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See-and-avoid Deficiencies Cited in Collision of Fighter and Light Airplane

The report said that the pilot of a Cessna 152 probably was taking aerial photographs and the pilot in the front seat of a Panavia Tornado was head-down, conducting operational checks, when the aircraft collided in good weather over relatively flat terrain.

FSF Editorial Staff

At 1132 local time Jan. 21, 1999, a Cessna 152 and a U.K. Royal Air Force (RAF) Panavia Tornado collided 655 feet above ground level (AGL) near Mattersey, Nottinghamshire, England. The Cessna pilot and passenger, and the Tornado student pilot and instructor pilot were killed. The collision occurred in visual meteorological conditions (VMC) in uncontrolled airspace.

The U.K. Air Accidents Investigation Branch (AAIB) said, in its final report, that the following causal factors were identified during the accident investigation:

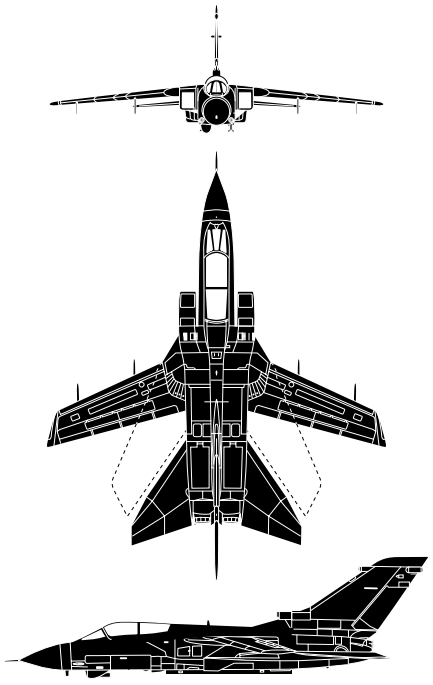
- "None of the pilots saw each other's aircraft in time to take effective avoiding action;
- "The Cessna pilot, while probably taking aerial photographs, conducted his flight at a height known to be vulnerable to an encounter with a military fast jet;
- "By not using the Civil Aircraft Notification Procedure [CANP] or informing any ATC [air traffic control] agency of his location and intentions, the Cessna pilot degraded the potential of other traffic to locate and avoid him;
- "When conducting operational checks, head-down, while at low level, the front-seat pilot [the student pilot] of the Tornado did not detect the Cessna. The rear-seat pilot [the instructor pilot] had a limited field of view ahead of his aircraft and would have been unable to detect other aircraft in the forward sector;
- "The principle of 'see and avoid' was suspended during a period in which none of the pilots was able to conduct an effective lookout; [and,]
- "Technology-based aids designed to enhance visual detection, such as strobe detectors and collision warning systems, which had been recommended in the light of previous midair collisions, had not been introduced into service."

The Cessna was operated by a flight school at Gamston Airfield. When the accident pilot arranged to rent the airplane from the flight school, he said that the purpose of the flight was to familiarize himself with the local area.

The pilot, 36, owned an aerial-photography business. Before earning his private pilot license in 1997, he employed other pilots to fly the aircraft while he took photographs.

"Once he had gained his [private pilot license], he undertook the dual role of flying the aircraft and taking photographs," the report said. "The hand-held camera that he used, a Nikon F4, was an auto-focus model that required both hands to hold the camera and operate the zoom [focal length] mechanism."

In February 1998, the pilot joined a flying club in Netherthorpe. Between February and July [the report does not provide the date], a flight instructor for the flying club observed the pilot flying one of the club's Cessna 150s low over houses. The flying club's chief flight instructor warned the pilot about the hazards of low flying and required that he take another check ride.



Panavia Tornado GR1

Development of the Panavia Tornado all-weather, multi-role combat aircraft began in 1970. First flight of the GR1, the U.K. Royal Air Force designation for the interdictor/strike version, occurred in 1974.

The aircraft accommodates two crewmembers in tandem seats. The variable-geometry wings sweep from 25 degrees to 67 degrees. Each of the two Turbo-Union RB199-34R turbofan engines is rated at 8,475 pounds thrust (37.7 kilonewtons) for squadron service and 8,320 pounds thrust (37 kilonewtons) for training service.

Maximum capacity of the wing and fuselage fuel tanks is 1,542 gallons (5,837 liters). Maximum takeoff weight is 45,000 pounds (20,412 kilograms). Time from brake release to 30,000 feet is less than two minutes. Maximum operating speed at altitude is 2.2 Mach.

