FINAL REPORT

AAIU Synoptic Report No: 2004-001
AAIU File No: 2002/0047
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In accordance with the provisions of SI 205 of 1997, the Chief Inspector of Accidents, on 12 September 2002, appointed Mr Graham Liddy as the Investigator-in-Charge to carry out a Field Investigation into this occurrence and prepare a Synoptic Report.

Aircraft Type and Registration:	Agusta B206 Jetranger EI-BKT
No. and Type of Engines:	1 x Rolls Royce Allison 250
Aircraft Serial Number:	8562
Year of Manufacture:	1978
Date and Time (UTC):	11 Sept 2002 @ 11.42 hrs
Location:	Dublin Port
Type of Flight:	Aerial work - photography
Persons on Board:	Crew - 3 Passengers - 0
Injuries:	Crew - 0 Passengers - 0
Nature of Damage:	Heavy landing damage
Commander's Licence:	ATPL(H)
Commander's Age:	58
Commander's Flying Experience:	10,034 hours of which 4,000 were on type
Information Source:	Pilot's Report and AAIU Field Investigation

1 FACTUAL INFORMATION

1.1 Background

EI-BKT was being used as a camera platform for a television documentary about the Irish landscape. The required permissions for this type of flight had been sought and received. The pilot did not work for the helicopter owners but they had been requested to obtain his services by the documentary producers, because of his considerable experience in this kind of work.

1.2 History of the Flight

On this flight, one of the proposed camera shots was of Dublin City, looking west, with the top of two tall chimneys of a major power station in the close foreground. The chimney tops are located 691 ft above sea level and 684 ft above ground level. Weather conditions at the time were excellent, with clear sky and a light wind from the south. The pilot approached the chimneys from the west, along a path parallel to the two chimneys and just to the north of the chimneys, with the intention of circling around the chimney area to get the required shot. The helicopter was flying slightly higher than the tops of the chimneys. As the helicopter passed the second chimney, it briefly entered the exhaust plume from the chimney. The engine suddenly lost all power and ran down. The pilot immediately lowered the collective and set up an autorotation. The tide was out at the time, exposing a large area of beach immediately south of the power station, and the pilot landed on this beach. As the beach area was wet and soft, the pilot opted for a vertical landing with little forward airspeed, as he was concerned that the skid undercarriage would dig in and cause the helicopter to pitch-over in a forward direction. As the helicopter touched on, the skids did start to dig in and the pilot raised the collective to counteract the forward pitch-over.

The helicopter was operating at the high end of the permissible weight envelope at the time of the autorotation. As a result the rate of descent was high, which produced a high rotor autorotative RPM. Consequently the pilot raised the collective during the descent to prevent rotor over-speed.

After landing, the pilot inspected the helicopter and found no damage. He initially spun the engine in the ventilation mode and found it rotated freely. He then started the engine, without difficulty, and found that it performed normally. At this time he was concerned that the incoming tide would immerse the helicopter. He therefore decided to take-off, with the camera crew still on board, and he flew the helicopter to the owner's facility at Dublin Airport, without further incident. On this flight he avoided flying over areas of population. On further inspection at Dublin Airport, the helicopter was found to have suffered significant damage, consistent with a low rotor RPM heavy landing.

1.3 Other Information

1.3.1 This helicopter is equipped with a spike under the main gearbox, which contacts a striker plate on the transmission platform in the event of excessive vertical or fore-and–aft movement of the main gearbox. This feature is designed to facilitate a quick inspection of the helicopter in the field after a suspect landing, in order to determine if excessive gearbox movement has occurred. On the subsequent inspection at Dublin Airport it was found that the spike had forcefully hit the striker plate. This inspection did not find any damage or defect in the engine.

1.3.2 The Investigation obtained the tape from the camera that was running during the incident. This shows that the helicopter flew into the plume of the second chimney. The plume is only barely visible on the tape during the approach to the chimney. It only becomes noticeable immediately before the helicopter enters it.

When the helicopter enters the plume the camera lens briefly mists over and then clears during the subsequent autorotation. The tape also shows the subsequent landing, which appears to have been well executed, and the landing does not appear exceptionally heavy. However this is somewhat difficult to determine, as the camera was held low on the side of the helicopter. The cameraman, who had considerable experience of helicopter filming operations, subsequently stated: "*there was nothing particularly rough about the landing*."

1.3.3 The pilot subsequently stated that the entire windscreen of the helicopter misted over after entering the plume and this obscured his vision significantly in the early segment of the autorotation.

1.3.4 One of the camera crew subsequently stated that he could not see an exhaust plume as the helicopter approached the chimney. A photograph was taken of the landing area shortly after the landing. The chimneys are clearly visible in the background and no plume is visible in the photograph (ref **Appendix A**).

1.3.5 On 18 September 2002, the Investigation informed the Irish Aviation Authority that:

"*Preliminary indications are that the helicopter flew into the exhaust plume of the power station chimneys, and that the flame-out was due to the ingestion of the plume. The presence of a large volume of oxygen-depleted combustion by-products, the very high temperature of the emitted gases or the presence of large amount of water vapour in the emissions, or a combination of these factors was, in all probability, sufficient to cause the flame-out. It is noteworthy that one of the camera crew stated that there was no visible plume at the time.*

Subsequent research indicates that this was not a unique event. Similar flame-outs have occurred as result of;

- *Flight over power stations, even when there was no visible plume.*
- *Flight over forest fires.*
- *Flight over burning buildings.*
- *Flight over volcanoes.*
- *Approaching oil/gas rigs from a downwind direction when natural gas was being vented or flared.*

It appears that the dangers of operating in such environments may not be generally appreciated.

