

AVIATION OCCURRENCE REPORT

RISK OF COLLISION

BETWEEN

AIR ATLANTIC  
BRITISH AEROSPACE JETSTREAM 41 C-FTVQ  
AND  
DEPARTMENT OF NATIONAL DEFENCE  
LOCKHEED T-33 PIRATE 61  
FREDERICTON, NEW BRUNSWICK 16 NM SE  
17 APRIL 1997

REPORT NUMBER A97H0004

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

## Aviation Occurrence Report

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Department of National Defence

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### *Summary*

Air Atlantic Flight 427, a Jetstream 41, had departed Saint John, New Brunswick, and was approaching Fredericton from the south-east along the Saint John River. Pirate 61, a military T-33 jet aircraft engaged in a military training exercise, was established in a holding pattern along the Saint John river. A risk of collision occurred when the two aircraft passed within 100 feet of one another.

## *Other Factual Information*

The Jetstream, with a crew of three and sixteen passengers onboard, had departed Saint John, New Brunswick, on an instrument flight rules (IFR) flight plan at 1122 Atlantic daylight time (ADT). This was a regularly scheduled commercial flight to Fredericton. The aircraft had been cleared to the Fredericton airport via direct to the Frenn intersection then direct to Fredericton, at an altitude of 5,000' above sea level (asl).

Once airborne out of Saint John, the crew of the Jetstream requested clearance to proceed "visual, around the camp", which was approved by the Moncton Area Control Centre (ACC). Provided that the crew kept the river to the left side of the aircraft, this route would ensure that the aircraft remained clear of the Gagetown restricted area CYR 724 (refer to appendix A). While this route kept the Jetstream within the designed protected airspace of its direct route to the Frenn intersection (V310 airway), the aircraft was as much as 1.6 nautical miles left of the centreline of the airway. This was a digression from the IFR requirement that the flight adhere as closely as possible to the centreline of the cleared routing. This adhoc "visual, around the camp" procedure had been a common IFR practice for a number of years whenever visual meteorological conditions (VMC) prevailed between Saint John and Fredericton. Generally, the route started toward the Frenn intersection, but turned left before reaching it and followed the right side of the river to Fredericton.

At 11:30:03, the Moncton ACC controller, observing a possible conflict, advised the Jetstream crew of westbound VFR traffic at the aircraft's 11 o'clock position six miles at an unconfirmed altitude of 4,300 feet. The crew of the Jetstream noted traffic on their traffic collision avoidance system (TCAS) corresponding to that position; however, the traffic was not detected visually. At 11:30:32, the controller informed the flight that the same traffic, possibly a high performance jet, was now at its 12 o'clock position five miles and was turning to an opposite direction at an unconfirmed altitude of 4,100 feet. The crew again noted a return on their TCAS corresponding to this latest information, but the traffic was not seen, despite both pilots looking out for it. At 11:31:01, the controller advised the Jetstream crew that the target was now at their 12 o'clock for three miles at 4500 feet and climbing. At that time, radar data indicates that the Jetstream was at 4,961 feet and commenced a shallow descent. The captain finally visually detected a military T-33 aircraft when it suddenly appeared on an apparent collision course. The captain steepened the descent and commenced a shallow-banked turn to the right. Both crew members observed the belly of the T-33 crossing in front of them in a steep-banked, climbing attitude proceeding from the bottom left to the top right of the Jetstream's pilot windscreen. The T-33 was observed to totally fill the pilot's windscreen, and the crew estimated the distance to be approximately 50 feet.

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<sup>1</sup> All times are ADT (Coordinated Universal Time minus three hours) unless otherwise noted.

<sup>2</sup> TCAS is an independent system designed to support the air traffic control system and complement the "see-and-avoid" concept. TCAS continuously scans the airspace around an aircraft and seeks a response from the transponders of nearby aircraft. TCAS monitors flight paths based on the responses from the transponders. The system generates a traffic advisory (TA) or resolution advisory (RA) when any flight path is going to enter the collision zone around the aircraft. The TCAS on the occurrence aircraft was an early model which did not provide a resolution advisory.