Source: *Jane's All the World's Aircraft*

On July 4, 1998, the pilot again was observed flying a club aircraft at low altitude.

"[The pilot] was then banned from flying at the Netherthorpe flying club," the report said.

On Jan. 19, 1999, the pilot applied for membership in the flying club operated by the Gamston flight school.

"His license and logbook were checked, and a proficiency check flight was arranged for the next day," the report said. "On 20 January 1999, he completed this flight with an assistant flying instructor during which his knowledge of the local procedures and airspace was checked.

"He was specifically briefed on the availability [of flight information service (FIS) from] RAF Waddington … and the use of the radar transponder when leaving the circuit in order to increase the conspicuity of his aircraft."

The Cessna was white and had two red stripes along the length of the fuselage. The airplane had red, green and white navigation lights, a white strobe light on each wing tip, a rotating red beacon light on the vertical stabilizer and a landing light in the engine cowling.

"It was also equipped with an ATC transponder, which was understood to have been serviceable when the aircraft took off on the accident flight, as were the lights," the report said.

At the time of the accident, the pilot had 282 flight hours, all in Cessna 150/152-series aircraft. The passenger on the accident flight was not a pilot.

"[The passenger] had accepted the offer of the flight in order to enjoy a day out and to provide some company for the pilot," the report said. "He had previously flown with this pilot on aerial-photography flights and had assisted by changing the [film] in the camera."

The Cessna departed from Gamston at 1110.

"After leaving the airfield circuit, the pilot did not make radio contact with any other agency, and no primary or secondary radar contact was noted by any of the local military or civil radar units," the report said.

The report said that the Cessna's transponder rotary switch was found in the "OFF" position after the accident.

"Lower airspace radar service (LARS) was available to the Cessna pilot from RAF Waddington, [but] the aircraft would need to have been flown at a height above the lower limit of radar coverage and, ideally, to have an active transponder," the report said. "Alternatively, the pilot could have requested FIS, which would not have been dependent on [ATC] radar."

Witnesses saw the Cessna maneuvering over Mattersey Thorpe, about 13 kilometers (seven nautical miles) north of Gamston.

"In the six-[minute] to eight-minute period prior to the accident, the Cessna was seen to complete at least two orbits to the left at low level," the report said. "A number of eyewitnesses said that the aircraft behaved as if [the occupants were] taking aerial photographs."

The Tornado was on a training flight from the Tri-national Tornado Training Establishment (TTTE) at RAF Cottesmore. Tornado flight crews from the RAF, the German air force, the German navy and the Italian air force received operational conversion training at the TTTE, which was closed in March 1999.

The accident airplane had a gray camouflage paint scheme and high-intensity strobe lights on the top and the bottom of the fuselage.

"The radar system fitted to this aircraft was not designed for acquiring or warning of the presence of other aircraft," the report said.

The Tornado had a head-up display (HUD), which projects flight and navigation information onto a screen in front of the pilot.

"This projected information is nominally focused at infinity, thus allowing the pilot to absorb this information while looking through the HUD, searching for distant objects, without the need to refocus the eyes," the report said. "The pilot can thereby maintain a constant lookout for other aircraft, obstructions and ground objects … with only occasional glances into the cockpit.

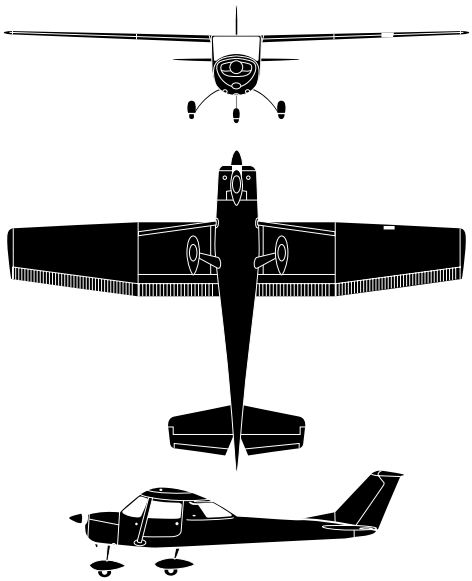
"However, this process ceases when the pilot conducts checks of the aircraft and its systems that require him to direct his attention to instruments within the cockpit."

