

# RESTRICTED – SERVICE INQUIRY

## PART 1.3 – NARRATIVE OF EVENTS

All times local.

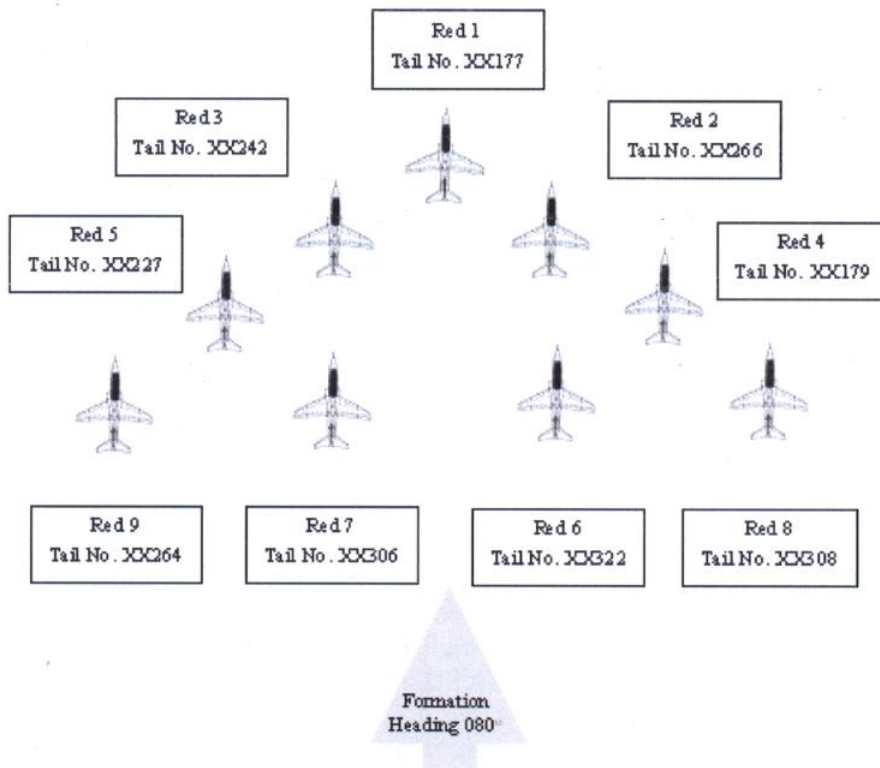
Glossary of abbreviations for all parts of this report is provided at the end of Part 1.3.

### BACKGROUND

1.3.1. **Overview.** On 20 Aug 11, following an uneventful display at the Bournemouth Air Festival and 2 local area flypasts, the Royal Air Force Aerobatic Team (RAFAT) recovered to Bournemouth International Airport (BIA). The team commenced a visual recovery at approximately 1345, positioning on the extended centre-line of runway 08 in ‘Big Vixen’ formation as shown at Figure 1. Visibility was in excess of 10km with a clearly defined horizon and a light wind from the Southeast. During the break to land (break), and after apexing at the targeted downwind height of 500ft, XX179 progressively overbanked with an accompanying downward steepening of the aircraft’s flight path. Noting that XX179 was descending, the pilot of XX266, who was now immediately behind XX179, transmitted 2 radio warnings of “4 check height”, which were heard by other members of the formation. Shortly after this, XX179 was observed to impact open fields south of the airport perimeter and broke up before coming to rest in the vicinity of the River Stour; there was no post-crash fire. No ejection was observed and the pilot of XX179 was located in the water close to the river bank and subsequently declared dead at the scene.