The Investigation also issued the following Interim Safety Recommendation:

"Interim Safety Recommendation:

The Irish Aviation Authority should issue an AIC (Aeronautical Information Circular) *alerting pilots and operators of helicopters of the dangers of engine flame-outs as a result of operating in environments of contaminated atmosphere, high temperature and/or combustion by-products, such as plumes from power stations, forest fires, burning buildings, or oil/gas rigs when natural gas was being vented or flared. The AIC should note that flame-outs can occur even when no plume is visible.* ***(SR 25 of 2002)***"

1.3.6 The IAA responded to this Interim Safety Recommendation by issuing AIC No 4 of 2003 on 1 January 2003 **Air Navigation Hazard – Exhaust Plumes** (ref **Appendix B**).

1.3.7 The Investigation was given excellent assistance by the operator of the power station. It was determined that the first (westerly) chimney encountered by the helicopter was not operating at the time, as the appropriate power units were undergoing maintenance. The second chimney served a steam boiler power unit of 270 Megawatts, which was running at about 75% capacity at the time of the occurrence. The fuel being used at this time was natural gas, the exhaust of which has a greater tendency to condense at or near ambient temperatures, compared to oil firing. The oxygen levels at the discharge point were estimated to be 4-5%. Oxygen levels of at least 12% are considered essential for the safe running of aircraft turbine engines.

1.3.8 An additional comment was made by the power station operator. In addition to exhaust plumes emitting from chimneys or stacks, there is also another hazard due to the fact that power stations may at any time experience a sudden emission of large quantities of steam, caused by the operation of safety valves. Such releases would pose a considerable hazard to low flying helicopters and aircraft. The power station operator also pointed out that there is the possibility of explosive debris emission from safety valves when they open suddenly.

1.3.9 The engine on this particular model of the B206 is not equipped with auto-ignition. Auto-ignition is designed to automatically re-ignite the engine in the event of a flame-out.

1.3.10 The power station chimneys are a Visual Flight Rules (VFR) reporting point within the Dublin Control Zone. Consequently low-level air traffic is frequently directed into this area.

2. ANALYSIS

2.1 When the helicopter entered the plume, it entered an environment of very high ambient temperature, with very high water vapour content and depleted oxygen content. The combined effect of these factors was to produce an atmospheric condition that quenched the flame in the combustion chamber of the engine. This caused the engine to run-down and stop.

2.2 The plume only became visible on the camera tape when the helicopter came very close to the chimney. The fact that the plume was located, from the pilot's view-point, close to the horizon, would have made visual detection of the plume more difficult. It is also noted that one of the camera crew on the aircraft stated that he did not see the plume and that the plume was not visible in the subsequent photograph (Appendix A).

2.3 The action, by the pilot, of raising the collective on landing, to prevent pitch-over, was both appropriate and necessary. However it had the secondary effect of suddenly lowering rotor RPM and thus caused the blades to flap. This in turn caused the gearbox to rock and was the prime cause of the damage to the helicopter.

2.4 The contents of the camera tape show that the flame-out, and subsequent autorotation and landing, were ably handled by the pilot. The available height, when the engine shut down, was also a significant factor in the successful autorotation.

2.5 Given that the chimneys are a VFR reporting point, frequently used by low level air traffic, a recurrence of this event may be more likely than generally perceived.

2.6 The plume from power stations is frequently invisible, particularly when the station is being powered by natural gas. In this case, neither the evidence of witnesses, the video tape nor the photograph taken after the event (Appendix A) indicate any discernable difference between the active and the inactive chimneys. Therefore the absence of a visible indication of an exhaust plume does not mean that no hazard exists.

3 CONCLUSIONS

3.1 The engine suffered a flame-out as a result of the helicopter being flown into the plume of an active power station.

3.2 The flame-out was caused by a combination of the high temperatures, the high moisture content and the depleted oxygen levels found within the plume.

4 SAFETY RECOMMENDATIONS

4.1 The IAA should review the use of the chimneys feature as a Reporting Point, with the objective of minimising the risk of low-level VFR traffic suffering engine stoppage due to plume ingestion. **(SR 1 of 2004)**

Appendix A

Photograph of the landing area, which was taken shortly after the event. The helicopter had restarted and moved a short distance away from the landing point. The ground marks were made during the landing, which took place towards the camera. The chimneys can be seen in the background. The inoperative chimney is on the left and the chimney that produced the exhaust plume is on the right. It is noteworthy that the plume is not visible in this photograph.

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Appendix B

IRELAND

AIC

AERONAUTICAL INFORMATION SERVICES
IRISH AVIATION AUTHORITY
CONTROL TOWER
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AIR NAVIGATION HAZARD – EXHAUST PLUMES

The purpose of this AIC is to bring to the attention of aircraft operators the potential hazards of engine flame-outs as a result of operating in close proximity to environments which emit high temperatures (i.e. up to 540°C) and combustion by-products.

These emissions are associated with but are not limited to, Power Stations, Industrial Chimneys, Oil/Gas Rigs and Shipping. Operators are advised that due to certain atmospheric conditions this exhaust plume may not be visible.

The consequence of entering such a gas plume may be the immediate flame-out of gas turbine powerplant(s) combined with a dramatic loss of lift due to increase in local density altitude.

Encounters with such gas plumes should not occur where the aircraft is otherwise in compliance with the Rules of the Air in relation to vertical and horizontal separation from structures.

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