Pirate 61, a military T-33 aircraft with one pilot onboard, had departed Canadian Forces Base (CFB) Greenwood, Nova Scotia, to participate in a military training exercise in CFB Gagetown's military restricted area CYR 724. The flight was being conducted in accordance with visual flight rules (VFR).

The purpose of the T-33's mission was to assist in the training of forward air controllers in directing air strikes against simulated ground enemy targets within CYR 724. This was but one of a number of such missions in an exercise named Nimrod Gale which was scheduled from 16 April to 2 May 1997. Throughout the exercise intense artillery, small arms fire, and jet fighter and helicopter activity was planned within CYR 724. In the interest of safety, aircraft awaiting specific taskings were required to remain clear of CYR 724 until authorized to enter the area by the forward air controllers. The presence of numerous weapons ranges on the western side of the Gagetown training area precluded any overflights coming from the west. Several geographical areas surrounding the restricted area had been designated as VFR holding points for these aircraft. These holding points, the majority being to the east and south of CYR 724, had been in use on such exercises over the previous 10 years. Depending on operational circumstances, aircraft could be required to loiter in the vicinity of these holding points for varying lengths of time.

One such holding point was Initial Point (IP) Delta, situated at the northern tip of Gagetown Island on the Saint John river. This IP is located within the specified boundaries of V310 airway and is approximately 2.4 nautical miles west of the airway's centre line. V310 is classified as Class E controlled airspace in which IFR and VFR flight operations are authorized. The lateral dimensions of the controlled airspace for this airway are 4 nautical miles each side of its centreline. This IP also lies within two miles of the direct route between the Saint John airport and Frenn intersection. It should also be noted that the Saint John River is a popular route for aircraft operating on VFR flight plans between Saint John and Fredericton.

The occurrence T-33 aircraft had arrived early at the southern boundary of the restricted area. The pilot was informed by the military forward air controller that his first run to the target would begin from IP Delta. The pilot flew to this IP, remaining clear of the range and following the river at 4500 feet asl. This altitude was chosen by the pilot because it satisfied the VFR direction of flight altitude requirement, and because of noise abatement, fuel conservation, and ease of navigation considerations. The pilot's intent was to enter a holding pattern over IP Delta while awaiting his instructions for his simulated bombing run. The T-33 arrived at its holding point at approximately 11:28 at which point the pilot entered a left-hand racetrack holding pattern. Radar data reveals that the aircraft's altitude fluctuated by plus or minus 200 feet while in the holding pattern.

The pilot of the T-33 first saw the Jetstream in a descent, overtaking and flying under him from the 7 o'clock position while the T-33 was in a left-hand orbit and passing through a north-westerly heading. This occurred as he was commencing his second racetrack pattern. The T-33 pilot estimated that when he saw the Jetstream that the two aircraft were between 300 and 500 feet apart.

At approximately 11:31:28, the two aircraft came close to colliding after approaching each other head on at a closure rate of approximately 400 knots. The distance between the two aircraft at their closest separation was estimated, based on the Jetstream pilots' observations and radar data, to be less than 100 feet.

The weather at the time of the occurrence was described by both crews as good with some haze in the area. The nearest aviation weather reporting station was at CFB Gagetown, 11 nautical miles to the west. At 11:41,

the weather observed at Gagetown was as follows: light winds, visibility 15 statute miles in light rain showers, scattered cloud at 5,100 feet, broken cloud at 8,000 feet, and an overcast layer at 25,000 feet.

Pilots operating IFR are required to provide their own separation visually from VFR aircraft when operating in visual weather conditions. Similarly, pilots of aircraft flying under VFR are required to provide their own separation from other aircraft. Both aircraft, therefore, were being flown using the see-and-avoid principle for collision avoidance. The effectiveness of this concept is dependant on the flight crew detecting aircraft on collision courses and taking appropriate and timely avoiding action. Breakdowns in the see-and-avoid principle are due almost entirely to the failure to see a threat aircraft. A pilot's ability to visually detect another aircraft is affected by many factors. Elements pertinent to this occurrence include physiological limitations of the human visual system, the pilot's awareness of the presence of another aircraft, and conspicuousness of the aircraft.