The student pilot, 25, was a pilot in the Italian air force and was making his second flight in a Tornado. He had 385 flight hours, including one flight hour in the Tornado.

"Prior to joining the TTTE course, the student had completed his basic flying training on the [Aermacchi] SF.260 aircraft in Italy," the report said. "He then attended the NATO [North Atlantic Treaty Organization] Joint Jet Pilot training course in [the United States], where he flew the [Cessna] T-37 and [Northrop] T-38 aircraft. Having qualified as a military pilot, he then flew the [Aermacchi] MB-339A aircraft in Italy in order to become familiar with military low flying in the European environment."

The RAF instructor pilot, 35, had 2,250 flight hours, including 974 flight hours in Tornados.

"The instructor had considerable instructional experience and had been instructing on Tornado aircraft at the TTTE for the past 22 months," the report said. "His previous tour had been as a Tornado pilot on an operational squadron."



Cessna 152

The Cessna 150/152 series aircraft are light two-seat, civilian trainers. The 150, introduced in 1958, has a 100-horsepower (74.5-kilowatt), four-cylinder Continental O-200A engine designed to use 80-octane aviation gasoline. The 152, which replaced the 150 in 1977, has a 108-horsepower (80.5 kilowatt) Lycoming O-235-N2C engine designed to use 100-octane aviation gasoline.

Maximum takeoff and landing weight is 1,670 pounds (758 kilograms). Standard usable fuel capacity is 24.5 gallons (92.7 liters). Optional usable fuel capacity is 37.5 gallons (141.9 liters).

Maximum rate of climb at sea level is 715 feet per minute. Maximum speed at sea level is 109 knots (202 kilometers per hour). Power-off stall speed with flaps fully extended is 43 knots (80 kilometers per hour).

Source: *Jane's All the World's Aircraft*

The report said, "[The training flight] was planned to commence with a brief introduction to low-level flying before pulling up for medium-level general handling, a practice diversion and extensive circuit work."

The Tornado took off at 1125 from RAF Cottesmore and was flown to 900 feet AGL.

"After takeoff, the instructor made radio contact with the Cottesmore departure controller, who reported no secondary radar response on his radar screen from the [Tornado]," the report said. "After leaving the Cottesmore [control] zone, the crew contacted Cranwell Air Traffic Control, [which] also informed the crew that no secondary radar response was visible on their radar screen and offered FIS.

"The instructor accepted the FIS and confirmed with the student pilot that the secondary radar transponder (known in the RAF as identification friend or foe [IFF]) was selected to

'ON' and that the correct code was set. The instructor left the Cranwell frequency at 1129 and [did not communicate thereafter with any ATC facility]."

The crew then conducted pre-low-level-flight checks, turned to a heading of 320 degrees and began a descent to 650 feet AGL.

"At this stage, the instructor was reminding the student pilot about steering and map-reading techniques with particular emphasis on the need to maintain a good lookout while at low level," the report said.

The crew at 1131 turned right to a heading of 041 degrees. The student pilot then began a routine "ops check" (operational check of the aircraft and systems).

"Towards the end of this check, the instructor provided sensor [information] and battery information, which is displayed in the rear cockpit, while the student pilot commenced a 15-degree bank turn to the right to recapture the planned low-level track," the report said.

The last item of the ops check was cabin pressurization. The cabin-pressurization gauge was about 45 millimeters (1.8 inches) in diameter and was located on the environmental-control panel near the front-seat pilot's right hip.

"While the student pilot was checking this instrument, the Tornado collided with the Cessna," the report said.

The Cessna was in a 30-degree-banked left turn at about 90 knots indicated airspeed (IAS) and the Tornado was in straight-and-level flight at 434 knots IAS when the collision occurred.

Witnesses said that the Tornado penetrated the Cessna behind the Cessna's right wing root. The report said that both occupants of the Cessna and the student pilot aboard the Tornado were killed during the collision.

"From the on-site examination of the debris, it was apparent that the collision had completely disrupted the [center] fuselage of the Cessna, causing instant fatal injuries to both occupants and destroying the integrity of the aircraft as a whole," the report said. "The Tornado appeared to have suffered major damage only to the cockpit windscreen and canopy, leading to immediate incapacitation of the crew, certainly fatal in the case of the front-seat pilot."

The report said that the rear-seat pilot likely was killed, also, during the collision. The Tornado remained flyable; the aircraft continued on course and descended to the ground 13 seconds after the collision.

