SHERIFFDOM OF GLASGOW AND STRATHKELVIN AT GLASGOW

SUBMISSIONS FOR THE FAMILY OF MARK EDWARD O'PREY

in the

FATAL ACCIDENT INQUIRY

into the deaths of

GARY LOUIS ARTHUR, ANTHONY LYNDON COLLINS, JOSEPH ROBERT CUSKER, COLIN GIBSON, ROBERT JAMES JENKINS, JOHN MCGARRIGLE, SAMUEL BELL MCGHEE, KIRSTY MARY NELIS, MARK EDWARD O'PREY and DAVID IAIN TRAILL

INTRODUCTION

1. These submissions adopt the framework of the Crown's Submissions.

LEGAL FRAMEWORK

2. The Crown's submissions as to the legal framework are admitted.

PROPOSED FINDINGS IN FACT

3. Subject to the following paragraph, the Crown's Proposed Findings-in-Fact are adopted.

4. It is submitted that the following be added to the Crown's Proposed Findings-in-Fact at or after §11 of the Crown's Submissions:
   "In police operations the F PUMP AFT or F PUMP FWD caution could be illuminated in circumstances where there was sufficient fuel to keep both the fuel pumps wet at a level attitude; but that the attitude of the helicopter was such that it could cause one of the pumps to be exposed and run dry for more than 3 minutes. In a nose down attitude the F PUMP AFT caution could be illuminated. In a nose up attitude the F PUMP FWD caution could be illuminated. It was not unusual to have fuel pump cautions displayed

during the flight in police operations. In these circumstances, pilots would regularly switch the corresponding transfer pump off until the helicopter returned to a level attitude (Bryers 24:94:8 – 24:95:5; Young 22:12:25 – 22:15:22; Trott 28:155:5 – 28:155:25)

THE CONSOLIDATED LIST OF ISSUES

5. The following submissions, under reference to specific Issues within the agreed Consolidated List of Issues, are made in amplification, qualification or contradiction to those of the Crown. In respect of those Issues on which no comment is made, the Crown's Submissions are accepted, or it is considered that no useful comment can be made. For the avoidance of doubt, and in accordance with the Joint Minute, the Crown's Submissions on Issues §§1, 2 and 3 are adopted: namely, (i) when and where the deaths occurred, (ii) when and where the aircraft crash occurred, and (iii) the cause of each of the deaths.

With reference to Issue §4.1: "how fuel was managed on the aircraft and in particular why both transfer pumps were switched OFF; rendering unusable the otherwise usable fuel in the main tank".

6. Reference is made to the question of whether there was ever any fuel-management reason for either of the transfer pumps to have been switched off in the first place.

7. The Crown's Submissions, and references to the evidence of Trott and Prior, point to the many variables that apply to any attempt to recreate the circumstances of the flight of G-SPAO; those variables have a bearing on whether, and if so when, the F PUMP AFT caution and F PUMP FWD caution may have illuminated. As accepted by the Crown at §4.1.3 it is possible that the F PUMP AFT caution illuminated at some point during transit back from Dalkeith; and, at §4.1.8, the possibility cannot be excluded that the F PUMP FWD caution illuminated around Dalkeith. Frequent references were made in evidence by pilots to the dynamic nature of flying in police duties and, as a generality, that pilots would regularly be switching the transfer pumps on and off, until the helicopter returned to a level attitude (Bryers 24:94:8 – 24:95:5; Young 22:12:25 – 22:15:22; Trott 28:155:5 – 28:155:25). The evidence points to Captain Traill as being an experienced pilot. It is submitted that in all these circumstances, it should be held, although the precise circumstances of the fuel system management during the flight cannot be determined, each of the cautions illuminated at some point and that there were sound reasons that required each of the pumps to have been turned off.

With reference to Issue § 4.5: "why, having acknowledged the LOW FUEL warnings, did the pilot not complete the actions detailed in the *Pilot's Checklist*".

8. In considering whether the pilot did or did not attempt to complete the actions detailed in the *Pilot's Checklist*, it is relevant to note that the BLEED AIR switch was found to be in the OFF position (AAIB Report, CP327 p71, Ep85). There is also some, equivocal, evidence (in the form of a photograph taken by the Scenes of Crime Officer) to support at least one of the prime pump switches being on at the time of the accident.[1] Turning the BLEED AIR switch off is part of the Pilot's Checklist in the event of a LOW FUEL 1 or a LOW FUEL 2 warning. Given the proximity of the prime pump switches to the transfer pump switches, and the fact that they are identical in nature, there is a possibility that either one or both of the prime pumps were switched on in error prior to the accident. The fact that the BLEED AIR switch is OFF supports the possibility that the pilot may have attempted to undertake the actions detailed in the Pilot's checklist.