The human visual system has physical limitations which reduce effective visual performance. For example, people are particularly attuned to detecting movement but are less effective at detecting stationary objects. Unfortunately, because of the geometry of collision flight paths, an aircraft on a collision course will appear to be a stationary object in the pilot's visual field.

In a potential mid-air collision situation, aircraft size and speed will influence a pilot's ability to acquire a target visually. In general terms, assuming that a pilot is looking in the correct direction, the visual detection of a target is largely a function of its size. A pilot will only see an approaching aircraft when the size of the target becomes large enough to meet the minimum resolution capability of the eye. The target will grow slowly, becoming conspicuously large only in the final brief period before collision when effective evasive action may not be possible. In fact, according to a 1989 USA Department of Transport report on the study of the effectiveness of the see-and-avoid concept, at closing speeds of 400 knots and above, escape from collision in these encounters is primarily due to chance.

It is generally recognized that traffic advisories will improve a pilot's ability to visually acquire another aircraft.

Research conducted by the Lincoln Laboratory during traffic alert and collision avoidance system (TCAS) flight testing confirms that the advisory provides advance warning of a potential conflict and will tend to increase the time that the crew will devote to the visual search for the traffic. Moreover, the advisory will aid the pilot in concentrating the visual search in the proper direction. These studies showed that guidance as to where to look increased the acquisition probability for the pilots, and found that a pilot who had been alerted to the presence of another aircraft was eight times more likely to see the aircraft than was a pilot who had not been alerted. In this instance, the T-33 aircraft was equipped with only one, single-channel ultra high frequency (UHF) radio. The primary medium for aeronautical communications in Canada is very high frequency (VHF) and very few (if any) civilian aircraft are equipped with UHF radios. The T-33 aircraft is the only Canadian military aircraft in service today which is equipped only with a single UHF radio. The pilot

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<sup>3</sup> W. Graham, See and Avoid/Cockpit Visibility. U.S. Department of Transportation DOT/FAA/CT-TN/89/18

<sup>4</sup> J.W. Andrews, Modelling of Air-to-Air Visual Acquisition. The Lincoln Laboratory Journal, Volume 2, Number 3 (1989)p478

was monitoring his operational UHF frequency. Under these circumstances, the pilot could not be informed by ATS of other aircraft traffic in his area. Moreover, the T-33 was not equipped with a TCAS which could have alerted the pilot of an approaching aircraft.

The contrast between an aircraft and its background affects significantly an aircraft's detectability, target detectability being hampered when the target's outline and brightness interacts with a complex and similar background. This detectability problem, known as contour interaction, is reduced by rapid angular motion relative to the background; however, as previously mentioned, collision or near collisions will not involve rapid relative motion. At the time of the occurrence, most of the snow along the Saint John river had melted, and snow patches still covered parts of the typically greyish and drab early spring countryside. The T-33 aircraft involved in this occurrence was painted in various shades of grey in a low-contrast camouflage pattern. This pattern would have, by its very design, rendered the aircraft relatively indistinguishable from its background. Similarly, the blue and grey paint scheme of the Jetstream would have provided little contrast when viewed against the cloud cover.

## *Analysis*

The probability of a mid-air collision in a given airspace is predicated, in part, on the number of aircraft operating in that airspace. The area immediately east of the Gagetown restricted area CYR 724 possesses two characteristics which attracts IFR and VFR traffic. On the one hand, aircraft operating IFR between Saint John and Fredericton are obliged to fly along the V310 airway and, pilots operating VFR between these two points are naturally inclined to follow the Saint John river. Given this concentration of civilian aviation traffic along this corridor, the use of IP Delta as a holding point for the T-33 military aircraft exposed military aircraft holding in this corridor to an increased potential for a mid-air or near mid-air collision with the civilian traffic. The informal practice of IFR traffic using the river as a "visual, around the camp" route further increased the volume of traffic over and near IP Delta.

The crew of the Jetstream sighted the T-33 during the final seconds of their approach while the pilot of the T-33 aircraft sighted the Jetstream after the near collision event had occurred. This occurrence illustrates the limitations of the see-and-avoid concept in a number of ways.

The Jetstream crew were alerted to the military traffic by the ATS controller and by their TCAS equipment. They were actively looking for the military jet traffic, but, despite their highly motivated efforts to sight the traffic, the crew were unsuccessful in seeing the T-33 until the very final seconds.