"The collision initiated the ejection sequence for the front seat of the Tornado, and that pilot was ejected from the aircraft; but command ejection of the rear seat did not take place," the report said. "The aircraft disintegrated on ground impact with the rear-seat pilot still in his seat."

The wreckage of both aircraft fell on open farmland.

"A postmortem and toxicological examination was carried out on all four victims," the report said. "In no case was there any evidence of pre-existing disease, alcohol, drugs or any toxic substance which may have caused or contributed to the cause of the accident."

Visibility at the accident site was between eight kilometers and 10 kilometers (five statute miles and six statute miles). Few clouds were in the area, with bases at 2,000 feet to 3,000 feet and tops at 4,500 feet to 5,000 feet. Surface wind was from 250 degrees at five knots.

"Several witnesses who saw the collision … recalled the weather as being clear, bright and sunny with good visibility," the report said.

The U.K. Center for Human Sciences studied whether the occupants could have seen each others' aircraft before the collision.

"The conclusions of this study are that the nature of the Cessna aircraft's final [maneuver] presented those on board with only a limited opportunity for detecting the Tornado, and it is likely that their attention was confined to ground references during this critical period," the report said. "The instructor pilot, in the rear seat of the Tornado aircraft, had an obstructed view in the forward sector and had no opportunity to detect the confliction.

"Only the student pilot, in the front seat of the Tornado, had any opportunity to detect the confliction. In principle, in the prevailing conditions a diligent visual scan would have had a moderate probability of revealing the Cessna in time to allow avoiding action to be taken. This principle was undermined by the student pilot's attention to a routine check procedure."

The report said that most midair collisions occur in good weather and good visibility.

"The problems of the visual detection of another aircraft and the recognition that it is on a collision course have long been acknowledged, and much research has been carried out into ways of avoiding such accidents," the report said.

The report said that, based on the investigation of a collision between an RAF Tornado GR1 and a Bell 206B helicopter in Kendal, Cumbria, June 23, 1993,[1] the AAIB recommended that the U.K. Ministry of Defence (MOD) conduct a study of military "fast jet" training at low altitude.

"The MOD accepted this recommendation and commissioned the Defence Evaluation and Research Agency (DERA) to

conduct the analysis and to evaluate various measures that might further enhance flight safety," the report said. "The study concluded that the principle of 'see and avoid' in the open flight information region (FIR) below 2,000 feet is generally more than 99 percent effective in resolving conflictions.

"At current flying rates (military and civil), this implies an expected collision rate of 0.118 per 10,000 flying hours for military fast-jet aircraft and of 0.005 per 10,000 flying hours (by military fast jets) for fast jet/general aviation [GA] aircraft. This predicts a random collision between a military fast jet and a [GA] aircraft about once every six years."

The DERA study examined three methods of increasing aircraft conspicuity: high-intensity strobe lights (HISLs); high-powered, forward-facing lights; and gloss-black paint schemes.

"The use of HISLs, rated at 2,000 candela, on military aircraft was calculated to produce a reduction in the expected collision rate from 2.202 to 1.870 per annum," the report said. "HISLs are now fitted to all military low-flying aircraft."

Equipping civil aircraft with HISLs was calculated to reduce the expected collision rate by 0.445 per year. Civil aircraft are not required to have HISLs.

The report said that operating high-powered, forward-facing lights on RAF aircraft was found to be effective in improving conspicuity but "viable" for installation only on the British Aerospace Hawk.

"All RAF training aircraft are now painted black, but fast-jet aircraft retain their camouflage paint scheme," the report said. "Using these conspicuity measures reduces the calculated collision rate by about 49 percent."

The DERA study also found that the expected collision rate would be reduced about 66 percent if all fast-jet aircraft were equipped with a collision warning system (CWS) and all light aircraft were equipped with an operating transponder.

"The MOD has since decided to procure a CWS for the Tornado G4 fleet (an updated variant of the GR1)," the report said. "The implementation and introduction into service will be dependent upon the selected technical solution, but the current planned-in-service date is 2004."

The report said that the CWS might provide warnings of potential conflicts only between CWS-equipped aircraft; the system might not be able to detect GA aircraft equipped with a lightweight, battery-powered transponder that is being developed to enable GA aircraft to be detected by all RAF aircraft. Development of the transponder is being studied by the U.K. Civil Aviation Authority (CAA).