9. It is recognised that the evidence does not permit determining why the fuel transfer pumps were allowed to remain off, leading to fuel starvation, and were not turned back on before the accident. However, it is submitted, under reference to §§10 and 11 below, that evidence exists from which to infer that the pilot had a rational basis upon which he may have believed that fuel was being supplied to the engines in the period from when it is calculated both of the LOW FUEL warnings became illuminated (at or about 22.06 hours, and on approach to, or at, Bothwell) until engine flame-out.

10. Reference is made to the evidence of Captain Rooney. The extent to which a LOW FUEL warning was regarded by a pilot, prior to the time of the accident, as spurious or as a genuine warning of imminent fuel starvation would depend on the information being displayed and on what had happened prior to the warning illuminating. In the event of water-contamination in the supply tank sensors causing the CAD to over-read, the CAD might show fuel decreasing in the main tank and the supply tanks as full. It would not be obvious to a pilot from the display on the CAD that the transfer pumps were off. In such a situation the amber caution for low fuel would not illuminate due to the over-reading. The first indication the pilot would have that there was a potential issue would be the illumination of the red LOW FUEL warning(s) in isolation. A pilot's initial reaction to

[1] The AAIB Report, CP327, at §2.2.7.1, pp86-87, Epp99 to 100 records that both prime pump switches were found to be in the ON position at the time of their examination, but their position at the time of the accident could not be verified.

that might be one of confusion. Such a pilot might prioritise the CAD display over the red LOW FUEL warning. There is a possibility that the pilot might not carry out all the actions on the Pilot's Checklist. The pilot might not check that the transfer pumps were on. In light of that conflicting information, the pilot might take the view that the red LOW FUEL warning(s) was(were) spurious and carry on (Rooney 25:81:6 - 25:98:25). Captain Rooney was pressed on this closely, in evidence, to the effect that it would not always be the case that a pilot would check his transfer pump switches. He remained of the view, in the event of the display showing full supply tanks, of no amber fuel caution having illuminated, and of intermittent LOW FUEL warnings, that it was possible that a pilot might consider the warnings were spurious. In such circumstances, such a pilot might not consider it necessary to check the fuel transfer pumps, but rather rely on the CAD display and his own fuel calculation. In those circumstances, one might consider that, given the CAD reading, showing fuel in the supply tanks, and one's own fuel calculations indicating sufficient fuel, the red low fuel warnings were spurious (Rooney: 25:173:11 to 25:175:17).

11. In considering the likelihood of a pilot considering the low fuel warning lights to have been spurious, it is also to be noted that pilots did not necessarily understand that the low fuel warning light (dependent upon the thermistors) was a fuel monitoring system that was independent of the amber fuel warnings and gauge (dependent on the capacitor sensors). Pilots, at the time of the accident, would not necessarily know that the fuel warning systems were independent of each other and that the low fuel warning lights took priority over the CAD display: (Bryers 24:119:22 to 24:120:5. Trott 28:24:24 to 28:25:6. Rooney: 25:97:5-24 and at 25:98: 21-25. See also Airbus Alert Service Bulletin EC135-28A-019 *per* Bernhard 10:143:2-20 speaking to a warning having been issued to the effect that low fuel warnings over-ruled fuel quantity indications on the CAD).

With reference to Issue §4.6: "whether the timing and/or initially intermittent character of the LOW FUEL warnings contributed to the *Pilot's Checklist* procedure not being completed".

12. As discussed in connection with Issue §4.5, in the event that the CAD was indicating full tanks, and given that the pilot's own fuel calculations were likely to have been in the order of 100-105kgs of fuel remaining, as the helicopter approached Bothwell, the intermittent character of the LOW FUEL 1 warning had the potential to provide the pilot with a rational basis upon which to doubt the LOW FUEL warnings and not to undertake said procedure.

With reference to Issue §4.13: "whether the designed time-interval between engine flame-outs was compromised by the design of the fuel tank system and, in particular, the undivided volume above the supply tanks, which, depending on the attitude of the helicopter, might have allowed fuel to spill from one supply tank to another".

13. For the reasons stated by the Crown (at §§ 4.13.1 to 4.13.4 of its Submissions), the designed intention[2] that a time-interval be achieved, by provision of a foam intrusion in one supply tank, may be compromised by fuel migration or spillage.

