MILITARY AIRCRAFT ACCIDENT SUMMARY
AIRCRAFT ACCIDENT TO ROYAL AIR FORCE
TORNADO GR1 ZA329 & TORNADO GR1 ZA593

Date:	9 Aug 1988
Parent Airfield:	RAF Cottesmore RAF Marham
Crew:	2 x Two
Casualties:	Four Fatal

CIRCUMSTANCES

1. On the evening of 9 Aug 88, at 2024Z, two RAF Tornados collided near the village of Blencarn, 6 nms NNE of Appleby, Cumbria. The collision occurred between a singleton aircraft from RAF Cottesmore on a Terrain Following (TF) training sortie and one of a pair of aircraft from RAF Marham practising formation TF techniques. All 4 aircrew were killed in the accident.

2. The Cottesmore aircraft, ZA 329, took off at 1936Z with an RAF instructor pilot and a German Air Force (GAF) student navigator to fly a pre-planned Tornado Operational Conversion Unit (TOCU) route. The sortie was to comprise both day, visual low flying and night automatic TF.

3. After take off the sortie proceeded as planned; as the pilot flew down the western border of Spadeadam Electronic Warfare Training Range (EWTR), he decided that it was becoming too dark to continue visually. The crew completed the TF checks and, with the autopilot engaged, the aircraft descended towards the selected 500 ft Set Clearance Height (SCH) and started a left turn from a heading of 177 degrees towards the demanded track of 100 degrees, to negotiate the 'roundabout' at Warcop (a designated geographic point around which low flying aircraft, approaching from different directions at night, must turn in a specified direction). As the aircraft was turning through a heading of approximately 107 degrees, flying at 415 Knot Corrected Air Speed (KCAS) and 620 ft agl, it collided with the other Tornado, ZA 593.

4. ZA 593 had taken off from Marham as the No 2 of a pair at 1955Z. Once airborne the pair climbed to medium level en route to Harrogate where they descended to low level. With TF checks complete, the two aircraft proceeded along parallel tracks 2 nms apart with auto-TF engaged at 500 ft SCH.

5. After a right turn to track 352 degrees, the leader of the pair noted that, as expected, his No 2 was in his 1:30 - 2 o'clock. He could see, with some difficulty, the lights of the aircraft against the backdrop of hills. The 2 aircraft remained in this relative position until shortly after a planned radar fix on a large factory to the NNW of Appleby. At this point, to the leader's astonishment, a fireball appeared where the No 2 had been. He assumed that his No 2 had exploded in mid-air. In fact, while flying straight and level at 620 ft agl, the No 2 had collided with the Cottesmore aircraft.

6. The collision occurred when it was almost dark (the sun had set at 1959Z). To the west and north the sky had a red hue from the sunset but it was darker to the east and south. House lights and car headlamps were clearly discernible and the weather in the area was excellent. Both of the aircraft involved in the collision had been seen to take off with anti-collision and navigation lights serviceable.

CAUSE

7. From the data and voice tracks produced by the Accident Data Recorders (ADRs) of both aircraft and the available eyewitness accounts, it was possible to reconstruct the sequence of events leading up to the collision. It was deduced that both aircraft had been serviceable at the moment of impact. Accordingly, 3 questions were considered to explain why the two aircraft, on separate sorties and flying in a structured night low flying system, collided:

a. Why were the aircraft at the same height in the same place?

b. Why were the crews not aware of the other's presence?

c. Why did the crews not see one another?

8. Both aircraft were flying in auto-TF with a SCH of 500 ft selected. The geometry of the collision precluded either aircrafts' TF radar seeing the other until it was too late for the system to react. It was extremely unfortunate that the aircraft crossed paths at precisely the same height, considering the variations in flight path produced by the auto-TF systems just prior to the collision. The night low flying rules in force at the time of the collision allowed both aircraft to be where they were and to be on their respective headings.

9. There were 3 means, other than visually, by which the crews might have been alerted to the other's presence. Singly or together, a pull-up cue from the auto-TF, a Radar Warning Equipment (RWE) indication, or a radio call might have warned the crews of the conflicting tracks.