When first advised of the T-33's presence, the Jetstream crew were overtaking the T-33 and were above and six miles behind it. The T-33 would have been below the horizon, and its low contrast paint scheme and relatively small size when viewed from this distance and against the surrounding terrain would have rendered the aircraft virtually impossible to detect. When advised that the T-33 was at five miles and had turned toward them, still below their altitude, the Jetstream crew's problem in detecting the T-33 was further compounded by a reduction in its profile which was now being viewed head-on and by the target now remaining more or less stationary in their field of view due to its collision trajectory. The closing speed of 400 knots limited significantly the time available for detection.

When advised that the T-33 was at 4500 feet and three miles climbing directly toward them (this information was also displayed on their TCAS), the crew unknowingly exacerbated the situation by commencing a shallow descent toward the target. This descent was not initiated consciously and was likely due to the crew focusing their attention toward locating the target, with a resulting lapse in the maintenance of altitude control.

The T-33 pilot, on the other hand, was contending with his own set of problems. The aircraft was equipped with only one UHF radio, and operational requirements dictated that the pilot monitor the forward air controller's frequency. The pilot, therefore, was unable to advise any ATC agency of his intentions nor was he able to be informed of the presence of the Jetstream. Moreover, the T-33 was not equipped with TCAS equipment which could have alerted the pilot of an aircraft approaching on a collision course. As a result, the pilot was required to scan his entire visual field rather than concentrate his scan in the direction of the approaching Jetstream.

When the T-33 initially entered the holding pattern, it was being overtaken directly from above and behind by the Jetstream, where it would not have been visible to the T-33 pilot. When the T-33 pilot entered his turn to the south-east, in a direction directly toward the Jetstream, the aircraft were approximately five miles apart. At that distance, the Jetstream would have presented a relatively small visual target, and its blue and grey colour scheme would have blended in with its background when viewed against the existing high cloud cover.

### *Findings*

1. The two aircraft came close to colliding after approaching each other at a closing speed of approximately 400 knots.
2. The crew of the Jetstream sighted the T-33 during the final seconds of their approach, while the pilot of the T-33 sighted the Jetstream after the near collision event had occurred.
3. The risk of collision occurred over a military visual holding point established within the confines of airway V310 and along a known VFR route.
4. The Jetstream crew was flying an informal "visual, around the camp" IFR procedure.
5. The T-33 was not equipped with onboard radio (VHF) or electronic equipment (TCAS) to alert the pilot to the presence of other aircraft.
6. The T-33's camouflage grey paint scheme blended in with the surrounding terrain.
7. The relatively small profiles of both aircraft when viewed head on made it difficult for the crews involved to visually detect either aircraft.
8. The high closure rate provided little time for the crews to detect the approaching aircraft.

### *Causes and Contributing Factors*

Neither flight crew saw the other aircraft in time to avoid the risk of collision. Contributing to the occurrence were the inherent limitations of the see-and-avoid concept which preclude the effective separation of aircraft with high closure rates and T-33's camouflage paint scheme combined with its relatively small profile, which rendered the aircraft virtually invisible against its geographical background.