14. Whilst the Crown says that it was unclear on the evidence whether the time-interval might be completely eliminated, it should be noted that the evidence of Mr Mendick was to the effect that theoretically the difference in volume of fuel between the two tanks could be eliminated by migration or spillage of fuel; although he did not have experience of the difference ever having been totally eliminated (8:126:17 to 8:127:17). The accident evidences that the difference in volume of fuel may be reduced so as to equate to a time-interval of only 32 seconds. The potential for the fuel and time differential to be reduced, and potentially eliminated, is of relevance to the precautions identified at Issue §5.5 (design of the fuel tank with a view to ensuring a time-interval between engine flame-outs). See below under discussion of Issue §5.5.

15. At this point, in considering the causes of the accident, and the extent to which the design intended to provide for a time-interval between any engine flame-outs, it is convenient to note pilots' understanding of these issues. The evidence from pilots was to the effect that it was understood that the supply tanks differed in capacity and there was something in the order of a 2-minute time-interval (*e.g.* Trott at 28:77:21-22 and 28:77.25 to 28:78:5). That understanding did not seem to draw on the terms of the flight maintenance manual, which was subsequently corrected (CP290), but rather from his training. It may be that some were influenced in their understanding of the time-interval by the terms of the flight maintenance manual (CP290), now corrected. Captain Trott was not aware of the potential, through fuel migration, for the time interval to be reduced. It does not appear that pilots have been provided with advice or training, since the accident, as to: (i) the actual difference in capacity of the supply tanks and the time-interval associated with that difference in capacity; (ii) the potential for that time-interval to be reduced, and possibly eliminated, by fuel spillage or migration between tanks. Captain Trott confirmed in evidence that he had not received any

[2] see AAIB Report, CP327 at §1.6.4.1. The foam intrusion reduces the capacity of Supply Tank 2, from the capacity of Supply Tank 1, at 49kg, to 44.5kg: and thus, provides for a 4.5kg difference in volume. The time difference is attributable to the burn rate for 4.5kg of fuel.

updating information or training in respect of the potential for fuel spillage and its potential to reduce the time-interval.

With reference to Issue §4.14: "why autorotation, flare recovery and landing were not completed successfully".

16. As the Crown note (at §4.14.4 of Submission), the AAIB state in their conclusions that autorotation and landing was not achieved "for unknown reasons" (AAIB Report CP327 at Ep107, under "(b) Causal Factors").

17. However, in addressing the Issue of *why* autorotation was not achieved, the Court will wish to have regard to evidence of: (i) an attempt having been made to enter autorotation; (ii) the practical difficulties of doing so.

18. The evidence of the rotor-speed (Nr) having been recovered on two occasions is evidence of the pilot having attempted to enter autorotation (see AAIB report, CP327, Table 3 at Ep45 – as to Nr recovery; Mr Marcus Cook 3:72:19 to 3:73:5; Captain Trott, 25:164:8-16).

19. Evidence of the practical difficulties faced by the pilot, in attempting a successful autorotation includes:
    a. the AAIB Report, CP327: the pilot was at about 500 to 750 feet, as opposed to heights adopted in training of 1,000 to 2,000 feet (p75, Ep87); at 500 to 750 feet, the pilot would have less time to establish stable autorotation (p75, Ep87);night-time conditions over built-up area. See Cook (3: 73:1 to 3:73:22): from the height of 500/600 feet to impact, there was less than 10 seconds.
    b. the evidence of Mr Rene Nater: the pilot is presented, potentially, with the surprise of the first engine flaming-out and then within 32 seconds the second engine flaming-out (9:177:5 to 25); the complexity of the manoeuvre and steps required compounded by night-time conditions, which make it a demanding task (9:178:12 to 9:180:18); that when one is at or below 900 feet, the prospects of successfully completing an autorotation are very poor, following double-engine flame-out (9:183:1 to 20).

20. Separately, the AAIB (CP327, §2.1.1, at pp76, Ep88, 2nd para.) note the helicopter had no forward speed at impact, which may imply that a flare manoeuvre had been carried out.

21. In conclusion, it is submitted that whilst, as the AAIB state, the evidence may not establish why, precisely, autorotation, flare recovery and landing were not completed successfully, the

evidence does permit the inference that the circumstances were such that it would have been highly unlikely that a pilot could have achieved a stable autorotation and thereupon landed successfully. Further, there is evidence that the pilot did attempt to achieve a stable autorotation and attempt a flare manoeuvre.

With reference to Issue §5.5 (as to such precautions as could reasonably have been taken and might have avoided the crash): "by designing the fuel tank system, and in particular the differential capacities of the supply tanks, in such a way as to ensure that the design objective of creating an interval of 3-4 minutes between engine flame-outs, or such other interval of time as would be represented by 4.5kg of fuel, or any other safe interval of time, was achieved".