10 It is not uncommon for the TF radar to 'see' an aircraft within its beam and begin to pull-up, thus alerting the crew to another aircraft's presence. However, in this case, the collision geometry prevented the TF radars from 'seeing' the other aircraft until within the last second before impact, too late for the system to react.

11. Neither of the Marham aircraft detected TF radar emissions on their RWE; this is not surprising in view of the geometry and the narrow look-angle of the TF. The leader of the pair did not detect any emissions from a Tornado Ground Mapping Radar (GMR) but the ADR voice track suggests that the No 2 did. It is probable that, in trying to locate the source of the emissions, the No 2 pilot looked first towards his leader's aircraft. The collision occurred at this point.

12. None of the 3 aircraft called on the radio that they were approaching the 'roundabout' at Marcop. The rules required that a call be made on the low level frequency 1 minute before arrival at the 'roundabout'. The surviving crew considered that their formation was passing sufficiently far from the geographic position of the 'roundabout', with no intention of turning around it, that a call was unnecessary. The Cottesmore aircraft was more than 1 minute away from its closest approach to the 'roundabout' when the collision occurred. In the circumstances, it was understandable that neither crew called.

13. All 3 crews were involved in night auto-TF activities which, by their nature, require the pilot to closely monitor both the head-down instrumentation and the Head-Up Display (HUD) symbology. This reduces the pilot's time for lookout. The navigator's workload is also high during auto-TF and, in any case, it is almost impossible for him to see directly forward. Why did each aircraft, in turn, fail to see the potential collision in time to avoid it?

14. Geometry was against the Cottesmore aircraft. 35 seconds before the collision, the No 2 of the Marham formation might have been visible to the left, but would have been so distant (7-8 nms) as to make pick-up unlikely. As the aircraft entered its left-hand turn, the No 2 was potentially visible until 17 seconds before impact when the canopy sill would have obscured him from view. However, the No 2 was approaching against the backdrop of hills to the south-east and would have been difficult to see. The navigator would have been unable to see over the engine intake while in the turn. Thus the crew of the Cottesmore aircraft had little or no chance of seeing the other Tornados.

15. The No 2 of the formation was alerted to the presence of another Tornado by the RWE indications, while the navigator was head-in taking a fix. Unfortunately, the pilot was then distracted by the auto-TF system as it caused the aircraft to balloon over an obstacle. As the aircraft descended back down towards the SCH, he would have been concentrating on the performance of the TF system. In the last 25 seconds before the collision, because of the geometry of the aircraft tracks, there would have been little relative motion of the Cottesmore aircraft in the windscreen to attract his attention. During the critical last few seconds, the ADR tape indicates that the pilot was almost certainly looking in the direction of his leader in the 8 o'clock; the Cottesmore aircraft was probably then hidden at around the 10:30 position behind the canopy arch. Thus circumstances conspired to prevent the No 2 from seeing the approach of the other aircraft.

16. The Cottesmore aircraft, because of the geometry, was further from the Marham lead aircraft than it was from the No 2 and the lead pilot had no indications, either from the RWE or the radio, that another aircraft was nearby. Therefore it was understandable that the leader of the formation did not see the Cottesmore aircraft.

17. The accident was the result of an extraordinary series of coincidences any one of which, if removed from the chain, might have prevented its occurrence. The impossible became the possible and resulted in a catastrophic collision and the loss of 4 lives.

SUBSEQUENT ACTIONS

18. Immediately following the accident the interim report of the investigation recommended a review of the night low flying regulations to improve deconfliction,

even though it had not been established that the accident occurred as a result of any deficiency in the existing Low Flying System. A review of the system had been underway prior to the accident and work was immediately accelerated. Pending the outcome of this work some additional restrictions were imposed on the Low Flying System at night. Following completion of this review, a completely restructured system was introduced in October 1988 for a six month trial period. At the end of the trial the new procedures were examined and further refinements to the Night Low Flying System were implemented on 1 June 1989. In the longer term, it is intended to introduce a computerised system of track deconfliction which will increase the flexibility of the system substantially.

CLAIMS

19. The majority of Claims have been settled in respect of damage caused by this accident. The total so far is some £31,000.