"A feasibility study has been completed with encouraging conclusions, but component-production difficulties for use in a production unit have resulted in further delays to the program," the report said.

The CAA also has studied the development of a system that could detect the strobe lights on military and civil aircraft.

"An operational evaluation was carried out and confirmed the technical viability and operational effectiveness of the system," the report said. "The prototype system was evaluated by the RAF with encouraging results. However, it has not yet been possible to manufacture commercially viable products."

The report said that the United Kingdom has 19 low-flying areas (LFAs), in which military fast jets fly below 2,000 feet AGL. Most low flying, however, is conducted between 250 feet and 500 feet AGL. Except for the Highland Restricted Area, in which terrain-following radar is used, all low flying in daylight is conducted in VMC.

"This means that crews must be able to fly by visual reference to the ground," the report said. "It also requires them to apply the 'see and avoid' principle in order to deconflict with other aircraft. When flying within the low-level system, military fast jets are normally limited to 450 knots, although speeds up to 550 knots can be authorized for specific purposes."

The report said that LFA airspace has "choke points" — areas in which aircraft operations are constrained because of factors such as nearby major urban areas and controlled airspace for public-transport operations.

"When flying within these constrained areas, military aircraft follow established unidirection flows when below 2,000 feet in order to reduce the risk of collision," the report said.

The established flow patterns are depicted on CAA chart ENR 6-5-2-1, "Areas of Intense Aerial Activity, Aerial Tactics Areas and Military Low Flying System."

"However, this 1:1,000,000 scale chart is published in one of four large manuals that constitute the U.K. *Aeronautical Information Publication* (*AIP*)," the report said. "It would be more practical and useful if this information was portrayed on those charts most widely used by GA pilots (1:500,000 and 1:250,000 topographical)."

After completing the investigations of the Aug. 29, 1991, collision of an RAF Sepecat Jaguar TA2 and a Cessna 152 at Carno, Wales,[2] and the collision at Kendal, the AAIB issued recommendations (92-08 and 94-02, respectively) for the depiction on civil aeronautical charts of military flow patterns in constricted areas of LFAs.

"Both the MOD and the CAA accepted the first AAIB recommendation relating to flow arrangements and choke points, but the CAA subsequently decided that portrayal of them on aeronautical charts was unnecessary [because the information

was available in the *AIP*]," the report said. "Since then, similar recommendations made by both the AAIB and the UKAB [U.K. Airprox Board] have been rejected for different reasons."

The UKAB, based on its investigation of a near-midair collision of an RAF Tornado and an unidentified Cessna aircraft, in 1998 recommended the use of arrow symbols to depict military flow patterns on civil aeronautical charts.

"The [UKAB said] that the introduction of flow arrows on those maps commonly used by civilian pilots flying at low level would make an important contribution towards safety," the report said. "The recommendation was rejected [by CAA] on the grounds that this information:

- "May cause obstruction and confliction between aeronautical and topographical symbols;
- "Could be potentially dangerous, as pilots operating in the vicinity of a published arrow may feel encouraged to concentrate in one direction only; [and,]
- "Inclusion of flow information and choke points would clutter rather than enhance charts."

Information on low-altitude military flight operations is included in U.K. Aeronautical Information Circular 82/1996 and in the U.K. CAA General Aviation Safety Sense Leaflet 18A, "Military Low Flying." The report said that these publications advise pilots conducting daytime visual flight rules operations in civil aircraft to fly above 2,000 feet if possible and to avoid flying between 250 feet and 1,000 feet.

Information on low-altitude military flight operations also is included in discussions of safety issues during "Safety Evenings" conducted by the CAA at flying clubs in the United Kingdom and during "Military/Civil Air Safety Days" conducted by the CAA and MOD at RAF bases.

Operational information on low-altitude flights by civil aircraft, based on CANP reports by civil aircraft operators, is provided to military flight crews by the Automated Low Flying and Flight Planning Enquiry and Notification System Operations Centre (ALFENS Ops), which coordinates low-altitude military flight operations. ALFENS Ops is based in the military section of the London Area Terminal Control Centre.

"[ALFENS Ops] operates a Freephone/Fax line for civilian operators to provide notification of their aerial activities at and below 1,000 feet AGL, with an expected duration in excess of 20 minutes at a specified location," the report said. "The intended activities are required to be notified to ALFENS Ops not less than four hours before commencement in order to allow for the timely dissemination of the information to all military users.