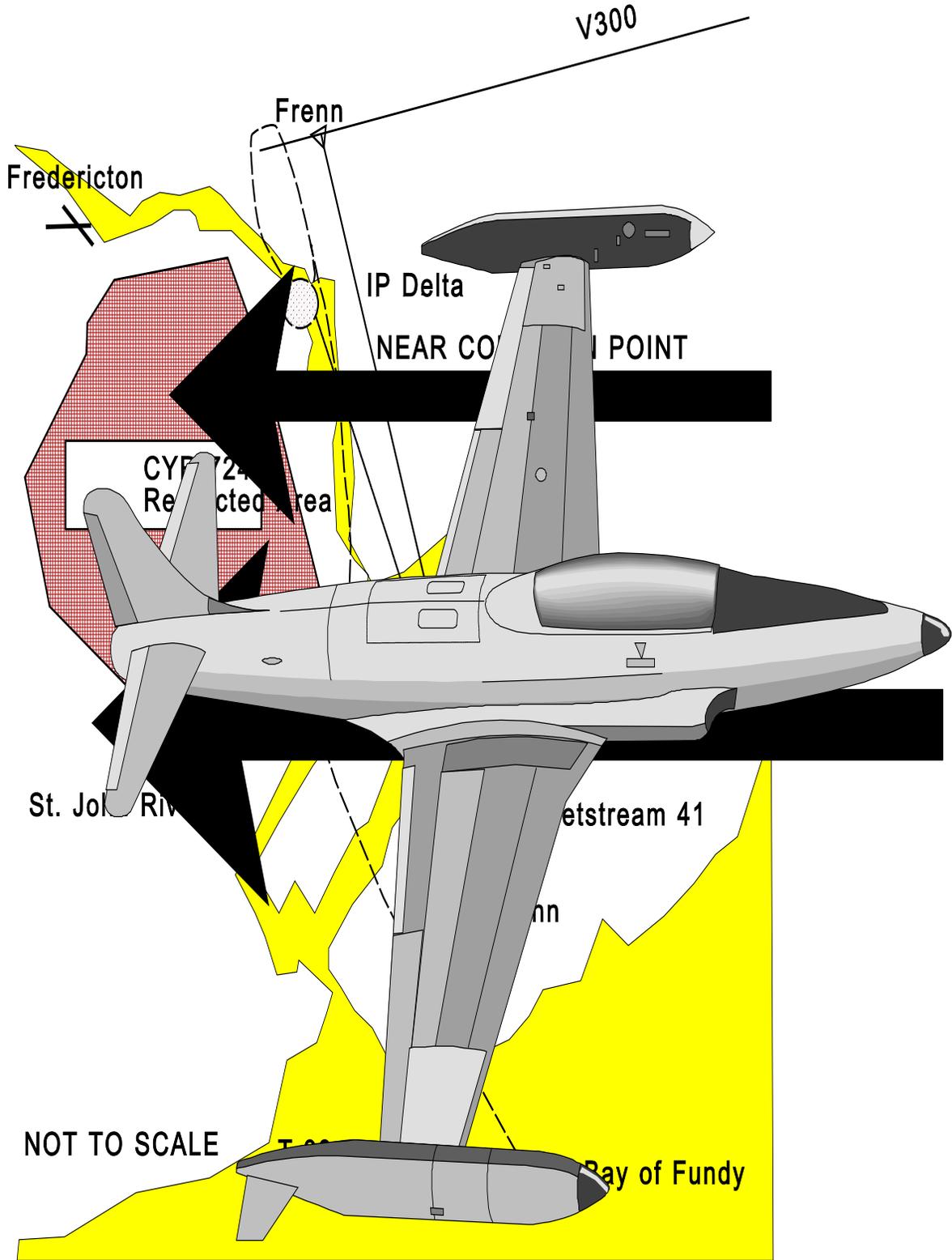
### *Safety Action*

Following this occurrence, DND personnel briefed all CFB Greenwood squadron pilots to exercise added vigilance when flying VFR. T-33 close air support pilots have been briefed to hold on the western side of the Saint John river when using IP Delta (as well as two other IPs in the immediate area) and to overfly the IPs themselves only when commencing their final run to the target. Exercise planners have been requested to remove five other IPs in the vicinity of the Saint John River from future exercises, and squadron pilots were briefed not to use these IPs in the future.

The T-33 aircraft fleet is presently undergoing an update, to be complete by the year 2000, which will provide for both UHF and VHF communications capability and the fitment of wing-tip strobe lights. When upgraded aircraft arrive on squadron, procedures will be initiated to ensure that ATC control frequencies are monitored on VHF while working missions in CYR 724 on UHF.

On 4 September 1997, NAV CANADA directed Moncton ACC to discontinue the use of the phraseology "visual around the camp is approved". Moreover, Moncton ACC were directed that, in the case of aircraft en route from Fredericton to Saint John requesting to proceed VFR, the aircraft may do so in accordance with VFR until a specified time, altitude or location (see MANOPS 444.2).

*This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson Benoît Bouchard, and members Maurice Harquail, Charles Simpson and W.A. Tadros, authorized the release of this report on 23 December 1997.*



*Appendix A*