Exhibit 1  
Annex M  
Witness 2  
Exhibit 29

**Figure 1 – Big Vixen Formation**



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1.3.2. **Background to Events.** The RAFAT deployed to BIA on the afternoon of 17 Aug 11 to complete a tasking schedule, detailed at Table 1, which would culminate with the Bournemouth Air Festival on 19-21 Aug 11. This event was a regular fixture on the RAFAT calendar, and was assessed as one of the more relaxed tasking schedules for the team which also offered a rare opportunity for spouses/partners to join team members over the weekend. The RAFAT arrived at BIA at 1445 on 17 Aug 11 and completed an evening display at Weymouth at 1725, which was assessed as good with only minor debrief points. On the morning of 18 Aug 11, poor weather delayed the planned departure from Bournemouth and this was further delayed by a suspected loose article in one of the aircraft. By the time the item was located in XX306, and the weather cleared, a planned flypast at Bournemouth and a show at Dawlish had to be cancelled. The remainder of the day passed uneventfully with a flat display flown at Fowey, which generated minor debrief points. That evening the RAFAT pilots dined together to celebrate a team member’s birthday, leaving the restaurant by 2230 and returning to their hotel in Padstow.

Exhibit 28  
Exhibit 22  
Witness 1-1  
Witness 2  
Witness 5  
Witness 6  
Witness 8  
Witness 11

**Table 1 – RAFAT Tasked Schedule 17-21 Aug 11**

Serial (a)	Date (b)	Event (c)	Times (local) (d)
1	17 Aug	Display Cromer	1130-1155
2		Transit BIA	1410
3		Display Weymouth	1700-1725
4	18 Aug	Flypast Bournemouth (land Newquay)	1110
5		Display Dawlish & one flypast	1545-1610
6		Display Fowey	1830-1855
7	19 Aug	Transit BIA	1100
8		PR Event	1210
9		Display Bournemouth	1530-1555
10		PR Event	1800
11	20 Aug	Display Bournemouth & 2 flypasts	1300-1325
12	21 Aug	PR Event	1300-1430
13		Display Bournemouth	1615-1640
14		Flypast Belvoir Castle (land Scampton)	1910

Exhibit 28

1.3.3. **Previous 24 Hours.** On the morning of 19 Aug 11 the RAFAT pilots left their hotel at approx 0945 and took off from Newquay airport, on schedule, to transit back to Bournemouth. After arriving at BIA, the team attended a PR event at Bournemouth Pier, before flying the afternoon’s tasking, which was a full display with a flat Left/Right break flown during the recovery. After the post-flight debrief, the team attended a further PR event. This was scheduled to end at 1900, but overran by approximately 30 minutes; thereafter the team returned to their hotel. That evening the pilot of XX179 met his wife, who had travelled to Bournemouth for the weekend, and they had dinner together. After a good night’s sleep XX179’s pilot awoke at approx 0800 and completed a 5 mile run with his wife, prior to breakfast. Thereafter, he collected the team’s packed lunches from a local bakery before meeting for transport to BIA at approximately 1130. Upon arrival at the Cobham Aviation working accommodation, the pilot of XX179 made teas and coffees for others and distributed lunches, which the pilots ate while preparing for the afternoon show.

Exhibit 22  
Witness 1-1  
Witness 2  
Witness 5  
Witness 6  
Witness 8  
Witness 11



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1.3.4. **Sortie Brief, Authorisation and Supervision.** All aspects of the pre-flight preparation were in accordance with routine RAFAT operations. The sortie was expected to be a rolling display, due to weather, with 2 flypasts at the end. Due to the forecast weather, the team planned to recover with sufficient fuel for instrument recoveries at their nominated diversion which resulted in some doubt over the ability to complete the flypast tasking. It was briefed that if any aircraft, post display, was below the minimum planned fuel for the flypasts then the team would recover to BIA as a formation of nine and that the secondary tasking would be cancelled. Post brief, a 'Formal Start' was cancelled, due to time constraints, and although Wg Cdr RAFAT had planned to fly with Red 5, his flying kit was not at the aircraft so he elected to cancel his participation rather than unnecessarily delay the team. The remainder of the start up, taxi and take off (SUTTO) progressed with nothing significant to report.

