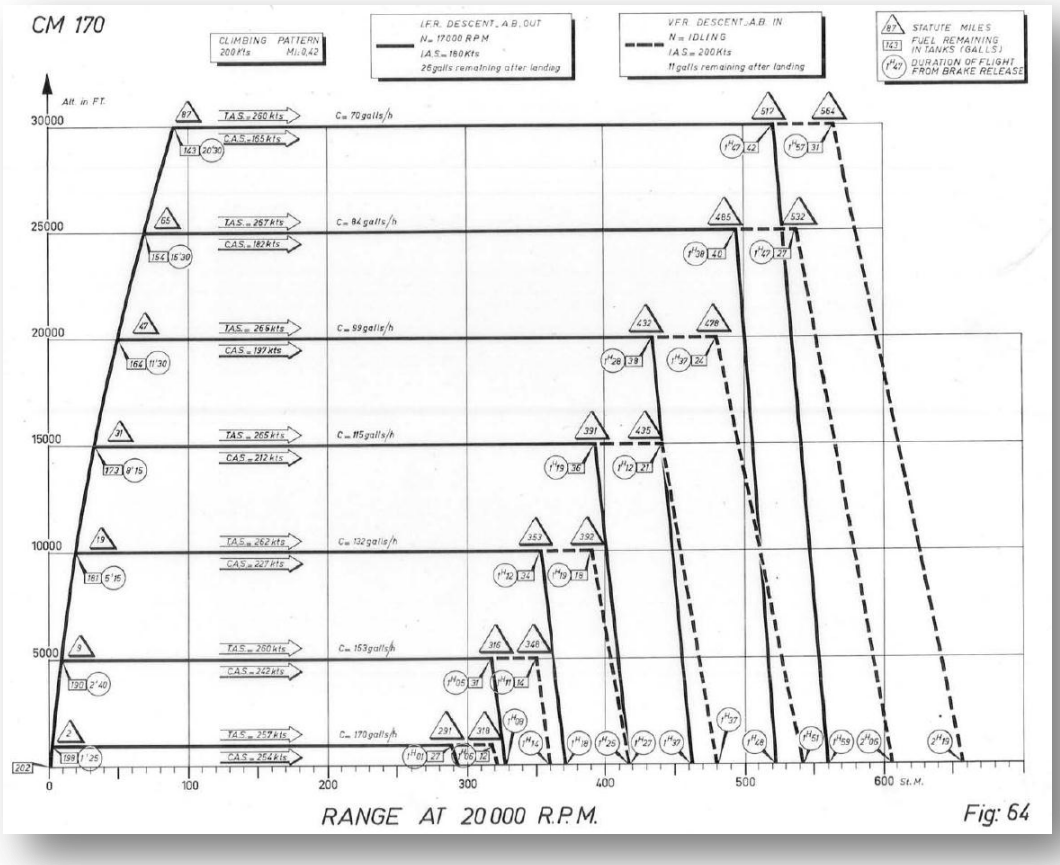
Capacity per tank ..... 125 L 27 imp.galls

Non-consumable fuel ..... None

980 L Total et
10 L inconsommable

12

Fig 64 from the Fouga Pilots' Handbook (Illustrations):



Annex 2

Study material

A number of different documents have been studied in this investigation. The following list is an attempt to present some of the used documentation.

Official Accident Reports

- Federation of Rhodesia and Nyasaland, Department of Civil Aviation, *"Report into the accident of 1961",* chaired by Colonel Maurice Barber, Federal Director of Civil Aviation, 1961
- Federation of Rhodesia and Nyasaland, *"Report of the Commission on the Accident Involving Aircraft SE-BDY",* chaired by Sir John Clayden, Chief Justice of the Federation, presented to the Federal Assembly, Salisbury, Federation of Rhodesia and Nyasaland, 1962
- United Nations General Assembly, *"Report of the Commission of the Investigation into the Conditions and Circumstances Resulting in the Tragic Death of Mr Dag Hammarskjöld and of Members of the Party Accompanying Him",* chaired by Rishikesh Shaha, 1962

Books in English

- Bengt-Åke Bengs, *"The Ndola Accident",* 1966
- Bengt Rösiö, *"The Ndola Disaster. Revised version",* for Swedish Ministry for Foreign Affairs November 1992 – February 1993
- Susan Williams, *"Who Killed Hammarskjöld? The Un, the Cold War and White Supremacy in Africa",* Hurst & Company 2011

Books and articles in Swedish

- Gunnar Möllerstedt, *"Generalsekreteraren",* Sveriges Radios Förlag 1981
- Gunnar Wall, *"Flygplanet som ingen saknade – Dag Hammarskjöld",* article from *"Historiens största mordgåtor",* Bonnier/Semic 2004
- Bengt Rösiö, *"Ndola",* Nerenius & Santérus 1996
- Bengt Rösiö, *"Ndola Slutrapport",* for Swedish Ministry for Foreign Affairs 1993
- Björn Virving, *"Termitstacken",* Termiten 1996
- Rolf Rembe & Anders Hellberg, *"Midnatt i Kongo",* Atlantis 2011
- Peter Berglund, *"Lokal anpassning i en fredsbevarande operation – den svenska flygstyrkan i Kongo 1960-1964",* Militärhögskolans Militärhistoriska avdelning 1996
- Jonas Waern, *"Katanga",* Atlantis 1980
- Kjell Peterzén, *"My TSA Memories",* http://www.transairsweden.com/Memories/peterzen2.php

Aircraft Manuals

- *"DC-6A and DC-6B Description and Operation Manual",* Douglas Aircraft Co, issued 24/12/1951, revised 1/02/1959
- "Potez Air Fouga", two parts ("Texte/Illustrations"), Fouga CM 170 Manual in English dated June 1959
- "Manuel de l'Equipage des Avions Fouga CM 170", two parts ("Textes/Planches") in French from 1975 (revision 06/1977)