"Aircrew of military fixed-wing aircraft flying at an IAS greater than 140 knots will avoid areas reported under CANP either laterally or vertically," the report said.

CANP is designed to collect and disseminate information on civil aircraft flights of more than 20 minutes' duration in areas within a two-nautical-mile circle. The report said that because of the time and geographical specifications, few fixed-wing aircraft pilots file CANP reports. Fixed-wing aircraft pilots filed 61 of 1,515 total CANP reports in 1997 and 22 of 1,770 total reports in 1998.

"If the CANP procedure is to encompass fully fixed-wing GA aircraft, then the notification criteria will have to be revised, notwithstanding the adverse effect on the planning considerations for military fast jets caused by an increased number of notifications," the report said.

In both 1997 and 1998, U.K. pilots and air traffic controllers filed 28 "Airprox" reports of conflicts between military fast jets and civil aircraft at and below 2,000 feet.

"Airprox is the term used whenever a situation exists in which, in the opinion of a pilot or a controller, the distance between aircraft, as well as their relative positions and speed, [are] such that the safety of the aircraft involved [is] or may [be] compromised," the report said.

A UKAB analysis of Airprox reports in 1997 and 1998 concluded that eight events involved risk of collision and that in 15 events "safety was not assured." (Nine of the 1998 reports had not been analyzed by the UKAB when the accident report on the Jan. 21, 1999, collision was published.)

The report discussed the U.K. definition of *aerial work* and whether regulation of aerial-photography flights should be increased.

U.K. regulations permit private pilots to receive remuneration for flying aircraft under certain conditions, such as flight instruction, glider towing and parachute operations.

"Aerial-photography flights, on which a pilot does not receive direct remuneration for flying the aircraft but does accept a commission from the profits accrued from the sales that he has generated, would seem to fall within an ill-defined area of legislation," the report said.

Based on the investigation of the collision at Carno, the AAIB recommended that the CAA include commercial aerial photography in its definition of aerial work, so that such operations will be "properly and safely regulated."

The report said, "The CAA accepted this recommendation [AAIB Recommendation 92-09] and stated that 'the Joint Aviation Authorities have adopted the ICAO [International Civil Aviation Organization] definition of aerial work, which includes aerial photography. The Authority will fully support the future development of Joint Aviation Requirements–Operations 2 (JAR-OPS 2), which will provide for the safe regulation of the activities of operators engaged in aerial photography flights of a commercial nature.'

"JAR-OPS 2 will relate to GA operations. It is presently in the discussion phase, and no forecast date for the document's promulgation is available."

ICAO defines aerial work as "an aircraft operation in which an aircraft is used for specialized services such as agriculture, construction, photography, surveying, observation and patrol, search and rescue, advertisement, etc."

The report said that the AAIB received assistance from the CAA to determine whether the Cessna pilot involved in the Jan. 21, 1999, collision was conducting aerial work.

"The opinion of the legal branch of the CAA was that this was a private flight since no valuable consideration was given or promised for the purpose of the flight," the report said.

The report said, "Nevertheless, the manner in which single-pilot, aerial-photographic flights are conducted cannot be considered to be safe, irrespective of whether they are technically commercial or private flights."

The report discussed temporary danger areas (TDAs) and temporary restricted areas (TRAs).

About 45 minutes after the collision occurred, a TDA was established at the accident site and a notice to airmen (NOTAM) regarding the TDA was published.

"[A] TDA is established where it is considered essential for the safety of life or property, and particularly for the protection of those engaged in search and rescue [operations], by inhibiting unauthorized flight within or over the designated area," the report said.

About an hour after the TDA was established, a TRA was established at the accident site and a NOTAM regarding the TRA was published. The TDA and TRA extended from the surface to 5,000 feet in a five-nautical-mile (nine-kilometer) radius from the collision point. ATC clearance is required before flight operations can be conducted in a TRA.

Nevertheless, a helicopter was flown over the accident site without ATC clearance while search and rescue operations were being conducted. The helicopter pilot said that he was not aware of the TDA or TRA.

"With the growth in the number of media organizations competing for early information and photographs, it is likely that the commercial pressures upon pilots to violate TDAs in such a manner will increase," the report said. "This demonstrates both the difficulty in making available information about TDAs and TRAs within a short time scale, and the consequent potential risk to search and rescue operations."