Exhibit 22  
Witness 1-1  
Witness 2  
Witness 5  
Witness 6  
Witness 8  
Witness 8  
Witness 11

### SORTIE PRE-ACCIDENT EVENTS

1.3.5. **Display and Flypasts.** Once airborne it became apparent that the cloud base over the display area was higher than forecasted so the team flew their full display. The display was regarded as being very good and this plaudit was transmitted to the team by Red 10, who had provided crowd commentary. Post-display, the team rejoined as a formation of 9 aircraft and, having confirmed they had sufficient fuel, conducted the 2 flypasts as planned. Upon completion of the flypasts, the team held southwest of BIA to allow a runway change and the recovery of a civilian charter flight. Throughout the display, the flypasts and the hold, the pilot of XX179 flew his aircraft accurately, he did not report any aircraft faults, he made all radio calls expected of him, and participated in some light hearted "banter" prior to recovery.

Exhibit 1  
Witness 1  
Witness 8

1.3.6. **Recovery.** At approx 1345, after receiving clearance from Air Traffic Control (ATC), the team commenced a visual recovery and positioned on the extended centre-line of runway 08 in 'Big Vixen' formation. Red 1 indicated that the break to land would be either a looping break or a flat Left/Right break with the former being defined by a loop over the airfield prior to initiating the break and the latter being initiated from a straight and level run-in. To maintain sufficient energy for a looping manoeuvre, Red 1 aimed to recover at a speed of 360Knots Indicated Air Speed (KIAS). Approximately 2 minutes prior to recovery, BIA ATC instructed the RAFAT that the Battle of Britain Memorial Flight (BBMF) had taxied and had a latest take off time to avoid overheating on the ground. Approximately one minute prior to recovery, Red 1 elected to fly a flat Left/Right break as this would save time and allow the BBMF to get airborne sooner.

Exhibit 1  
Exhibit 30  
Witness 1

1.3.7. **The Break.** The break is used to expedite the joining procedure for high-performance aircraft when the run-in to the airfield is to be made at a higher speed than the circuit speed. The aircraft is flown in the direction of landing over, or slightly offset to, the runway in use prior to initiating a turn through 180°, which allows the aircraft to be positioned at the correct offset distance and to decelerate the aircraft to the correct circuit speed, using airbrakes, or other high drag devices, as necessary. The standard flat Left/Right break comprised a run-in, at not below 100ft above ground level (AGL), followed by a climbing break, outwards in pairs to 500ft, in the order Red 8 and 9, 4 and 5, 2 and 3, 6 and 7, and then 1.

Exhibit 10  
Exhibit 11



**ACCIDENT SEQUENCE**

1.3.8. **Break.** Red 1 instructed the team to commence the break, whereupon Reds 8 and 9 rolled and pitched outwards. The pilot of XX179 then verbally initiated the break for himself and Red 5; this was the last transmission made by him. XX179 rolled to approximately 75° of right bank, an acceleration of 6.3G was applied, the throttle was selected to idle and the airbrake extended. The subsequent execution of the break appeared normal until half way around the turn when XX179 slowly, but progressively, overbanked with an accompanying increase in the nose down attitude. Several civilian eye witnesses, who were in the area of the River Stour and the village of Throop, became aware of an extremely low flying “Red Arrow” aircraft in a right wing low attitude with the nose pointing down. Within the formation, the pilot of XX266, Red 2, who was completing his downwind turn, now noted that XX179 was descending and immediately transmitted 2 radio warnings of “4 check height”. Although Red 2 did not observe any change to the attitude of XX179, the aircraft’s ADR indicated that XX179 commenced rolling to the left and pitching nose up. Witnesses who saw the aircraft immediately prior to impact reported an aircraft with wings level in a flat attitude.

Exhibit 1  
Annex M  
Annex G  
Witness 2  
Witness 6  
Witnesses 24-29

1.3.9. **Crash Site Ground Orientation and Accident Data.** The accident occurred to the north of Bournemouth, on private land, in the vicinity of Throop as shown at Figure 2. Ground marks and aircraft debris ran in a westerly direction for approximately 500m to the western bank of the River Stour. At the widest point, aircraft debris was scattered to a width of 120m. The overall debris footprint covered an area of approximately 46 000 m<sup>2</sup>.