22. A means of preventing simultaneous flame-out of both engines is, self-evidently, highly desirable. As noted by the Crown (Submission at §5.5.2, and under reference to Mr Mendick's evidence), certification requirements demand a degree of engine separation. (It was not, however, clear to the authors of these Submissions whether certification requirements require a time-interval be provided for by differing capacities in the supply tanks.) Airbus sought to provide a time-interval between engine flame-outs, should fuel starvation occur (AAIB Report, CP327 at p13, Ep25), by means of the foam intrusion creating a 4.5kg difference in fuel capacity. Such time-interval, potentially, allows fuel checks to be made and a pilot to be on greater alert for the possibility of emergency measures such as autorotation following a double-engine flame-out. Provision of a time-interval between flame-out is only of practical benefit if the time-interval permits the pilot: a period of time to overcome the surprise that a pilot may experience on an engine flame-out (Nater, 9: 177: 5-25. Trott, 28: 127: 10 to 22); time to evaluate the situation and options; time to carry out checks and to take remedial action; time for remedial action to take effect (in this regard it is relevant to note that some 10 seconds would be have been required for the transfer pumps to have effected transfer of fuel to the supply tanks; and that the evidence did not explore what, if any, time would have been required to re-start the engines); an opportunity to land.

23. The difference in capacity of 4.5kg, between the two tanks, would only ever allow for a time-interval of about 1 minute 20 seconds to 1 minute 30 seconds. Airbus has recognised that an earlier statement to the effect that the foam intrusion and consequent difference in capacity would provide for a 3 to 4- minute time interval was wrong (Mr Bernhard, in respect of CP306 at: 10: 112:17 to 10:115:7).

24. As discussed above (at §14 hereof), the accident is evidence that the design objective can translate to only 32 seconds; and, theoretically, may be eliminated. It seems on the evidence that it is not possible to predict what time-interval may be available (for depending on flight conditions a greater or lesser amount of fuel migration may have occurred). Accordingly, the evidence calls into question the extent to which the design objective (of achieving a time-interval such as to allow the pilot a reasonable period of time to check for inadvertent fuel starvation or, separately, prepare for the possibility of a double-engine flame-out) is achieved. It further calls into question whether any useful safety margin may be achieved in the circumstances where the flight has involved manoeuvring that may lay lead to fuel migration between flights.

25. It is recognised that the evidence did not explore the extent to which, or the means by which the design objective (of a 4.5kg, or greater, differential between supply tanks) could be ensured. Mr Mendick explained that complete separation of the supply tanks would reduce the fuel that would be available to both engines and that the desire is that the degree to which fuel is kept separate from both engines should be kept to a minimum (7:24:12-25).

26. Accordingly, it is recognised that the evidence does not permit the Court to make findings as to how a reasonable time-interval might be ensured, through changes to the design of the fuel tanks.

27. It is, however, submitted that:
    a. contrary to the Crown's position (at §5.5.3), it may properly be inferred, on the available evidence, that a time-interval equivalent to about 4kg of fuel would, at the least, have increased the chances of avoiding the accident.
    b. the evidence does not permit a finding as to how a time-interval equivalent to 4kg (or more) may be achieved, but that as achieving such is highly desirable consideration should be given to how that might be achieved by the manufacturer. (See §30 below.)
    c. (as discussed further below) advice and training should be given to pilots to the effect that the time interval is likely to be no more than 1m 20secs to 1m 30secs, and may through fuel migration/spillage be significantly less. (See §29 below.)

Issue §7.3: whether, and the extent to which, any recommendations should be made by this Court

28. It is submitted that the following be considered as recommendations to be made by the Court.

29. It is submitted that operators of the EC135 should take steps to instruct their pilots on the nature of the fuel differential in the supply tanks of the EC135; and the time-interval in flame-out on fuel starvation such differential may permit. However, pilots should further be instructed that flight conditions, in particular dynamic flying of the sort that police operations involve, may lead to fuel migration that significantly reduces, and potentially, eliminates such interval. Support for the need for such training and instruction of pilots is found in the evidence of Captain Trott, discussed above at §15.

30. As discussed above, it is desirable that a time-interval be achieved between flame-out in situations of fuel starvation. It is apparent from this accident that the design intention of achieving something in the order of 1m 30 secs, was not achieved. It is recognised that the evidence did not address how that, or a greater, time-interval might be achieved. Whilst it may be thought that making any recommendation on this issue is therefore beyond the scope of this Inquiry, it is submitted that the Court should give consideration to making a recommendation that the manufacturer give consideration to ways in which the design intention (4kg differential and a consequent time-interval in the order of 1m 30 secs) might be ensured.

30th July 2019

Jonathan Brodie QC

Dana Forbes, Advocate