Based on the investigation findings, the AAIB made the following recommendations:

- "The CAA should discuss with GA organizations such as the General Aviation Safety Council (GASCo), the British Helicopter Advisory Board (BHAB) and the Aircraft Owners and Pilots Association (AOPA) the provision of a code of conduct relating to aerial photography. They should also examine the benefits accruing from a trade association or similar body to look after the interests of this particular aerial activity. [Recommendation 99-31];
- "The CAA should revisit its action on AAIB Recommendation 92-09 with a view to introducing into national legislation an appropriate definition of aerial work, which should be aligned with both the ICAO definition and that likely to be promulgated in JAR-OPS 2 and [JAR-OPS] 4. This work should anticipate the formal adoption of JARs and be completed as soon as possible. [Recommendation 99-32];
- "The MOD should examine the content and sequencing of routine checks conducted while at low level so as to ensure that they do not compromise the safety of the crew or other aircraft. Future aircraft procurement programs for similar aircraft (fast jet) should emphasize the requirement for an optimum field of view for both crewmembers together with automated self-monitoring of the aircraft systems, with the crew only becoming involved in system management following a malfunction. [Recommendation 99-33];
- "The CAA should include within its safety-promotion program the following advice to GA operators who plan to use the low-level airspace:
  - "Maximum use of ATC flight information services;
  - "The permanent display of all available external lighting;
  - "The routine use of notification procedures;
  - "The routine use of the radar transponder, including height information;
  - "Avoidance of the typical height band used by military low-flying aircraft (250 to 1,000 feet); [and,]
  - "Avoidance of known concentrations of military low-flying activity. [Recommendation 99-34];
- "The CAA and the MOD should together investigate ways in which the concept of the Military/Civil Air Safety Day can be extended. [Recommendation 99-35];
- "The MOD should review its planned procurement programs for a collision warning system to ensure that a compatible system is developed. [Recommendation 99-36];
- "The CAA should review the status of its strobe detector program against the background of other technologies

that might assist pilots in preventing collisions in the air. [Recommendation 99-37];

- "The CAA and MOD should review the criteria under which GA operators may notify their intentions to ALFENS Ops using CANP. The aim should be to expand the scope of the procedure so as to encourage and facilitate wider use of the procedure by those GA operators both seeking and needing the protection afforded by the procedure within the capability of military fast jet operations to guarantee avoidance. [Recommendation 99-38];

- "The CAA should reconsider their responses to AAIB Recommendations 92-08 and 94-02 and arrange for suitable charts to show those concentrations of military low-flying aircraft that are brought about by the constrictions placed upon the UKLF [U.K. low-flying] system. The charts should depict flow arrows and choke points. Particular attention should be paid to a suitable scale and the ready availability of charts likely to be in widespread use by GA operators. [Recommendation 99-39]; [and,]

- "The CAA should consider how best to ensure the effective promulgation and enforcement of TDAs. [Recommendation 99-40]."♦

[This article, except where specifically noted, was based on U.K. Air Accidents Investigation Branch Aircraft Accident Report 4/2000, *Report on the accident involving Royal Air Force Tornado GR1, ZA 330, and Cessna 152, G-BPZX, at Mattersey, Nottinghamshire, on 21 January 1999*. The 70-page report contains diagrams, illustrations and appendixes.]

References and Notes

1. U.K. Air Accidents Investigation Branch (AAIB). Aircraft Accident Report 2/94, *Report on the accident involving Royal Air Force Tornado GR1, ZG 754, and Bell 206B JetRanger III, G-BHYW, at Farleton Knott near Kendal, Cumbria, on 23 June 1993*. The report said that the Tornado was on a routine low-level training flight and the JetRanger was on an aerial pipeline-inspection flight when they collided 380 feet above ground level (AGL). The Tornado was substantially damaged during the collision and was landed at an airport without further incident; the two crewmembers were not injured. The JetRanger pilot and passenger were killed when the helicopter struck the ground.

2. AAIB. Aircraft Accident Report 2/92, *Report on the accident involving Royal Air Force Jaguar T2A, XX843, and Cessna 152, G-BMHI, at Carno, Powys, Wales, on 29 August 1991*. The report said that the Jaguar was on a routine low-level training flight and the Cessna was on an aerial-photography flight when they collided between 300 feet and 400 feet AGL. Both crewmembers ejected from the Jaguar; the rear-seat pilot was seriously injured; the front-seat pilot was killed. The Cessna pilot was killed during the collision.

Accident Prevention

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