Annex L  
Exhibit 2

**Figure 2 - Aerial Photograph of XX179 Crash Site Viewed from Northeast**



1.3.10. **Ground Impact Sequence and Observations.** The crash sequence consisted of 6 phases as follows: wing tip ground contact; fuselage impact; detachment of the wing; the ground slide of the fuselage across the

Annex L  
Annex H



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field; impact with tree line; and the transition of the fuselage across the River Stour.

- a. **Wing Tip Ground Contact.** The initial wing tip ground contact can be seen at Figure 2. XX179 struck 2 barbed wire fences on either side of the track and debris from the right wing was found in the immediate vicinity of the track. The aircraft struck a wooden fence post which punctured a hole in the right lower forward section of the air intake, leaving a broken portion of the post protruding from the airframe. XX179's roll angle, as it crossed the track, was calculated<sup>1</sup> to be 18° right wing low with the aircraft continuing to roll out of bank. Witness marks on the airbrake confirmed that the airbrake was extended as the aircraft struck the first barbed wire fence.
- b. **Fuselage Impact.** Rolling out of bank, the fuselage impact occurred in a 'wings level' attitude. This left a prominent 'V' shaped discolouration caused by the breakup of the diesel smoke pod. High collision forces shattered XX179's canopy.
- c. **Detachment of the Wing.** The first substantial ground scar occurred when the remaining leading edge of the right wing dug into the ground following the fuselage impact. This resulted in the detachment of the wing section from the fuselage. Once detached the wing section tumbled a further 200m where it came to rest, upside down, to the south of the main fuselage track. The detachment forces altered the fuselage's direction of travel, as shown on Figure 2.
- d. **Ground Slide of the Fuselage Across the Field.** The detachment of the wing levered the fuselage up into the air for approximately 50m after which it returned to the ground in a nose down attitude. XX179's pitot probe was found stuck in the ground in a bent 'curved nose' shape at the start of the fuselage ground slide phase. During this phase, the fuselage bounced along the ground in a linear trajectory, stabilised by the rear empennage. Metallic debris and fragments of canopy transparency were found scattered along the linear track. The ground marks featured the prominent lower rear fuselage strake marks which cut tracks through the ground.
- e. **Impact with Tree Line.** The fuselage struck an area of trees on the eastern side of the River Stour. The collision resulted in the destruction of the front fuselage and cockpit structure. The sequence of collisions with the trees caused the aircraft to spin in the lateral plane and subsequent collisions caused damage to the rear of the fuselage. Substantial aircraft wreckage was found on the eastern bank and in the River Stour. The force of the collision was sufficient to rip the front and rear ejection seats out of the cockpit.

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<sup>1</sup> Calculated by on-site engineering forensic evidence using aircraft geometry from the wing tip contact marks, fence post collision and barbed wire witness marks on the airbrake.

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- f. **Transition of the Fuselage Across the River Stour.** Post tree impact, XX179 had sufficient momentum for the remainder of the fuselage to travel across the river. It came to rest, upside down, on the western bank.

### ESCAPE SYSTEMS

- 1.3.11. **Escape Systems.** No ejection had been observed and the front cockpit seat pan firing handle was found still in its stowage. Although the canopy had suffered major damage, the Miniature Detonating Cord (MDC) had not fired. Witness 2  
Witness 6  
Annex L

### AIRCREW EQUIPMENT ASSEMBLIES (AEA)

- 1.3.12. **Aircrew Equipment Assemblies.** The pilot of XX179 had been wearing a Mk 10c helmet and issued flying clothing which included anti-G trousers, leg restraint garters and a Mk40 LSJ life preserver. The pilot's personal survival pack and emergency escape parachute assembly were recovered from the accident scene. Annex A

### DEGREE OF INJURY

- 1.3.13. The following injuries resulted from the accident:
- a. **Pilot.** The pilot died of severe multiple injuries. The injuries suggest that the pilot was exposed to a peak deceleration during the crash sequence in excess of 200g, and the crash forces were non-survivable. Death would have been instantaneous. Annex B
- b. **Civilian Personnel.** There were no injuries to civilians.

### DAMAGE TO AIRCRAFT, PUBLIC AND CIVILIAN PROPERTY

- 1.3.14. Damage to aircraft, public and civilian property was assessed as follows:
- a. **Aircraft.** The damage to XX179 has yet to be formally classified; however, the Panel provisionally assessed it to be Cat 5 (Scrap). Exhibit 111
- b. **Aircraft Costs.** The net book value for XX179 was £374,812.79. Exhibit 79
- c. **Civilian Damages.** The accident site has been returned to its former state with no residual environmental issues. The remuneration cost of the crash site totaled £45 700. Exhibit 80  
Annex E

### LOSS OF, OR DAMAGE TO, CLASSIFIED MATERIAL

- 1.3.15. There was no loss of classified material from the crash site.



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### AIRCRAFT RECOVERY

1.3.16. A comprehensive search of the crash site was conducted by the Military Air Accident Investigation Branch (MilAAIB) and the Joint Aircraft Recovery and Transportation Squadron (JARTS) with the assistance of specialist Police teams. Following a site inspection by the SI Panel, XX179 was removed by JARTS under the control of the MilAAIB. The wreckage was recovered to MOD Boscombe Down by 1200 on 25 Aug 11 and the site was deemed clear.

Annex L

### SITE HANDOVER

1.3.17. The accident site was cleared and signed over to the Defence Infrastructure Organisation (DIO) on 25 Aug 11.

Annex L

### GLOSSARY

Acronym/ Abbreviation	Explanation
22 (Trg) Gp	22 (Training) Group
AAIB	Air Accident Investigation Branch
AAES	Aircraft Assisted Escape System
ACL	Air Combat Leader
ADR	Air Data Recorder
AEA	Aircrew Equipment Assemblies
AGL	Above Ground Level
AGSM	Anti-G Straining Manoeuvre
AGV	Anti-G Valve
AHRS	Attitude and Heading Reference System
ALARP	As Low As Reasonably Practicable
A-LOC	Almost Loss of Consciousness
AOA	Aircraft operating Authority
AOC	Air Officer Commanding
AoR	Area of Responsibility
ASIMS	Air Safety Information Management System
ASMP	Air Safety Management Plan
ASMS	Air Safety Management System
ATC	Air Traffic Control
Attention Getter	Flashing warning light to attract the attention of the pilot
Banter	Light hearted humour
BBMF	Battle of Britain Memorial Flight
B/F Servicing	Before Flight Servicing
BIA	Bournemouth International Airport
Break	Break to land manoeuvre
CA	Congested Area
CAM	Continuing Airworthiness Manager
CAR	Corrective Action Requirement
Cat	Category
CFS	Central Flying School
Circus Engineers	RAFAT engineers who fly as back seat passengers to provide engineering support at detachment locations
Comdt	Commandant
Crew in	Process of pilot arriving at aircraft including the in cockpit pre-start checks
CWP	Central Warning Panel
CWS	Central Warning System
daN	Deca Newton (unit of force)
DAU	Data Acquisition Unit

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DD	Display Directive
DDH	Delivery Duty Holder
DIO	Defence Infrastructure Organisation
DLod	Defence Lines of Development
DOF	Degrees of Freedom
Down day	A stand down day from duties (a day off from work).
EA	Environmental Agency
EMS	Engineering Management System
F700	The engineering record for a specific aircraft tail number.
FCAGT	Full Coverage Anti-G Trousers
Flat Display	The RAFAT Flat Display is a modified display which may be flown if the cloud base is 1000ft provided the visibility is at least 3km. A modified Flat Display can be flown in a 700ft cloud base
FLO	Family Liaison Officer
Flt Lt	Flight Lieutenant
Formal Start	A synchronised start sequence sometimes used at more formal occasions.
Full Display	The RAFAT Full Display can only be flown if the cloud base is at least 5500ft AGL and the visibility is at least 5.5km
G-LOC	G induced Loss Of Consciousness
Gp	Group
GPS	Global Positioning System
Gz	The magnitude of acceleration being applied to the human body is usually referred to in units of "G" which is a ratio of acceleration against earth's gravity. In physiological terms Gz is the acceleration measured through the spine. An acceleration which pushes the spine downwards is referred to as +Gz
HF	Human Factors
Hot	Flying at a faster than planned
HP	High Pressure
Hrs	Hours
IAM	Institute of Aviation Medicine (now named RAF CAM)
JARTS	Joint Aircraft Recovery and Transportation Squadron
JEngO	Junior Engineering Officer
JSP	Joint Service Publication
KIAS	Knots Indicated Air Speed
Km	Kilometres
LP	Low Pressure
LSJ	Life Saving Jacket
MAA	Military Aviation Authority
Major Servicing	Servicing task completed every 2400 flying hours on the Hawk T Mk1
MAOS	Maintenance Approved Organization Scheme
MAP	Maintenance and Airworthiness Processes
Minor Star Servicing	Servicing task completed every 1200 flying hours on the Hawk T Mk1
MDC	Miniature Detonating Cord
MiAAIB	Military Air Accident Investigation Branch
Mk	Mark
MOU	Memorandum of Understanding
MPCM	Manual of Post Crash Management
MRP	Military Aviation Authority Regulatory Publications
MSD	Minimum Separation Distance
MOD	Ministry of Defence
NB	Not Below
OC	Officer Commanding
Octas	The unit of measurement for cloud cover. 1 Octa of ccloud would equate to an eighth of the sky being obscured. 8 Octas refers to a sky that has total cloud coverage.



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OCU	Operational Conversion Unit
ODH	Operational Duty Holder
PCM	Post Crash Management
PDA	Public Display Authority
PEC	Personal Equipment Connector
PFCU	Powered Flight Control Unit
POL	Petrol, Oil, Lubricants
PR	Public Relations
PT	Project Team
QFI	Qualified Flying Instructor
QTI	Qualified Tactics Instructor
OCU	Operational Conversion Unit
RA	Regulatory Article
RAF	Royal Air Force
RAFAT	Royal Air Force Aerobatic Team
RAF CAM	Royal Air Force Centre of Aviation Medicine
Rolling Display	The RAFAT Rolling Display is a modified display which may be flown if the cloud base is 2500ft provided the visibility is at least 5.5km
RR	Risk Register
RtL	Risk to Life
RTS	Release to Service
SEngO	Senior Engineering Officer
SEP	Safety and Environmental Panel
SI	Service Inquiry
SME	Subject Matter Expert
SNOW	Serial Number Of Work
SOP	Standard Operating Procedure
SQEP	Suitably Qualified and Experienced Person
Sqn Ldr	Squadron Leader
STANAG	Standardization Agreement
SUAS	Southampton University Air Squadron
SUTTO	Start Up Taxi and Take Off
TOLERABLE	<p>The zone between UNACCEPTABLE and BROADLY ACCEPTABLE risks is the TOLERABLE region. Risks in this region typically arise from activities that Aviation Duty Holders are prepared to tolerate in order to secure benefits, in the expectation that:</p> <ul style="list-style-type: none"> <li>- The nature and level of the risks are properly assessed and the results used properly to determine control measures. The assessment of the risks needs to be based on the best available evidence and, where evidence is lacking, on the best available advice.</li> <li>- The residual risks are not unduly high, in accordance with extant MAA guidance, and ALARP.</li> <li>- The risks are periodically reviewed to ensure that they still meet the ALARP criteria..</li> </ul>
TGOs	22 (Training) Group Orders
USAF	United States Air Force
Wings level	When the aircraft lateral axis is level with respect to the horizon
Wg Cdr	Wing Commander
WHAM	What's Happening Manager (RAFAT internal document detailing schedule for the team)



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